Precast Concrete BIM Standard Documents

NOTE: THE MAPPINGS TO IFC HAVE BEEN UPDATED, AS OF MID 2011, TO 2X3. THE CURRENT IFC BINDINGS ARE ACCESSIBLE ON THE IFC SOLUTIONS FACTORY WEBSITE: http://www.blis-project.org/IAI-MVD/

Volume II
IFC Binding Documents for Precast Concrete Specific Concepts

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Executive Overview

This is an intermediate release of the Model View Definitions for data exchanges of precast concrete information. It outlines the MVDs in three volumes:

- **Volume 1:** Overview, with specification of Exchange Models for use various use cases and the High Level Concepts making up the Exchange Models. These define what information is to be included in the exchanges and to what level of detail. They are presented in Model View Definition (MVD) diagrams.

- **Volume 2 (this volume)** contains the detailed binding definitions for all of the exchange concepts that are used in the diagrams of volume 1. These are IFC 2x4 bindings, and graphic depictions of the IFC entities and property sets used with their relationships, implementation rules, figures showing typical situations in precast buildings, and Part 21 file examples using EXPRESS. All of these are also available on the "IFC Solutions Factory" IAI MVD website, at http://blis-project.org/IAI-MVD/.

- **Volume 3** contains the detailed binding definitions for all of the exchange concepts that have been defined by other groups developing MVDs and that are re-used in the MVDs of volume 1. All of these are also available on the "IFC Solutions Factory" IAI MVD website, at http://blis-project.org/IAI-MVD/.

- Volume 4 defines the specific model views that are developed for implementation, testing and certification. It also describes the test public demonstrations used for preliminary implementation.

The MVD is based on the functional specification called an Information Delivery Manual (IDM), completed in January, 2009, under this contract. This Model View Definition (MVD) specifies at the implementation level the information needed to support the workflows defined in the IDM, covering the major digital exchanges dealing with precast concrete . The exchanges are defined to be implemented using the Industry Foundation Classes (IFC) model schema. The IFC bindings will support a set of standard export and import exchange capabilities for commercial software products, enabling seamless exchange of digital information and enhancing work processes.

A particular exchange will depend on varied subsets of the overall model data. Thus these subsets or modules will be used selectively in multiple different contexts. We adopt the idea of information 'Concepts' to represent the information items in a way that allows them to be composed for different workflow cases. Implementers can re-use the software modules and testing and certification of modules may also possible. The notion of Concepts has grown from previous implementation activities, led by the BLIS effort in the early 2000s.

The Concepts are drawn directly from the Information Delivery Manual (IDM) that was prepared by the Precast Concrete BIM Project team, including the PCI Advisory Board and the Technical Support Team. The Concepts include such varied issues as the degree of detail needed, connectivity, aggregation and nesting relationships, type of geometry representation, and others used in different workflows. Our Concepts were also drawn from a library of Concepts that have been proposed or defined by other BIM standard efforts in the IFC Solutions factory website: (http://www.blis-project.org/IAI-MVD/). These Concepts are available for possible re-use and

some of them may have already been implemented by BIM software companies. The Concepts for any domain such as precast form a hierarchical lattice, from high-level aggregated Concepts to leaf ones, the leaves providing bindings to IFC (e.g., the associated IFC implementation code). The bindings are based on the 2.x3, currently the production version available on the buildingSMART website: http://www.buildingsmart-tech.org/specifications/ifc-releases/ifc2x3-tc1-release/summary.

The current diagrams start with the IDM requirements from which they were derived. These are followed by the Concept structures need to support those functions. These are then associated with the leaf bindings to IFC, using a diagramming method that is widely used within the IFC community. In many cases, certain information about a precast piece needs to have different representation and these alternatives are included in the Concept bindings.

This initial draft addresses all Concepts developed to the Precast BIM Standard. It was reviewed and tested to gain feedback from both precast concrete information users and from software implementers regarding definitional issues and adequacy of documentation. The current bindings reflect the technical team's judgment regarding best implementation of the IDM requirements. These will be reconciled, as needed, with software implementation capabilities and limitations.

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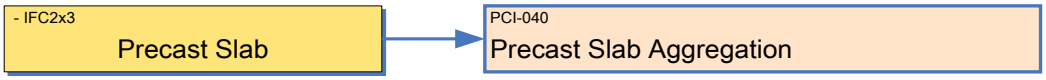
IFC Release Specific Concept Description (Release 2x3)

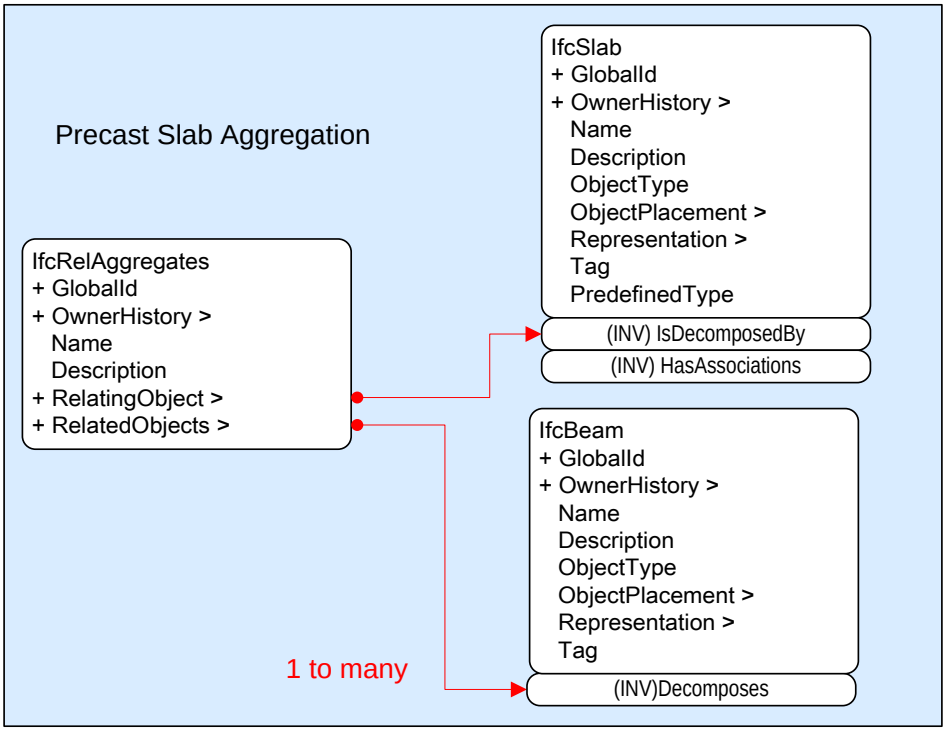
Precast Slab Aggregation

Reference	PCI-040	**Version**	1.1	**Status**	Draft
Relationships	Slab is considered here an aggregation of multiple parts. These may be doubletees, hollowcore or precast slabs.				
History	Created April 17, 2009, updates Nov.16, 2012				
Authors	Eastman, Charles				
Document Owner	Precast/Prestress_Concrete_Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

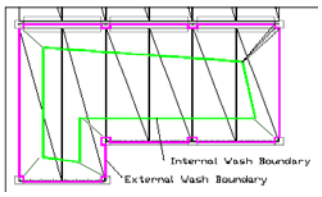
IfcSlab

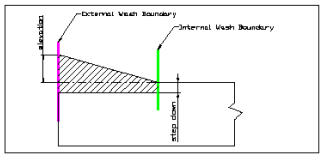
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>

Description	<Open>
ObjectType	Must be IfcSlab
ObjectPlacement	May be absolute, relative or relative to grid.
Representation	Must have its own brep geometry.
Tag	<Open>

IfcRelAggregates

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	refers to a slab entity with geometry, material, possibly embeds that are within the slab itself, but not in its other components. Embes in DT or other compoents are not to be part of slab except through inheritance.
RelatedObjects	references each of the component beams in this slab. Slabs component pieces are assumed to be mutually spatially disjoint, without overlaps. They may overlap the slab





Slabs are a composition of individual precast pieces, such as hollow core, doubletees or solid slabs. The cut shapes of these components fit inside of the slab shape. The shape of a slab is defined as a general purpose shape, boundary representation because its top may not be planar because of toppings. Carry should be made to ensure that the slab shape and its components, when unioned together, has no spaces between. Thus specific recommendations of shape are defined for each type of embedded beam

Example: Part21 file for IcfBeam type assignments
#341=

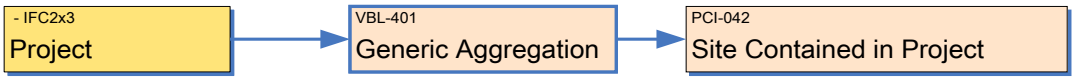
```
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#99,#337,'TS_4201');
#360=
IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDE
FINED.);
#423=
IFCBEAM('1A0gmi0000yZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#410,#419,'TS_2628');
#462=
IFCBEAM('1A0gmi0000xZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#449,#458,'TS_2624');
#501=
IFCBEAM('1A0gmi0000wZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#488,#497,'TS_2620');
#540=
IFCBEAM('1A0gmi0000vZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#527,#536,'TS_2616');
#579=
IFCBEAM('1A0gmi0000uZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#566,#575,'TS_2612');
#1454=
IFCBEAM('1A0gmi0000A34oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#1441,#1450,'TS_2122');
#1493=
IFCBEAM('1A0gmi0000934oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#1480,#1489,'TS_2118');
#1532=
IFCBEAM('1A0gmi0000834oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#1519,#1528,'TS_2114');
#1571=
IFCBEAM('1A0gmi0000734oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#1558,#1567,'TS_2108');
#3406=
#3500=
IFCRELAGGREGATES('3QM6ooNoz02vFwZd5JedV9',#20,$,$,#2069,(#1571,#1532,#1493,#1454,#579,#540,#501,#462,#42
3,#341));
```

PCI NBIMS Examples - 1.ifc

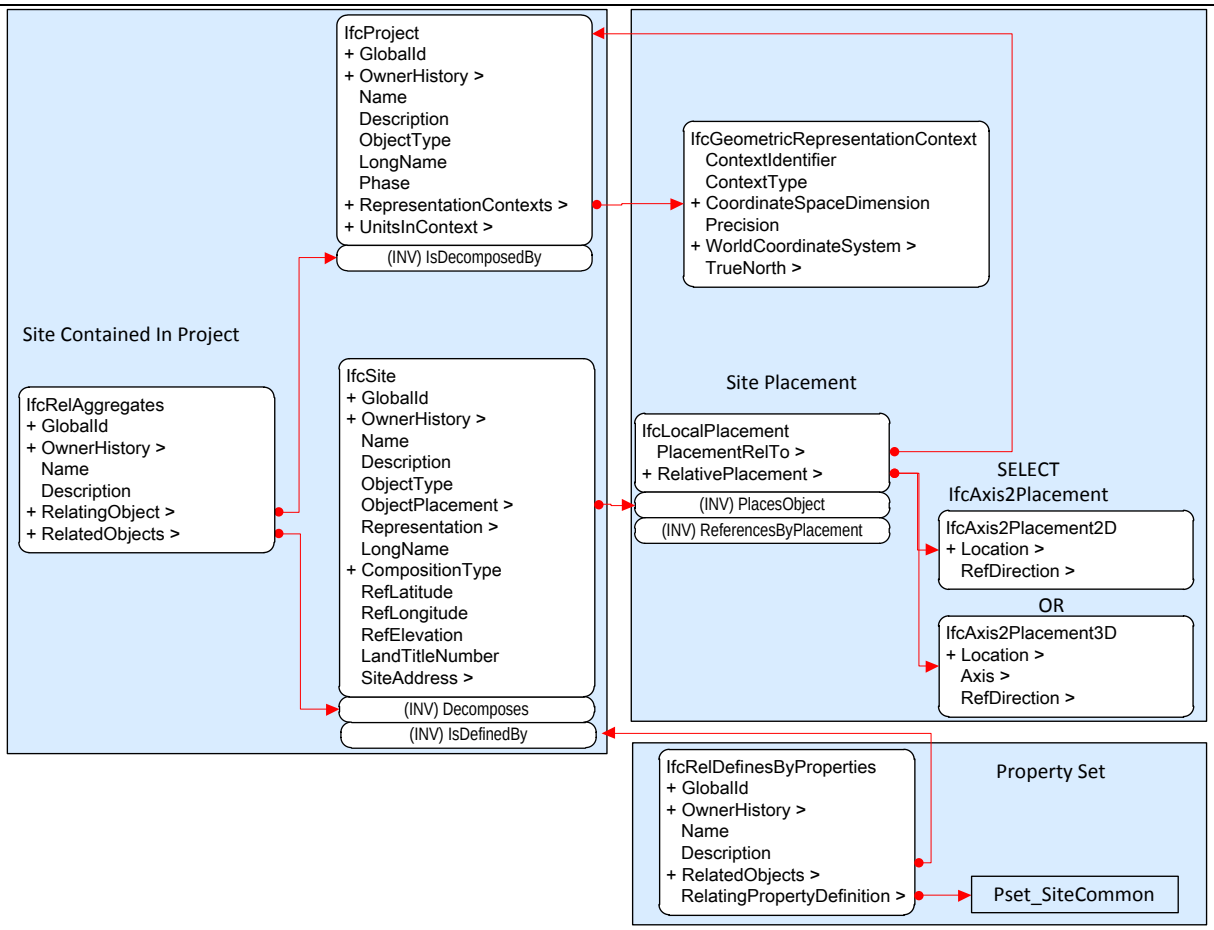
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)

IFC Release Specific Concept Description (IFC 2x3**)** Site Contained in Project					
Reference	PCI-042	**Version**	1.1	**Status**	Draft
Relationships	Spatial Hierarchy				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

The Spatial Configuration Hierarchy consists of one instance for each element instance in the hierarchy: one project (always), one for each Site in the project, one or more Buildings for each Site; there will be optionally one or more BuildingStorey for each Building. (Spaces are defined as another level in the Spatial Containment Hierarchy.)

1. Each Spatial Configuration Hierarchy entity is to reference the next higher level in the hierarchy that are part of, as a logical relationship. These should be assigned as encountered.

The qualification of COMPLEX or PARTIAL Spatial Containment Entities should be ignored at this time.

2. LocalPlacement reference is made to the next higher level in the hierarchy – Project- consistent with the logical placement.

IfcSite

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	The *Name* attribute has to be provided for the project. It is the short name for the project.

Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional. Should be a subtype of IfcObjectPlacement
Representation	Optional. Should be a subtype of IfcProductRepresentation.
LongName	Optional.
CompositionType	Should be an enumeration of type IfcElementCompositionEnum
RefLatitutde	Optional. Should use IfcCompoundPlaneAngleMeasure entity
RefLongitude	Optional. Should use IfcCompoundPlaneAngleMeasure entity
RefElevation	Optional
LandTitleNumber	Optional
SiteAddress	Optional. Address given to the site for postal purposes. Should use IfcPostalAddress entity.

A Site plays an important role in terms of spatial coordinate coordination. The IfcLocalPlacement.PlacementRelTo relation can take 2 types of value:

1. Reference the Project coordinate system defining a Project base coordinate system relative to the context defined by Geometric RepresentationContext.
2. If the Project coordinate system is not to be the Site reference, then PlacementRelTo is left blank to indicate this site's origin is the global coordinate system

The property sets relating to the IfcSite are defined using the Pset_SiteCommon, attached by the IfcRelDefinesByProperties relationship.

Quanties relating to site are defined as follows using IfcElementQuantity and attached by the IfcRelAssignsProperties as follows.

Name	Description	Value Type
NominalPerimeter	Perimeter of the Site boundary. The exact definition and calculation rules depend on the method of measurement used.	*IfcQuantityLength*
NominalArea	Area for this site (horizontal projections).	*IfcQuantityArea*

IfcRelAggregates

The spatial structure elements are linked together by using the objectified relationship IfcRelAggregates (see diagram). The IfcSite references spatial elements by its inverse relationships.

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	Must be an IfcProject entity
RelatedObject	Must be an IfcSite entity

IfcProject:

1. IfcProject is the root of any decomposition tree. It shall therefore not be used to decompose any other object definition.
2. IfcProject has an associated IfcGeometricRepresentationContext that objects within the project references.
3. The Project is the first Spatial Configuration Member. It must be assigned a name in the IfcProject.Name. It carries the default units to be applied for the project in Project.UnitsInContext.

A Project, if it includes geometry, must also reference from RepresentationContexts one or more GeomtetricRepresentationContexts. It specifies the world coordinate system, TRUE NORTH, if not the y-axis of the coordinate system, and optionally precision.

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	The *Name* attribute has to be provided for the project. It is the short name for the project.
Description	<Open>
ObjectType	Optional
LongName	Optional
Phase	Optional. Applicable values have to be agreed upon by view definitions or implementer agreements
RepresentationContexts	Context of the representations used within the project. There shall be no instance of *IfcGeometricRepresentationSubContext* directly included in the set of *RepresentationContexts*.
UnitsInContext	Units globally assigned to measure types used within the context of this project.

	Must be an IfcUnitAssignment entity

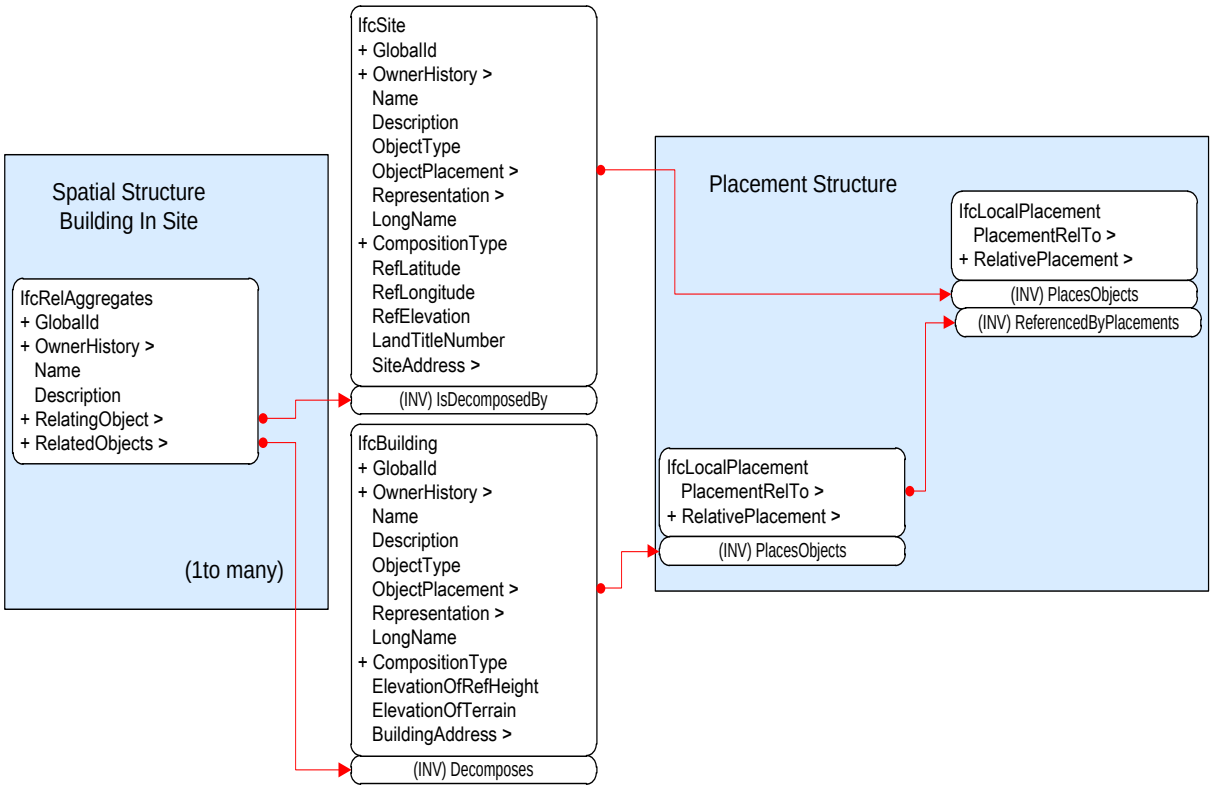
Example: Part21 file

```
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#40= IFCGEOMETRICREPRESENTATIONCONTEXT('Body','Model',3,1.0000000E-5,#37,$);
#43= IFCGEOMETRICREPRESENTATIONCONTEXT('BoundingBox','Model',3,1.0000000E-5,#37,$);
#46= IFCPROJECT('3AWw8wyvz14QTe3PMyD$a8',#20,'Project','Description','Object
type','LongName','Phase',(#40,#43),#18);
#53= IFCLOCALPLACEMENT($,#37);
#56= IFCSITE('2$umvcgY11QPrba$dmh585',#20,'Undefined',$,$,#53,$,$,.ELEMENT.,$,$,0.,$,$);
#66= IFCLOCALPLACEMENT(#53,#37);
#3372= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b3UuEL5',#20,$,$,#46,(#56));
```

IFC Release Specific Concept Description (IFC 2x3) Building Contained in Site					
Reference	PCI-043	**Version**	1.1	**Status**	Draft
Relationships	Spatial Hierarchy				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

The Spatial Configuration Hierarchy consists of one instance for each element instance in the hierarchy: one project (always), one for each Site in the project (optional), one or more Buildings for each Site; there will be optionally one or more BuildingStory for each Building; Spaces are optional defined as another level in the Spatial Containment Hierarchy.

Each Spatial Configuration Hierarchy entity is to reference the next higher level in the hierarchy that are part of, as a logical relationship. These should be assigned as encountered.

IfcBuilding

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Optional
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductrepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
ElevationOfRefHeight	Elevation above sea level of the reference height used for all storey elevation measures, equals to height 0.0. It is usually the ground floor level. Must be IfcLengthMeasure
ElevationOfTerrain	Elevation above the minimal terrain level around the foot print of the building, given in elevation above sea level. Must be IfcLengthMeasure
BuildingAddress	Address given to the building for postal purposes. Must be IfcPostalAddress

Building provides a basic element within the spatial structure hierarchy for the components of a building within a Project. If Sites are specified, a Building is associated to a Site. Multiple Buildings may be part of the same Site, in a one-to-many relationship. If a Project consists of a single Building it may optionally directly reference the Project and define the Global coordinate system for the Project.

One or more Building entities reference the Site or Project they are part of, as a logical relationship. Each is added as encountered. (IGNORE THIS ASPECT) If a Building includes multiple other Buildings, where one Building is a “master” for the others, these are logically organized as the “master” Building being COMPLEX and the others PARTIAL. This is their logical relationship.

IfcRelAggregates

The spatial structure elements are linked together by using the objectified relationship IfcRelAggregates (see diagram).

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>

RelatingObject	Must be an IfcSite entity
RelatedObject	Must be an IfcBuilding entity

IfcSite

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	The *Name* attribute has to be provided for the project. It is the short name for the project.
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional. Should be a subtype of IfcObjectPlacement
Representation	Optional. Should be a subtype of IfcProductRepresentation.
LongName	Optional.
CompositionType	Should be an enumeration of type IfcElementCompositionEnum
RefLatitutde	Optional. Should use IfcCompoundPlaneAngleMeasure entity
RefLongitude	Optional. Should use IfcCompoundPlaneAngleMeasure entity
RefElevation	Optional
LandTitleNumber	Optional
SiteAddress	Opional. Address given to the site for postal purposes. Should use IfcPostalAddress entity.

IfcLocalPlacement

A Building also plays an important role in terms of spatial coordinate coordination. The IfcLocalPlacement.PlacementRelTo relation can take 2 types of value:

1. Reference the Site coordinate system when one or more buildings are to be spatially related through a Site base coordinate.

2. If the Site coordinate system is not to be the Building reference, then PlacementRelTo is left blank to indicate this Building's origin is the global coordinate system. This ESPACIALLY applies when there is only one Building instance or no Site

Attribute	Implementation agreements

PlacementRelTo	Optional. The PlacementRelTo relationship of IfcLocalPlacement shall point (if relative placement is used) to the IfcSpatialStructureElement of type IfcSite, or of type IfcBuilding (e.g. to position a building relative to a building complex, or a building section to a building).
RelativePlacement	If the relative placement is not used, the absolute placement is defined within the world coordinate system.

Example: Part21 file

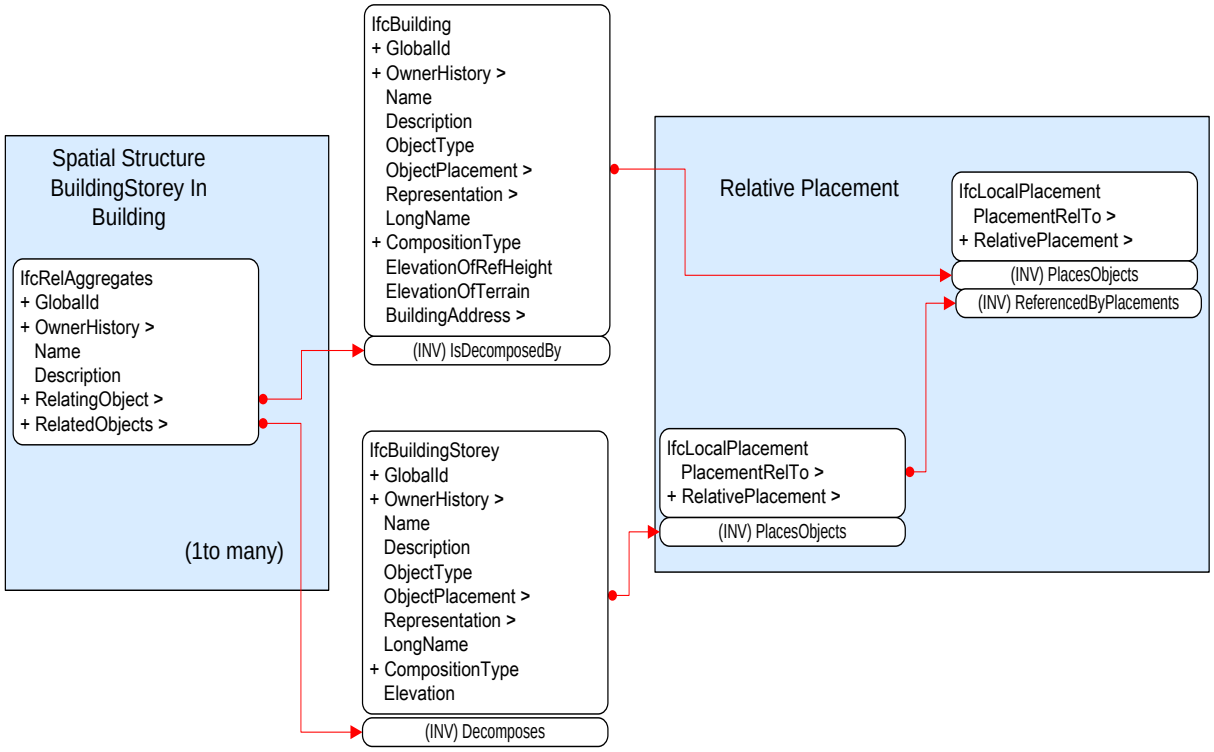
Part 21 File for Building contained in Site

```
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#40= IFCGEOMETRICREPRESENTATIONCONTEXT('Body','Model',3,1.0000000E-5,#37,$);
#43= IFCGEOMETRICREPRESENTATIONCONTEXT('BoundingBox','Model',3,1.0000000E-5,#37,$);
#46= IFCPROJECT('3AWw8wyvz14QTe3PMyD$a8',#20,'Project','Description','Object
type','LongName','Phase',(#40,#43),#18);
#53= IFCLOCALPLACEMENT($,#37);
#56= IFCSITE('2$umvcgY11QPrba$dmh585',#20,'Undefined',$,$,#53,$,$,.ELEMENT.,$,$,0.,$,$);
#66= IFCLOCALPLACEMENT(#53,#37);
#69= IFCBUILDING('3tk6iR4IzDSuhkRrm3_5Bb',#20,'Undefined',$,$,#66,$,$,.ELEMENT.,$,$,$);
#79= IFCLOCALPLACEMENT(#66,#37);
#3372= IFCRELAGGREGATES('1IpcTr3X67Ph$9b3UuEL5',#20,$,$,#46,(#56));
#3374= IFCRELAGGREGATES('2pjVqjxITEDhGcmTSgYJyQ',#20,$,$,#56,(#69));
```

IFC Release Specific Concept Description (IFC 2x3) Building Storey Contained in Building					
Reference	PCI-044	Version	1.1	Status	Draft
Relationships	Spatial Hierarchy				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

BuildingStory provides a basic spatial classification within the spatial structure hierarchy for the components of a Building. BuildingStory is only defined if there is a Building. A BuildingStory has an elevation, defining the approximate height relative to others. The heights and thus the Storeys are ordered. Building Story is considered the primary receiver of Spaces.

IfcRelAggregates

Attribute	Implementation agreements

GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	Must be an IfcBuilding entity
RelatedObject	Must be an IfcBuildingStorey entity

IfcLocalPlacement

Attribute	Implementation agreements
PlacementRelTo	Optional. The *PlacementRelTo* relationship shall point to the local placement of the *IfcSpatialStructureElement* of type "IfcBuilding", or of type IfcBuildingStorey (e.g. to position a building storey relative to a building storey complex, or a partial building storey to a building storey), if relative placement is used.
RelativePlacement	If the relative placement is not used, the absolute placement is defined within the world coordinate system.

IfcBuilding

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Optional
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductrepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
ElevationOfRefHeight	Elevation above sea level of the reference height used for all storey elevation measures, equals to height 0.0. It is usually the ground floor level. Must be IfcLengthMeasure
ElevationOfTerrain	Elevation above the minimal terrain level around the foot print of the building, given in elevation above sea level. Must be IfcLengthMeasure
BuildingAddress	Address given to the building for postal purposes. Must be IfcPostalAddress

IfcBuildingStorey

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Optional
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductrepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
Elevation	Optional. Elevation of the base of this storey, relative to the 0,00 internal reference height of the building. The 0.00 level is given by the absolute above sea level height by the ElevationOfRefHeight attribute given at IfcBuilding.

Example: Part21 file

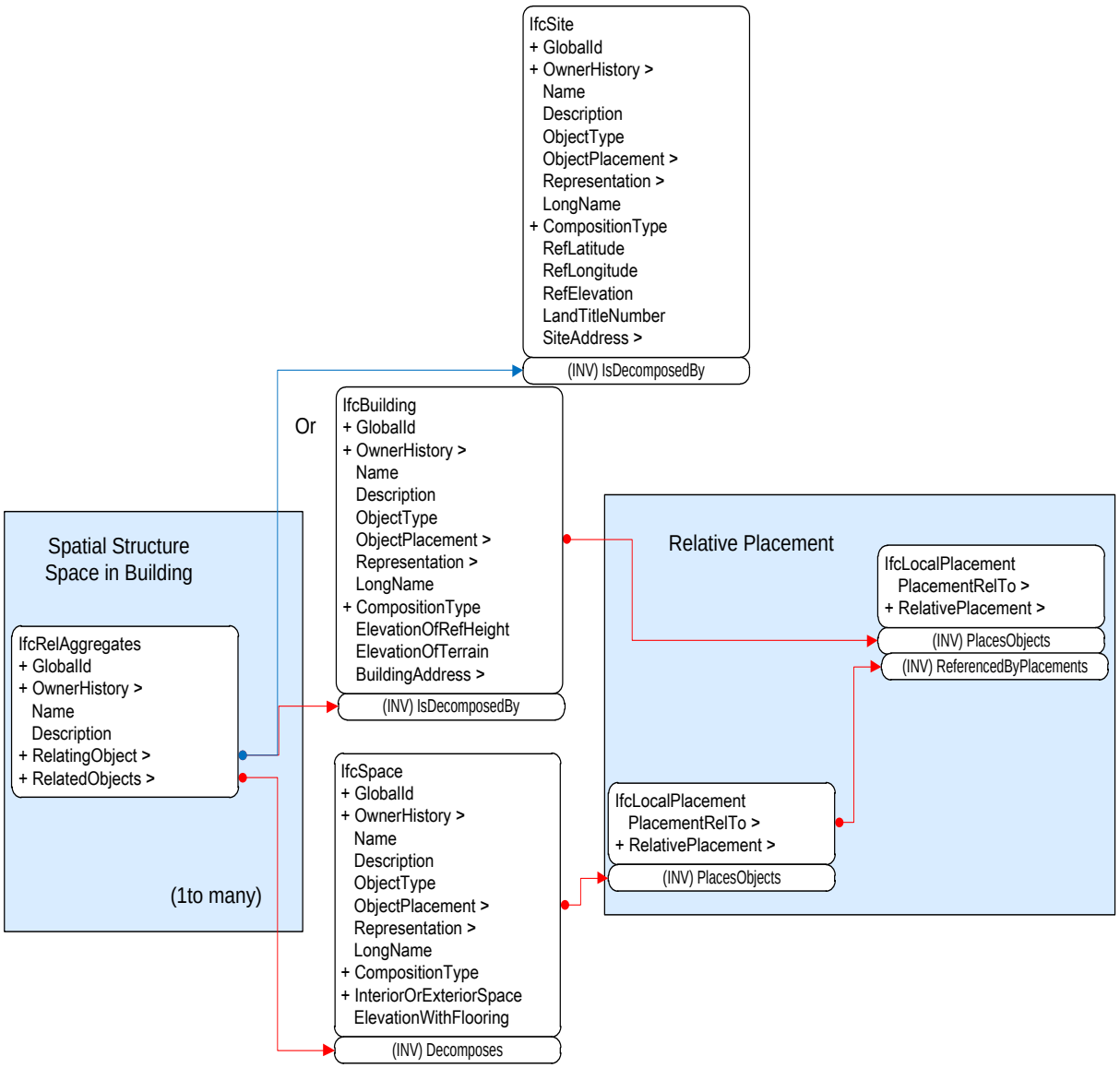
Part 21 File for BuildingStorey contained in Building

```
#46= IFCPROJECT('3AWw8wyvz14QTe3PMyD$a8',#20,'Project','Description','Object
type','LongName','Phase',(#40,#43),#18);
#53= IFCLOCALPLACEMENT($,#37);
#56= IFCSITE('2$umvcgY11QPrba$dmh585',#20,'Undefined',$,$,#53,$,$,.ELEMENT.,$,$,0.,$,$);
#66= IFCLOCALPLACEMENT(#53,#37);
#69= IFCBUILDING('3tk6iR4IzDSuhkRrm3_5Bb',#20,'Undefined',$,$,#66,$,$,.ELEMENT.,$,$,$);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#92= IFCCARTESIANPOINT((220.,602.5,2300.));
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#3376= IFCRELAGGREGATES('3QM6ooNoz0lvFwZd5JedV9',#20,$,$,#69,(#82));
```

IFC Release Specific Concept Description (IFC 2x3**)** Space Contained in Building					
Reference	PCI-045	**Version**	1.1	**Status**	Draft
Relationships	Spatial Hierarchy				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

Space is an Object with many attributes and a bounded designated region, assigned to a Story within a Building. Spaces are optional in the Spatial Containment hierarchy. Spaces are considered part of the Spatial Containment hierarchy because it supports accessing of objects entirely within a Space.

Spaces at Building or Site level.

IfcRelAggregates

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data

Name	<Open>
Description	<Open>
RelatingObject	Must be an IfcBuilding entity
RelatedObject	Must be an IfcSpace entity

IfcLocalPlacement

Attribute	Implementation agreements
PlacementRelTo	Optional. The *PlacementRelTo* relationship shall point to the local placement of the *IfcSpatialStructureElement* of type "IfcBuilding", if relative placement is used.
RelativePlacement	If the relative placement is not used, the absolute placement is defined within the world coordinate system.

IfcBuilding

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Optional
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductrepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
ElevationOfRefHeight	Elevation above sea level of the reference height used for all storey elevation measures, equals to height 0.0. It is usually the ground floor level. Must be IfcLengthMeasure
ElevationOfTerrain	Elevation above the minimal terrain level around the foot print of the building, given in elevation above sea level. Must be IfcLengthMeasure
BuildingAddress	Address given to the building for postal purposes. Must be IfcPostalAddress

IfcSpace

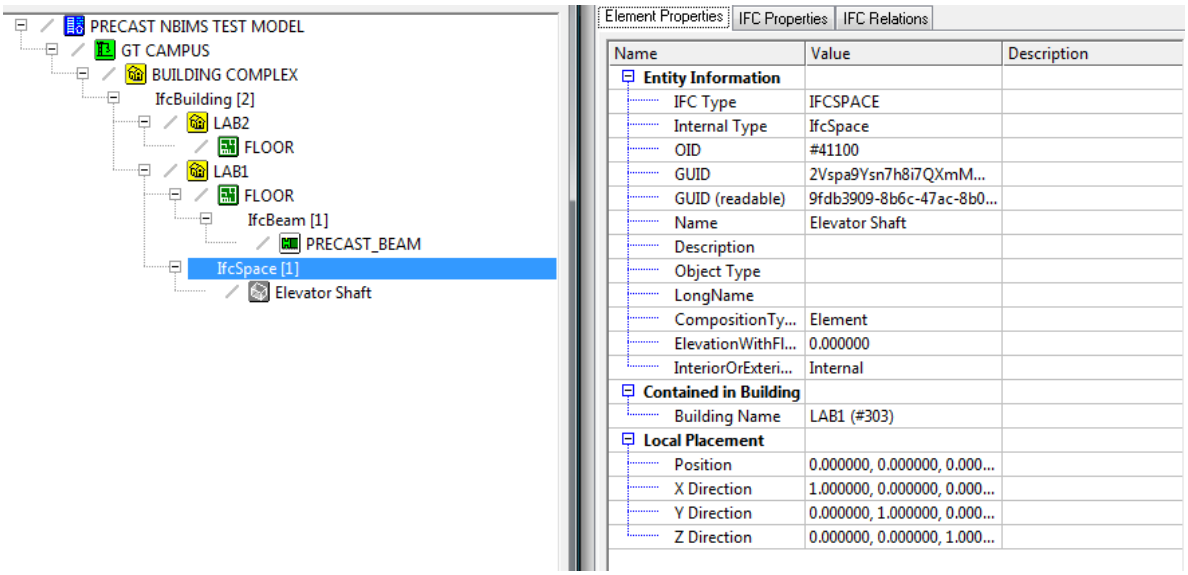
Attribute	Implementation agreements

GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Space.Name should be assigned.
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductrepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
InteriorOrExteriorSpace	Optional. Enumeration of type IfcInternalOrExternalEnum
ElevationWithFlooring	Optional. Level of flooring of this space; the average shall be taken, if the space ground surface is sloping or if there are level differences within this space.

Example: Part21 file

Part 21 File for Space contained in Building

#13= IFCOWNERHISTORY(#12,#5,$,.NOCHANGE.,$,$,$,1242151847);
#74= IFCLOCALPLACEMENT(#61,#44);
#87= IFCAXIS2PLACEMENT3D(#40,#36,#28);
#90= IFCLOCALPLACEMENT(#74,#87);
#93= IFCBUILDING('2lMYiz6PH5nPbYgp0myV00',#13,'Main Building',$,$,#90,$,$,.ELEMENT.,$,$,$);
#292= IFCCARTESIANPOINT((-3180.2197,-1094.3327,0.));
#296= IFCAXIS2PLACEMENT3D(#292,#36,#28);
#299= IFCLOCALPLACEMENT(#90,#296);
#302= IFCSPACE('1bJRitt695SP_HdGztqaA_',#13,'ElectricalStorageArea',$,$,#299,$,$,$,$,$);
#312= IFCRELAGGREGATES('0RtLL773f4fAE0M7lNgeGS',#13,'BuildingContainer','BuildingContainer for Spaces',#93,(#302));



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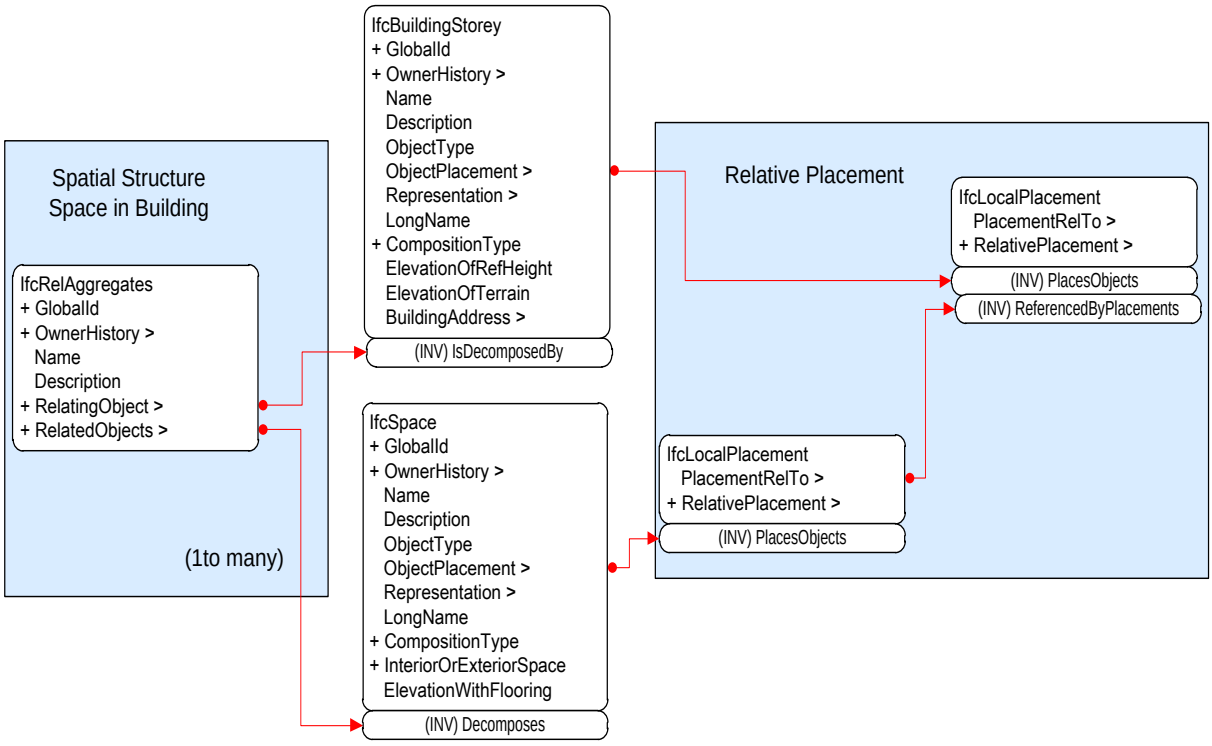
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (IFC 2x3**)** Space Contained in Building Storey					
Reference	PCI-046	**Version**	1.1	**Status**	Draft
Relationships	Spatial Hierarchy				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

Space is an Object with many attributes and a bounded designated region, assigned to a Story within a Building. Spaces are optional in the Spatial Containment hierarchy. Spaces are considered part of the Spatial Containment hierarchy because it supports accessing of objects entirely within a Space.

Spaces at Building Storey level.

IfcRelAggregates

Attribute	Implementation agreements

GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	Must be an IfcBuildingStorey entity
RelatedObject	Must be an IfcSpace entity

IfcLocalPlacement

Attribute	Implementation agreements
PlacementRelTo	Optional. The *PlacementRelTo* relationship shall point to the local placement of the *IfcSpatialStructureElement* of type "IfcBuildingStorey", if relative placement is used.
RelativePlacement	If the relative placement is not used, the absolute placement is defined within the world coordinate system.

IfcBuildingSorey

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Optional
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductrepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
ElevationOfRefHeight	Elevation above sea level of the reference height used for all storey elevation measures, equals to height 0.0. It is usually the ground floor level. Must be IfcLengthMeasure
ElevationOfTerrain	Elevation above the minimal terrain level around the foot print of the building, given in elevation above sea level. Must be IfcLengthMeasure
BuildingAddress	Address given to the building for postal purposes. Must be IfcPostalAddress

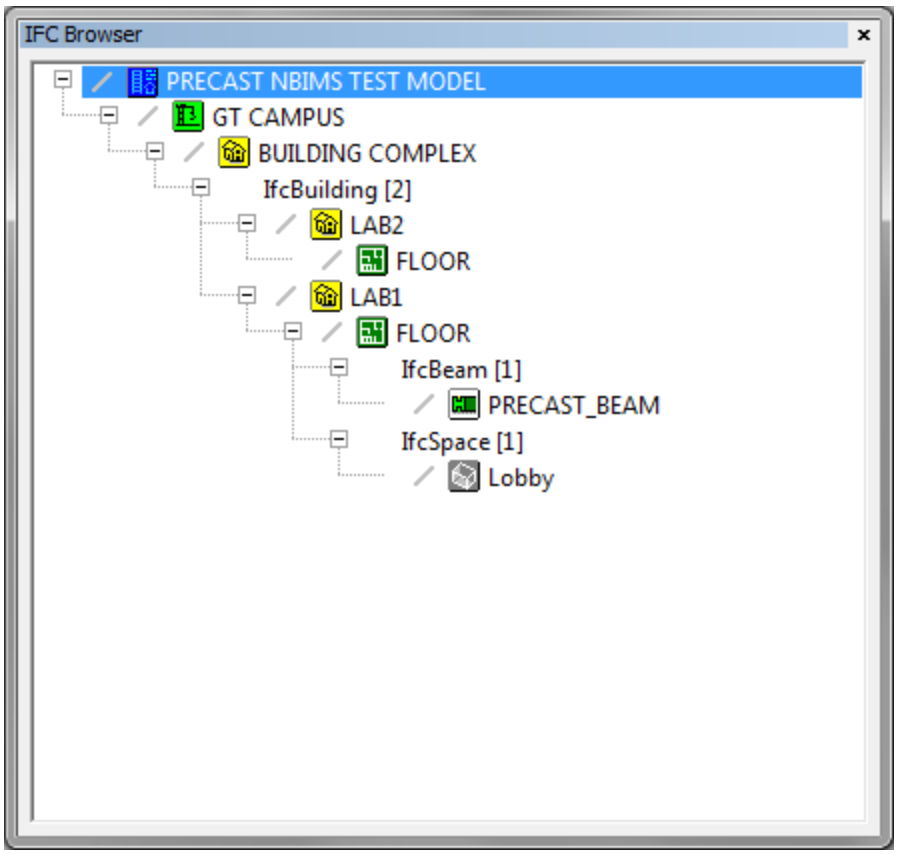
IfcSpace

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Space.Name should be assigned.
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductrepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
InteriorOrExteriorSpace	Optional. Enumeration of type IfcInternalOrExternalEnum
ElevationWithFlooring	Optional. Level of flooring of this space; the average shall be taken, if the space ground surface is sloping or if there are level differences within this space.

Example: Part21 file

Part 21 File for Space contained in Building

#13= IFCOWNERHISTORY(#12,#5,$,.NOCHANGE.,$,$,$,1242151847);
#74= IFCLOCALPLACEMENT(#61,#44);
#87= IFCAXIS2PLACEMENT3D(#40,#36,#28);
#90= IFCLOCALPLACEMENT(#74,#87);
#93= IFCBUILDINGSTOREY('2IMYiz6PH5nPbYgp0myV00',#13,'Floor1',$,$,#90,$,$,.ELEMENT.,$,$,$);
#292= IFCCARTESIANPOINT((-3180.2197,-1094.3327,0.));
#296= IFCAXIS2PLACEMENT3D(#292,#36,#28);
#299= IFCLOCALPLACEMENT(#90,#296);
#302= IFCSPACE('1bJRitt695SP_HdGztqaA_',#13,'ElectricalStorageArea',$,$,#299,$,$,$,$,$);
#312= IFCRELAGGREGATES('0RtLL773f4fAE0M7lNgeGS',#13,'BuildingContainer','BuildingContainer for Spaces',#93,(#302));



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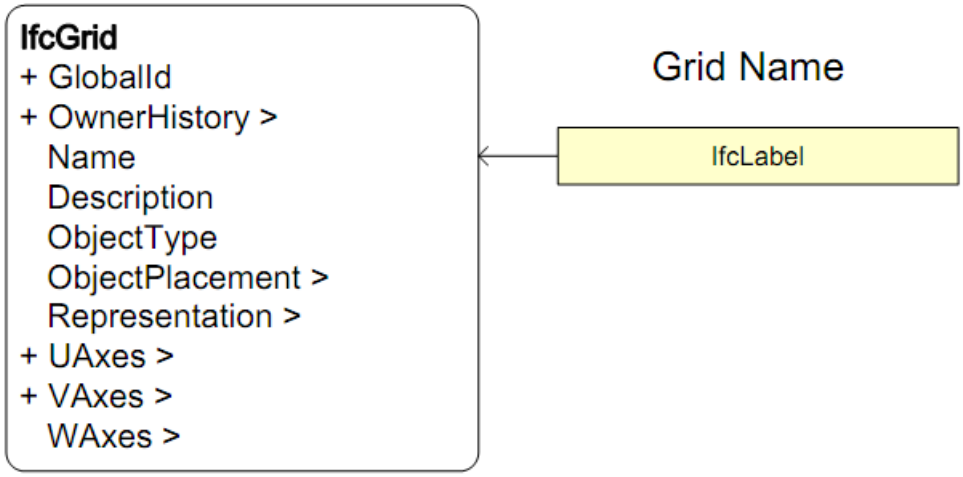
IFC Release Specific Concept Description (<IFC Release 2x3>)

Grid Name

Reference	PCI-047	**Version**	1.1	**Status**	Draft
Relationships	Implements general concept 'Grid Name'				
History	v.1.0 8-Aug-09, Revised Nov 18, 2012				
Authors	Manu Venugopla; Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

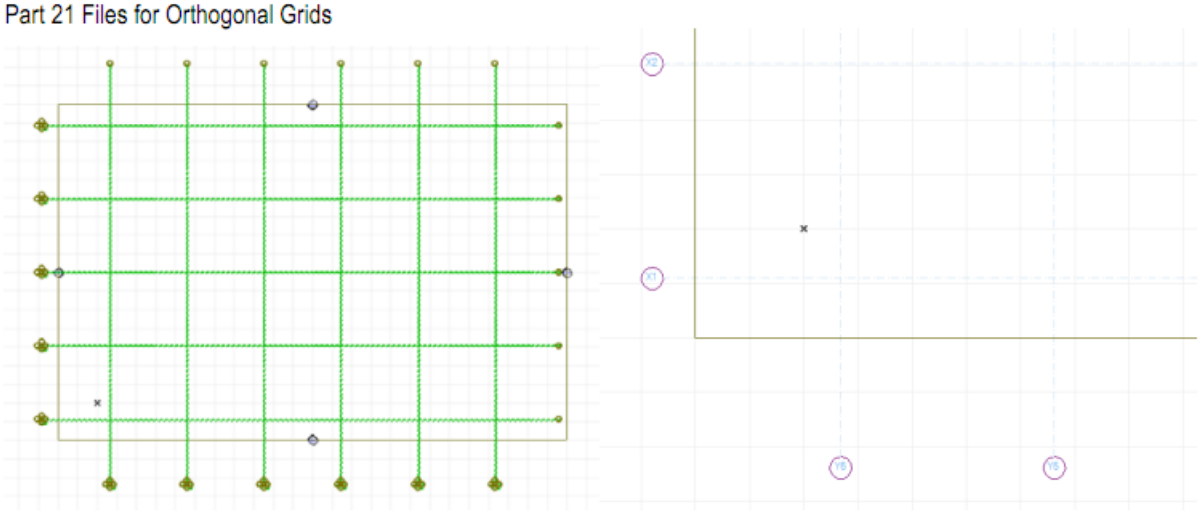
IfcGrid

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Name should be assigned.
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductRepresentation

UAxes	LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the first row of grid lines)
VAxes	LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the second row of grid lines.)
Waxes	OPTIONAL LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the third row of grid lines. It may be given in the case of a triangular grid.)

Example:

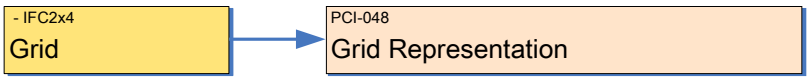
Part 21 Files for Orthogonal Grids



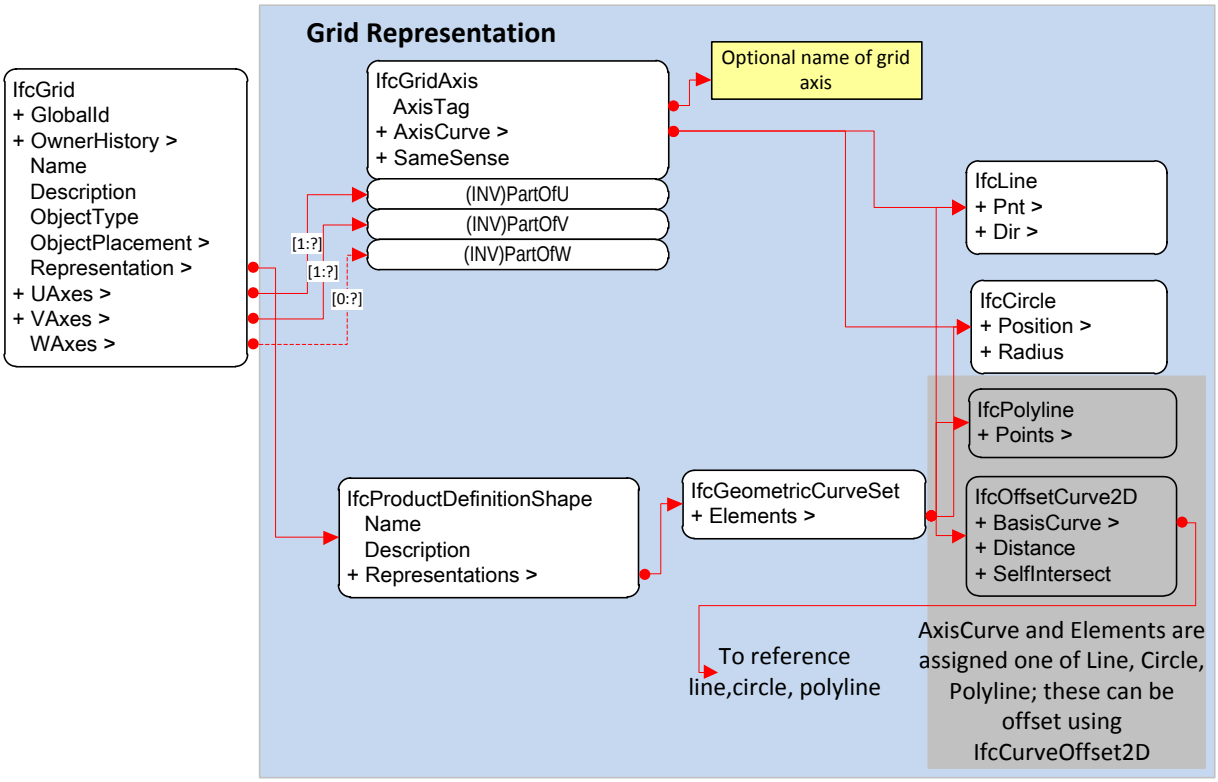
```
#13= IFCOWNERHISTORY(#12,#5,$,.NOCHANGE.,$,$,$,1242151847);
#103= IFCCARTESIANPOINT((0.,0.));
#107= IFCCARTESIANPOINT((32000.,0.));
#112= IFCPOLYLINE((#103,#107));
#116= IFCGRIDAXIS('X1',#112,.T.);
#133= IFCGRIDAXIS('X2',#129,.T.);
#150= IFCGRIDAXIS('X3',#146,.T.);
#167= IFCGRIDAXIS('X4',#163,.T.);
#184= IFCGRIDAXIS('X5',#180,.T.);
#201= IFCGRIDAXIS('Y6',#197,.T.);
#218= IFCGRIDAXIS('Y5',#214,.T.);
#299= IFCLOCALPLACEMENT(#90,#296);
#302=
IFCGRID('1bJRitt695SP_HdGztqaA_',#13,'OrthogonalGrid',$,$,#299,$,(#116,#133,#150,#167,#184),(#201,#218,#235,#253,
#270,#287),$);
```

IFC Release Specific Concept Description (IFC 2x3**)** Grid Representation					
Reference	PCI-048	**Version**	1.1	**Status**	Draft
Relationships	PCI-049, PCI-050				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

Grid Representation

Attribute	Implementation agreements
IfcGeometricCurveSet	The *IfcGeometricCurveSet* shall be an (and the only) *Item* of the *IfcShapeRepresentation*. It should contain an *IfcGeometricCurveSet* containing subtypes of *IfcCurve*, each representing a grid axis.

IfcCurve	Applicable subtypes of *IfcCurve* are: *IfcPolyline*, *IfcCircle*, *IfcTrimmedCurve* (based on*BaseCurve* referencing *IfcLine* or *IfcCircle*).
IfcGridAxis	AxisCurve is the underlying curve which provides the geometry for this grid axis. Each instance of IfcGridAxis refers to the same instance of IfcCurve that is contained within the IfcGeometricCurveSet that represents the IfcGrid.

Informal Proposition

1. Grid axes, which are referenced in different lists of axes (UAxes, VAxes, WAxes) shall not be parallel.
2. Grid axes should be defined such as there are no two grid axes which intersect twice.

IfcGrid:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Space.Name should be assigned.
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductRepresentation
UAxes	LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the first row of grid lines)
VAxes	LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the second row of grid lines.)
Waxes	OPTIONAL LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the third row of grid lines. It may be given in the case of a triangular grid.)

IfcGridAxis

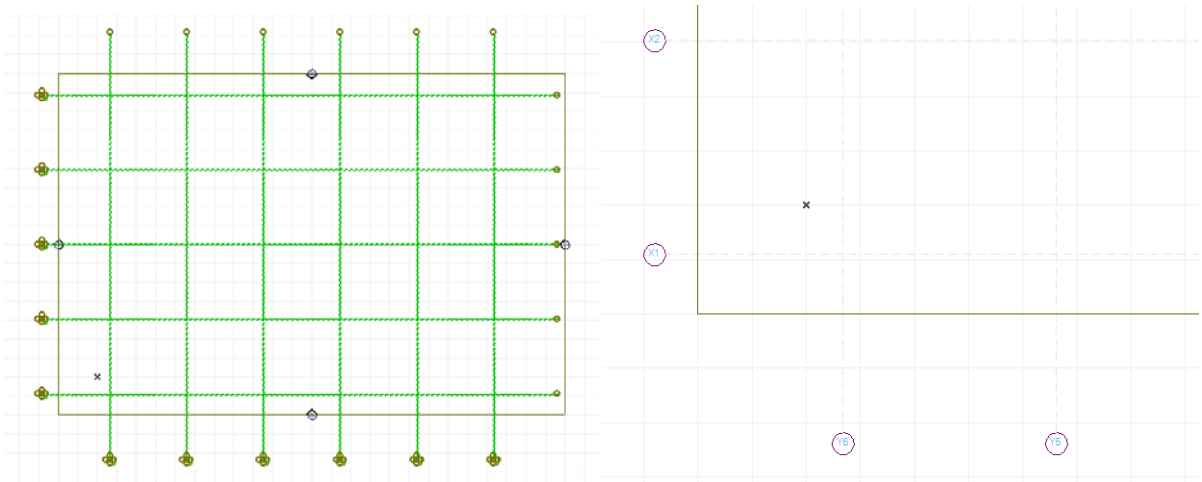
Attribute	Implementation agreements
AxisTag	OPTIONAL. Tag name for this grid axis
AxisCurve	Underlying curve which provides the geometry for this grid axis. Should be a subtype of IfcCurve.
SameSense	Defines whether the original sense of curve is used or whether it is reversed in the context of the grid axis. IfcBoolean entity.

Formal Proposition:

1. The dimensionality of the grid axis is 2.
2. Each of the three attributes of IfcGrid (UAxes, VAxes, WAxes) should refer to a new IfcGridAxis (Unique).

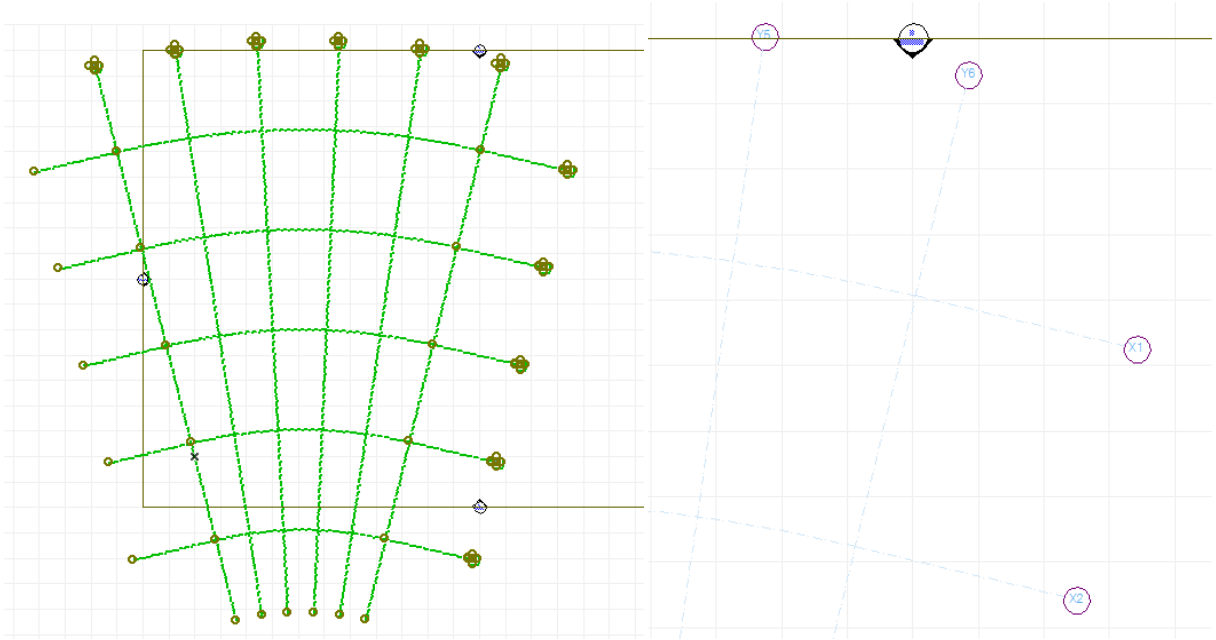
Example: Part21 file

a) Orthogonal Grids: As shown in Figure, the orthogonal grid is represented by poly-lines.



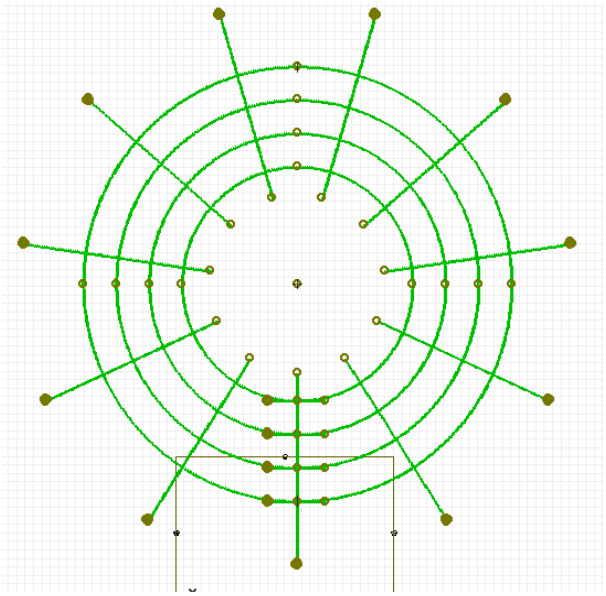
#15=IFCBUILDING('3CXhjzWsj71PpgLNK2bFjs',#114,'StWGridPlacement_','StWGridPlacement_',$,#16,$,$,.ELEMENT.,0.,0.,$);
#16=IFCLOCALPLACEMENT(#9,#6);
#18=IFCRELAGGREGATES('1$I13Cr7H34ekJnEVzD2qx',#114,'BuildingContainedinSite',$,#13,(#15));
#19=IFCGRID('377y2whmj83waAdwq0y8Ug',#114,'Grid-1-FF0','Default','STWPC_ENTITY_GENERIC_GRID',#22,$,(#28,#32,#36),(#38,#40,#42,#44),$);
#20=IFCCARTESIANPOINT((0.,-0.0254,0.));
#21=IFCAXIS2PLACEMENT3D(#20,#4,#5);
#22=IFCLOCALPLACEMENT(#16,#21);
#24=IFCRELCONTAINEDINSPATIALSTRUCTURE('0Cd6IoZNDDdQ4KDSRT_ZPL',#114,$,$,(#19,#45,#57,#69),#15);
#25=IFCCARTESIANPOINT((0.,0.));
#26=IFCCARTESIANPOINT((9.144,0.));
#27=IFCPOLYLINE((#25,#26));
#28=IFCGRIDAXIS('A-1',#27,.T.);
#29=IFCCARTESIANPOINT((0.,9.144));
#30=IFCCARTESIANPOINT((9.144,9.144));
#31=IFCPOLYLINE((#29,#30));
#32=IFCGRIDAXIS('A-2',#31,.T.);
#33=IFCCARTESIANPOINT((0.,18.288));
#34=IFCCARTESIANPOINT((9.144,18.288));
#35=IFCPOLYLINE((#33,#34));
#36=IFCGRIDAXIS('A-3',#35,.T.);
#37=IFCPOLYLINE((#25,#29));
#38=IFCGRIDAXIS('A-1',#37,.T.);
#39=IFCPOLYLINE((#29,#33));
#40=IFCGRIDAXIS('A-2',#39,.T.);
#41=IFCPOLYLINE((#26,#30));
#42=IFCGRIDAXIS('B-1',#41,.T.);
#43=IFCPOLYLINE((#30,#34));
#44=IFCGRIDAXIS('B-2',#43,.T.);

b) Polar Grid: The polar grid is represented by trimmed curve (circle) and poly-lines. In this example, X-axis used circles and Y-axis used poly-lines.



#13= IFCOWNERHISTORY(#12,#5,$,.NOCHANGE.,$,$,$,1242152327);
#103= IFCCARTESIANPOINT((0.,0.));
#107= IFCCARTESIANPOINT((16622.95,4067.61));
#123= IFCCIRCLE(#120,36000.);
#126= IFCTRIMMEDCURVE(#123,(#103,IFCPARAMETERVALUE(0.)),(#107,IFCPARAMETERVALUE(27.5)),.T.,.CARTESIAN.);
#131= IFCGRIDAXIS('X1',#126,.T.);
#163= IFCGRIDAXIS('X2',#158,.T.);
#195= IFCGRIDAXIS('X3',#190,.T.);
#227= IFCGRIDAXIS('X4',#222,.T.);
#260= IFCGRIDAXIS('X5',#255,.T.);
#265= IFCCARTESIANPOINT((0.,-4000.));
#269= IFCCARTESIANPOINT((1.7763568E-12,23200.));
#273= IFCPOLYLINE((#265,#269));
#277= IFCGRIDAXIS('Y6',#273,.T.);
#379= IFCLOCALPLACEMENT(#90,#376);
#382= IFCGRID('3DHOF8hFr3WfbbbWlWu5zd',#13,$,$,$,#379,$,(#131,#163,#195,#227,#260),(#277,#294,#311,#328,#345,#362),$);

c) Circular Grids: The circular grid is represented by poly-lines and circles.



#13= IFCOWNERHISTORY(#12,#5,$,.NOCHANGE.,$,$,$,1242153669);
#112= IFCGRIDAXIS('X2',$,.T.);
#125= IFCGRIDAXIS('X3',$,.T.);
#138= IFCGRIDAXIS('X4',$,.T.);
#151= IFCGRIDAXIS('X5',$,.T.);
#156= IFCCARTESIANPOINT((-40000.,31200.));
#160= IFCCARTESIANPOINT((-12800.,31200.));
#164= IFCPOLYLINE((#156,#160));
#168= IFCGRIDAXIS('Y12',#164,.T.);
#185= IFCGRIDAXIS('Y11',#181,.T.);
#202= IFCGRIDAXIS('Y10',#198,.T.);
#219= IFCGRIDAXIS('Y9',#215,.T.);
#236= IFCGRIDAXIS('Y8',#232,.T.);
#254= IFCGRIDAXIS('Y7',#250,.T.);
#271= IFCGRIDAXIS('Y6',#267,.T.);
#288= IFCGRIDAXIS('Y5',#284,.T.);
#305= IFCGRIDAXIS('Y4',#301,.T.);
#322= IFCGRIDAXIS('Y3',#318,.T.);
#339= IFCGRIDAXIS('Y2',#335,.T.);
#356= IFCGRIDAXIS('Y1',#352,.T.);
#369= IFCLOCALPLACEMENT(#90,#366);
#372=
IFCGRID('3InRPKHIP4XPxAr9zRfzFp',#13,$,$,$,#369,$,(#112,#125,#138,#151),(#168,#185,#202,#219,#236,#254,#271,#288,#305,#322,#339,#356),$);

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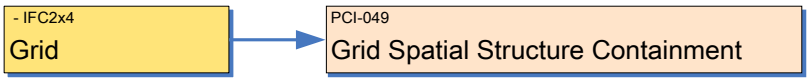
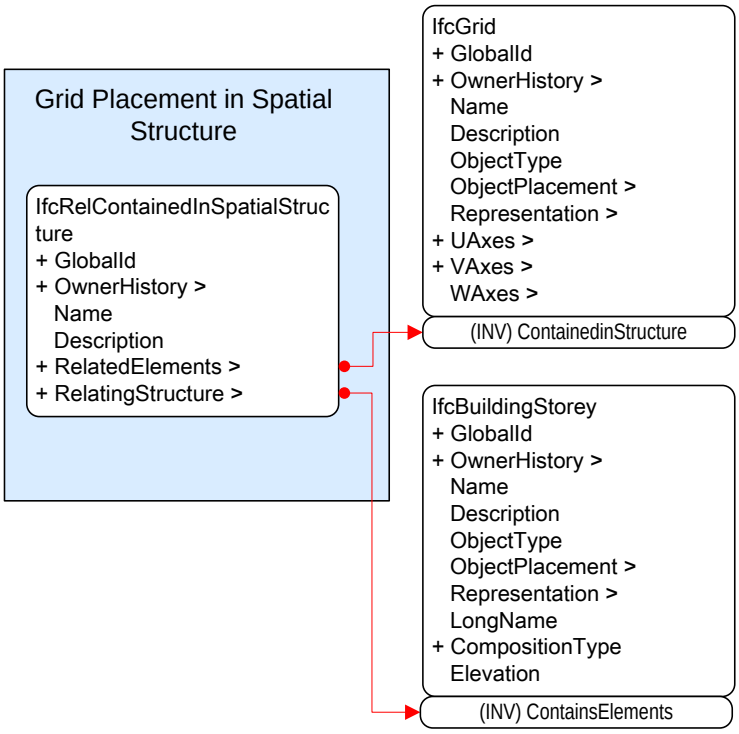
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (IFC 2x3**)** Grid Placement in Spatial Structure					
Reference	PCI-049	**Version**	1.1	**Status**	Draft
Relationships	PCI-048, PCI-050				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

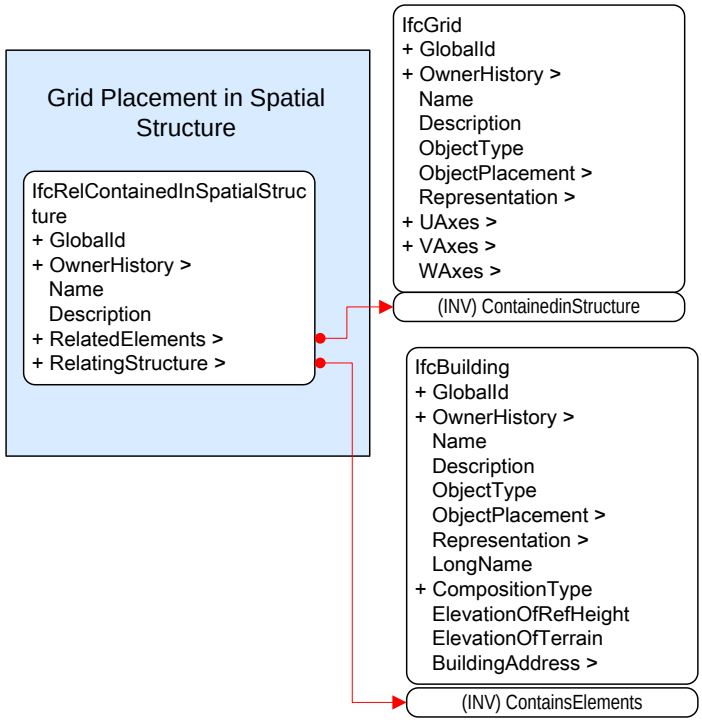
Usage in view definition diagram



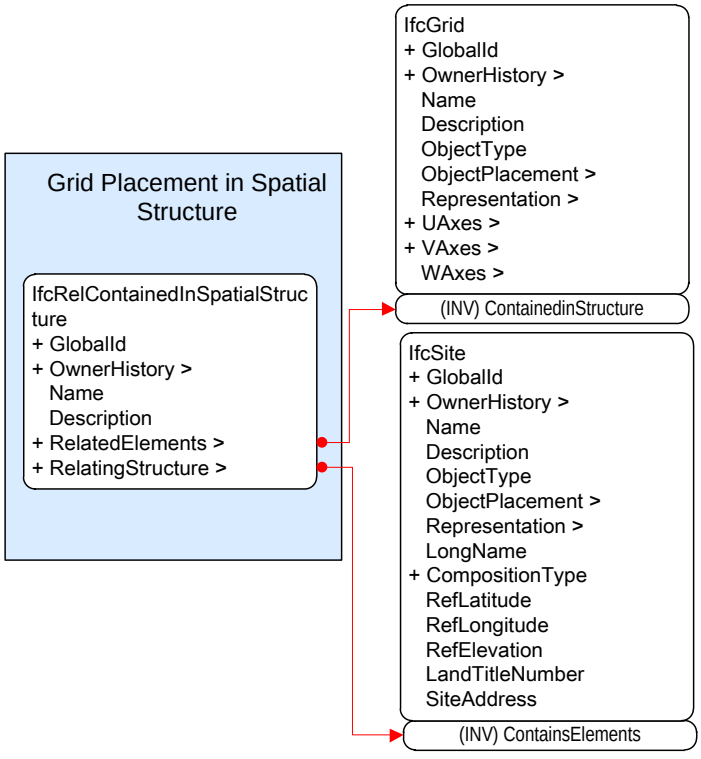
Instantiation diagram Grid associated with Building Storey



Grid associated with Building



Grid associated with Site



Implementation agreements

IfcRelContainedInSpatialStructure

IfcRelContainedInSpatialStructure is used to assign grid to a spatial structure element (either to a building storey or directly to a building to which the grid is primarily associated).

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedElements	Must be an IfcGrid Entity
RelatingStructure	Must be a subtype of IfcSpatialStructureElement (IfcBuilding and IfcBuildingStorey are the valid options)

IfcGrid**:**

The design grid can be used in plan, section or in any position relative to the world. (Refer: ObjectPlacement w.r.t GridAxis) e.g. on floor level in building storey or on façade at building level.

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Space.Name should be assigned.
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductRepresentation
UAxes	LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the first row of grid lines)
VAxes	LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the second row of grid lines.)
Waxes	OPTIONAL LIST [1:?] OF UNIQUE IfcGridAxis. (List of grid axes defining the third row of grid lines. It may be given in the case of a triangular grid.)

IfcBuildingStorey

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data

Name	Optional
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductrepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
Elevation	Optional. Elevation of the base of this storey, relative to the 0,00 internal reference height of the building. The 0.00 level is given by the absolute above sea level height by the ElevationOfRefHeight attribute given at IfcBuilding.

IfcBuilding

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Optional
Description	<Open>
ObjectType	Optional
ObjectPlacement	Optional
Representation	Is a subtype of IfcProductRepresentation
LongName	Optional. IfcLabel
CompositionType	Subtype of IfcElementCompositionEnum
ElevationOfRefHeight	Elevation above sea level of the reference height used for all storey elevation measures, equals to height 0.0. It is usually the ground floor level. Must be IfcLengthMeasure
ElevationOfTerrain	Elevation above the minimal terrain level around the foot print of the building, given in elevation above sea level. Must be IfcLengthMeasure
BuildingAddress	Address given to the building for postal purposes. Must be IfcPostalAddress

Example: Part21 file

#15=IFCBUILDING('3CXhjzWsj71PpgLNK2bFjs',#114,'StWGridPlacement_','StWGridPlacement_',$,#16,$,$,.ELEMENT.,0.,0.,$);

```
#16=IFCLOCALPLACEMENT(#9,#6);
#18=IFCRELAGGREGATES('1$I13Cr7H34ekJnEVzD2qx',#114,'BuildingContainedinSite',$,#13,(#15));
#19=IFCGRID('377y2whmj83waAdwq0y8Ug',#114,'Grid-1-
FF0','Default','STWPC_ENTITY_GENERIC_GRID',#22,$,(#28,#32,#36),(#38,#40,#42,#44),$);
#20=IFCCARTESIANPOINT((0.,-0.0254,0.));
#21=IFCAXIS2PLACEMENT3D(#20,#4,#5);
#22=IFCLOCALPLACEMENT(#16,#21);
#24=IFCRELCONTAINEDINSPATIALSTRUCTURE('0Cd6IoZNDDdQ4KDSRT_ZPL',#114,$,$,(#19,#45,#57,#69)
,#15);
#25=IFCCARTESIANPOINT((0.,0.));
#26=IFCCARTESIANPOINT((9.144,0.));
#27=IFCPOLYLINE((#25,#26));
#28=IFCGRIDAXIS('A-1',#27,.T.);
#29=IFCCARTESIANPOINT((0.,9.144));
#30=IFCCARTESIANPOINT((9.144,9.144));
#31=IFCPOLYLINE((#29,#30));
#32=IFCGRIDAXIS('A-2',#31,.T.);
#33=IFCCARTESIANPOINT((0.,18.288));
#34=IFCCARTESIANPOINT((9.144,18.288));
#35=IFCPOLYLINE((#33,#34));
#36=IFCGRIDAXIS('A-3',#35,.T.);
#37=IFCPOLYLINE((#25,#29));
#38=IFCGRIDAXIS('A-1',#37,.T.);
#39=IFCPOLYLINE((#29,#33));
#40=IFCGRIDAXIS('A-2',#39,.T.);
#41=IFCPOLYLINE((#26,#30));
#42=IFCGRIDAXIS('B-1',#41,.T.);
#43=IFCPOLYLINE((#30,#34));
#44=IFCGRIDAXIS('B-2',#43,.T.);
```

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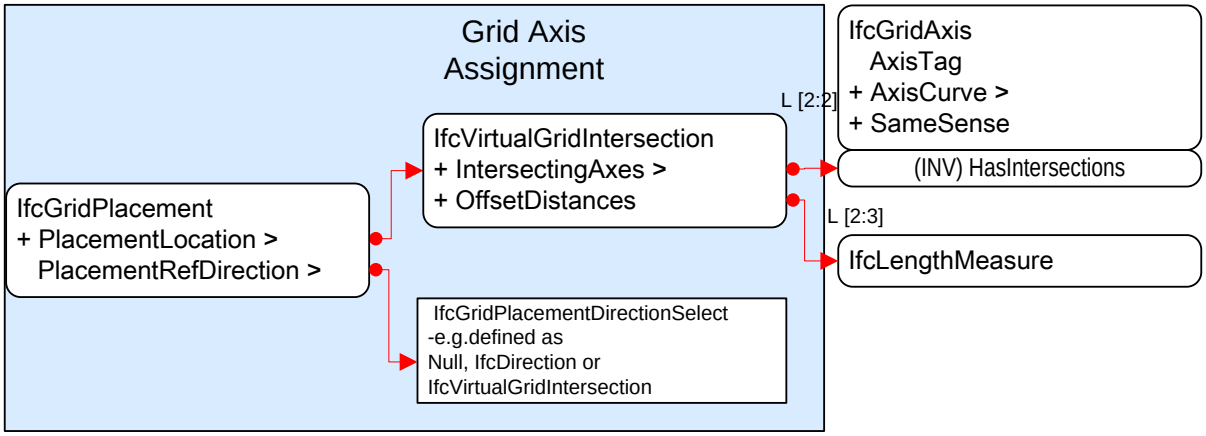
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (IFC 2x4**)** Grid Axis Assignment					
Reference	PCI-050	**Version**	1.1	**Status**	Draft
Relationships	PCI-048, PCI-049				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcGridPlacement

The IfcGridPlacement provides a specialization of IfcObjectPlacement in which the placement and axis direction of the object coordinate system is defined by a reference to the design grid as defined in IfcGrid. The design grid can be used in plan, section or in any position relative to the world.

Attribute	Implementation agreements
PlacementLocation	The IfcGeometricCurveSet shall be an (and the only) *Item* of the IfcShapeRepresentation. It should contain an *IfcGeometricCurveSet* containing subtypes of IfcCurve, each representing a grid axis.
PlacementRefDirection	Applicable subtypes of *IfcCurve* are: IfcPolyline, IfcCircle, IfcTrimmedCurve (based on BaseCurve referencing IfcLineor IfcCircle).

IfcVirtualGridIntersection

Defines the derived location of the intersection between two grid axes.

Attribute	Implementation agreements
IntersectingAxes	Two intersecting grid axes. They should not intersect at more than one point.
OffsetDistances	(Optional) Offset values may be given to set an offset distance to the grid axis for the calculation of the virtual grid intersection. If attribute OffsetDistances is omitted, the intersection defines the placement or ref direction of a grid placement directly. If OffsetDistances are given, the intersection is defined by the offset curves to the grid axes

IfcGridAxis

Attribute	Implementation agreements
AxisTag	OPTIONAL. Tag name for this grid axis
AxisCurve	Underlying curve which provides the geometry for this grid axis. Should be a subtype of IfcCurve.
SameSense	Defines whether the original sense of curve is used or whether it is reversed in the context of the grid axis. IfcBoolean entity.

Example: Part21 file

```
#25=IFCCARTESIANPOINT((0.,0.));
#26=IFCCARTESIANPOINT((9.144,0.));
#27=IFCPOLYLINE((#25,#26));
#28=IFCGRIDAXIS('A-1',#27,.T.);
#29=IFCCARTESIANPOINT((0.,9.144));
#37=IFCPOLYLINE((#25,#29));
#38=IFCGRIDAXIS('A-1',#37,.T.);
#90=IFCGRIDPLACEMENT(#91,$);
#91=IFCVIRTUALGRIDINTERSECTION((#28,#38),(0.,0.));
```

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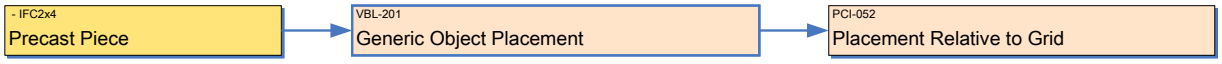
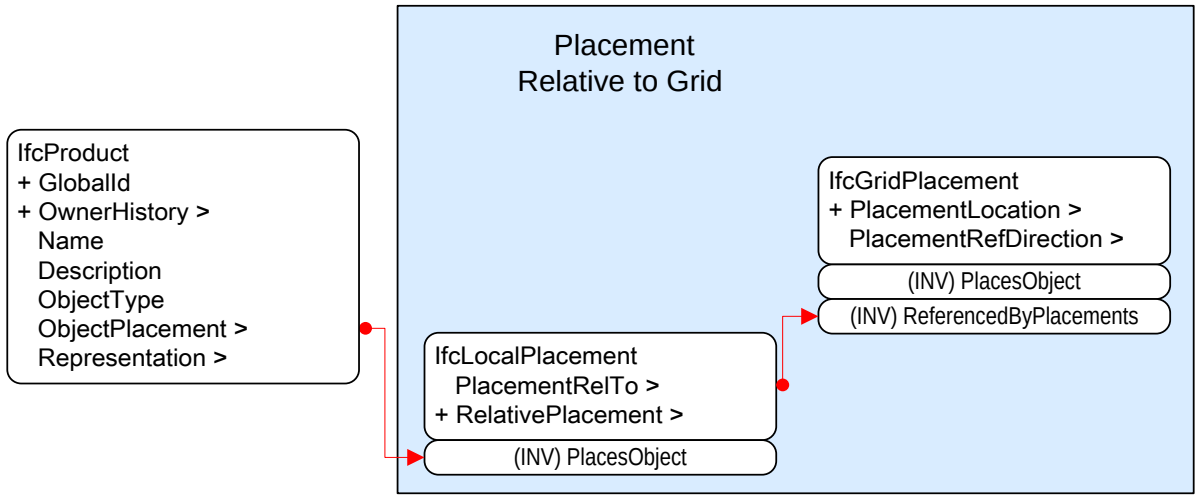
IFC Release Specific Concept Description (IFC 2x3) Placement Relative to Grid					
Reference	PCI-052	**Version**	1.1	**Status**	Draft
Relationships	PCI-048, PCI-049				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcSpatialStructureElement: Generalization of all spatial elements that might be used to define a spatial structure. Could be IfcSite, IfcBuilding, IfcBuildingStorey or IfcSpace

IfcProduct: Could be subtypes of IfcBuildingElement like IfcSlab, IfcBeam, IfcColumn etc or any other subtypes of IfcProduct.

The *IfcVirtualGridIntersection* defines the derived location of the intersection between two grid axes. Offset values may be given to set an offset distance to the grid axis for the calculation of the virtual grid intersection. (Refer: **IfcGridAxisPlacement**)

IntersectingAxes: Two grid axes which intersects at exactly one intersection (see also informal proposition at IfcGrid). If attribute OffsetDistances is omitted, the intersection defines the placement or ref direction of a grid placement directly. If OffsetDistances are given, the intersection is defined by the offset curves to the grid axes.

IfcGridPlacement

The IfcGridPlacement provides a specialization of IfcObjectPlacement in which the placement and axis direction of the object coordinate system is defined by a reference to the design grid as defined in IfcGrid. The design grid can

be used in plan, section or in any position relative to the world.

Attribute	Implementation agreements
PlacementLocation	The IfcGeometricCurveSet shall be an (and the only) *Item* of the IfcShapeRepresentation. It should contain an *IfcGeometricCurveSet* containing subtypes of IfcCurve, each representing a grid axis.
PlacementRefDirection	Applicable subtypes of *IfcCurve* are: IfcPolyline, IfcCircle, IfcTrimmedCurve (based on BaseCurve referencing IfcLineor IfcCircle).

Example: Part21 file

```
#25=IFCCARTESIANPOINT((0.,0.));
#26=IFCCARTESIANPOINT((9.144,0.));
#27=IFCPOLYLINE((#25,#26));
#28=IFCGRIDAXIS('A-1',#27,.T.);
#29=IFCCARTESIANPOINT((0.,9.144));
#37=IFCPOLYLINE((#25,#29));
#38=IFCGRIDAXIS('A-1',#37,.T.);
#90=IFCGRIDPLACEMENT(#91,$);
```

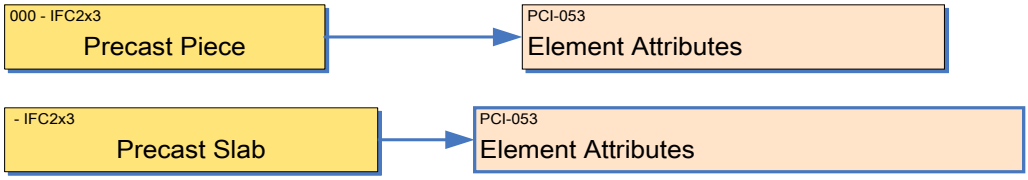
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (IFC2x3)

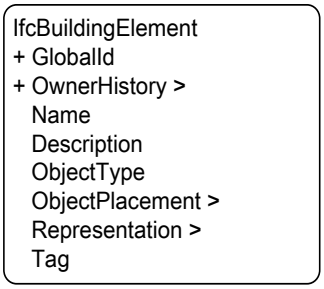
Element Attributes

Reference	PCI-053	**Version**	1.1	**Status**	Draft
Relationships	Element attributes assigned to precast or non-precast building elements.				
History					
Authors	Ivan Panushev November 2009, Chuck Eastman 15 November 2012				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	The instance types of IfcBuildingElement in this case should be assigned according to the Appendix A on page **Error! Bookmark not defined.**.
ObjectPlacement	Should carry the location of the precast piece. See different placement methods
Representation	Should carry the geometric representation of the precast piece.
Tag	Should carry the Piece Mark of the precast piece (e.g. TS_4201 in the example below).

IfcBuildingElement (ABS) –

Example: Part21 file for IfcProperySet assigned to IfcBeam

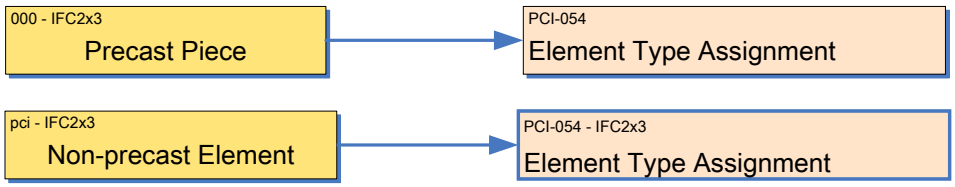
#341=
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');

IFC Release Specific Concept Description (IFC 2x3**)**

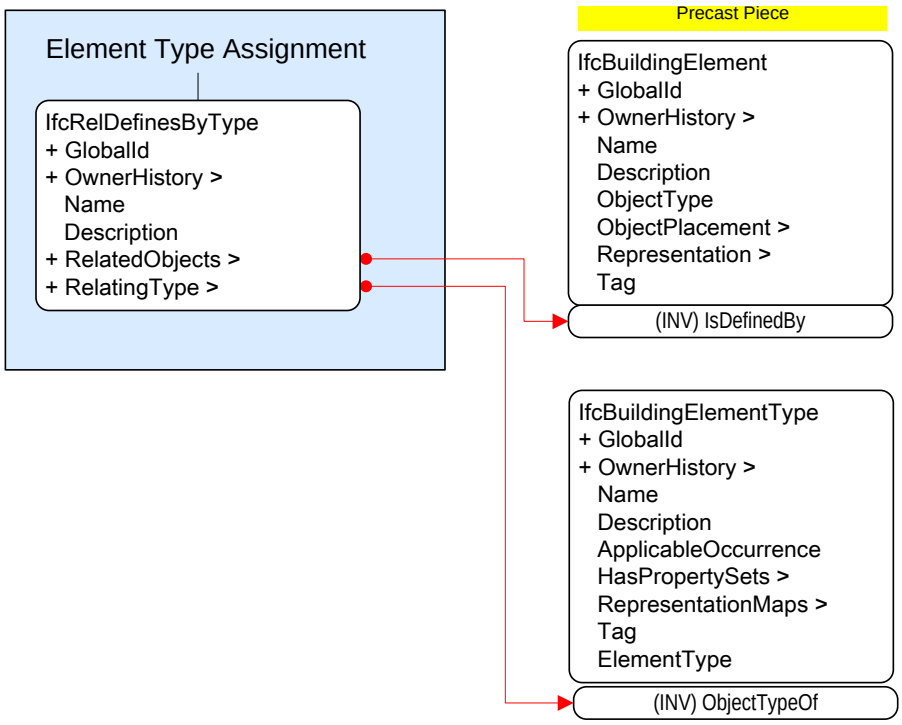
Element Type Assignment

Reference	PCI-054	**Version**	1.1	**Status**	Draft
Relationships	Associates an ElementType to an Element instance, associating the ElementType's information. BuildingElement may be any BuildingElement subtypes: Beam, Column, Simple Slab, Simple Wall, Member, Pile, Ramp, Stair or ProxyElement.. Similarly, BuildingElementType may be any of the matching subtypes.Some of these Elementand Element types have specific attributes. these are addressed in PCI-053 and PCI-080				
History	Edited 15 November, 2012				
Authors	Ivan Panushev / Aram Chuck Eastman chuck.eastman@coa.gatech.edu				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelDefinesByType

Attribute	Implementation agreements

GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedObjects	Must be subtype of IfcBuildingElement. See precast piece or precast piece mark concept bindings for rules about appropriate subtype selection.
RelatingType	Must be a sub-type of IfcBuildingElementType. The subtype must match the subtype of IfcBuildingElement (e.g. IfcBeam must have IfcBeamType for RelatingType)

IfcBuildingElement subtypes can be Precast Piece

IfcBuildingElement Representation should be (INV) of ProductRepresentation

IfcBuildingElementType can take any of its subtypes

Example: Part21 file for IcfBeam type assignments

```
#1571=
IFCBEAM('1A0gmi0000734oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#1558,#1567,'TS_2108');
#3406=
IFCRELDEFINESBYTYPE('2axqNaAIT0xgpSjZD$JSfR',#20,$,$,(#1571,#1532,#1493,#145
4,#579,#540,#501,#462,#423,#341),#360);
```

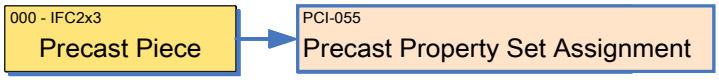
PCI NBIMS Examples - 1.ifc

IFC Release Specific Concept Description (<IFC Release 2x3>)

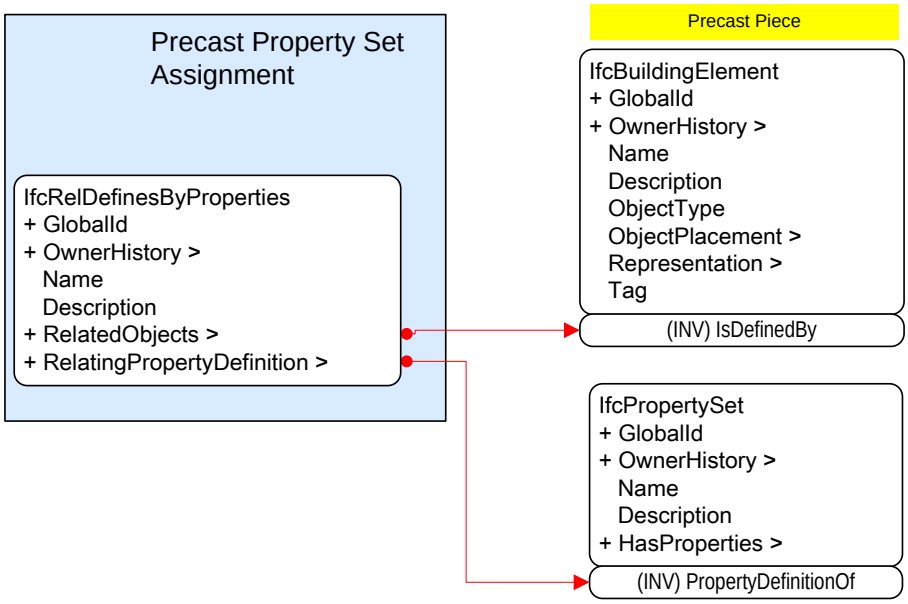
Precast Property Set Assignment

Reference	PCI-055	**Version**	1.1	**Status**	Draft
Relationships	Associates any Precast Property Set with a subtype of Element or Element Type.				
History	v.1.0 8-Aug-09; Revised Nov 21, 2012				
Authors	Rafael Sacks;				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfCBuildingElement (ABS) – This must be one of the following:

IfcBeam, IfcBeamType; IfcColumn, IfcColumnType; IfcCovering, IfcCoveringType ; IfcCurtainWall, IfcCurtainWallType; IfcFooting, IfcFootingType; IfcMember, IfcMemberType; IfcPile, IfcPileType; IfcRailing, IfcRailingType; IfcRamp, IfcRampType; IfcRampFlight, IfcRampFlightType; IfcRoof, IfcRoofType; IfcSlab, IfcSlabType; IfcStair, IfcStairType; IfcStairFlight, IfcStairFlightType; IfcWall, IfcWallType; IfcWallStandardCase

IfcPropertySet

Attribute	Implementation agreements

GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
HasProperties	<Open>

Example: Part21 file for IcfBeam type assignments

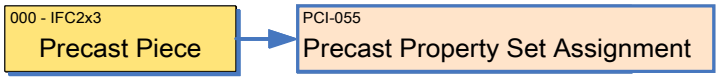
```
#341=
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#
99,#337,'TS_4201');

#382=
IFCPROPERTYSET('38ahHn1tj5j8Z$TYiLJ$Un',#20,'Pset_Gatech_General','Pset_Gatech_General',(#
366,#370,#374,#378));

#3380=
IFCRELDEFINESBYPROPERTIES('0LKxyBnDf7leOD$QJ0VaAh',#20,'NameRelDefByProperties','Des
criptionRelDefByProperties',(….., #341),#382);
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

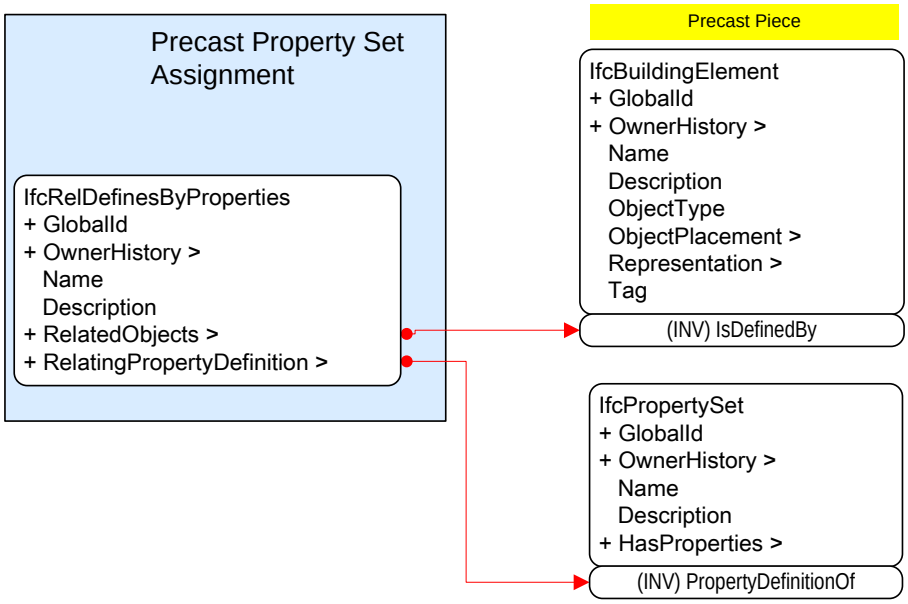
Precast Property Set Assignment

Reference	PCI-055	**Version**	1.1	**Status**	Draft
Relationships	Associates any Precast Property Set with a subtype of Element or Element Type.				
History	v.1.0 8-Aug-09; Revised Nov 21, 2012				
Authors	Rafael Sacks;				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfCBuildingElement (ABS) – This must be one of the following:

IfcBeam, IfcBeamType; IfcColumn, IfcColumnType; IfcCovering, IfcCoveringType ; IfcCurtainWall, IfcCurtainWallType; IfcFooting, IfcFootingType; IfcMember, IfcMemberType; IfcPile, IfcPileType; IfcRailing, IfcRailingType; IfcRamp, IfcRampType; IfcRampFlight, IfcRampFlightType; IfcRoof, IfcRoofType; IfcSlab, IfcSlabType; IfcStair, IfcStairType; IfcStairFlight, IfcStairFlightType; IfcWall, IfcWallType; IfcWallStandardCase

IfcPropertySet

Attribute	Implementation agreements

GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
HasProperties	<Open>

Example: Part21 file for IcfBeam type assignments

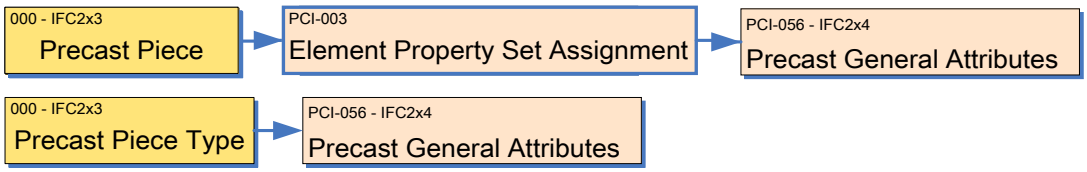
```
#341=
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#
99,#337,'TS_4201');

#382=
IFCPROPERTYSET('38ahHn1tj5j8Z$TYiLJ$Un',#20,'Pset_Gatech_General','Pset_Gatech_General',(#
366,#370,#374,#378));

#3380=
IFCRELDEFINESBYPROPERTIES('0LKxyBnDf7leOD$QJ0VaAh',#20,'NameRelDefByProperties','Des
criptionRelDefByProperties',(….., #341),#382);
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

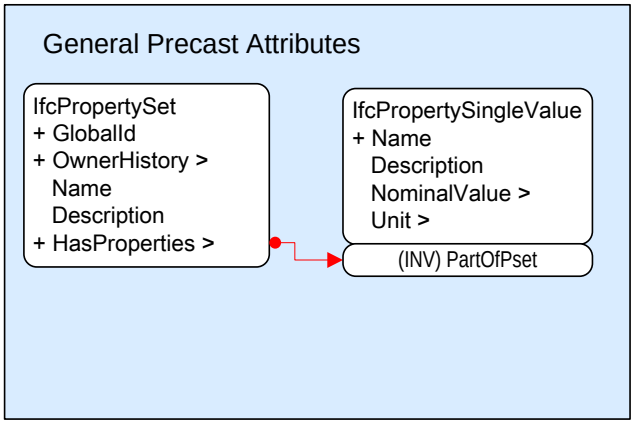
Precast General Attributes

Reference	PCI-056	**Version**	1.1	**Status**	Draft
Relationships	General precast attributes assigned to precast piece or precast piece type.				
History	v.1.0 8-Aug-09; Revised Nov 21, 2012				
Authors	Shiva Aram; Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcPropertySet

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Must be “Precast Concrete Element General Properties”
Description	<Open>
HasProperties	Must point to the full list of properties defined in the table below; one IfcPropertySingleValue must appear for each property listed in the able

IfcPropertySingleValue

Name	Must be from the table below
Description	<Open>
NominalValue	Must be from the table below
IfcUnit	Must be from the table below

The following property set definition is provided in IFC 2x4:

PropertySet Definition:

PropertySet Name	Pset_PrecastConcreteElementGeneral
Applicable Entities	IfcBeam IfcBeamType IfcBuildingElementPart IfcBuildingElementPartType IfcBuildingElementProxy IfcBuildingElementProxyType IfcColumn IfcColumnType IfcCovering IfcCoveringType IfcCurtainWall IfcCurtainWallType IfcFooting IfcFootingType IfcMember IfcMemberType IfcPile IfcPileType IfcRailing IfcRailingType IfcRamp IfcRampType IfcRampFlight IfcRampFlightType IfcRoof IfcRoofType IfcSlab IfcSlabType IfcStair IfcStairType IfcStairFlight IfcStairFlightType IfcWall IfcWallType IfcWallStandardCase
Applicable Type Value	
Definition	Definition from IAI: Production and manufacturing related properties common to different types of precast concrete elements. The Pset can be used by a number of subtypes of IfcBuildingElement. If the precast concrete element is a sandwich wall panel each structural layer or shell represented by an IfcBuildingElementPart may be attached to a separate Pset of this type, if needed. Some of the properties apply only for specific types of precast concrete elements.

Property Definitions:

Name	Data Type	Definition
TypeDesignator	IfcLabel	Type designator for the precast concrete element. The content depends on local standards. For instance in Finland it usually a one-letter acronym, e.g. P=Column, K=reinforced concrete beam,etc.
ElementWeight	IfcMassMeasure / MASSUNIT	The weight of the concrete element. Usually expressed in kg.
ElementGrossVolume	IfcVolumeMeasure / VOLUMEUNIT	The gross volume of concrete element. Usually expressed in cubic metre (m3).
ElementNetVolume	IfcVolumeMeasure / VOLUMEUNIT	The net volume of concrete element. Openings, voids, chamfers, etc. are subtracted from the gross volume. Usually expressed in cubic metre (m3).
CornerChamfer	IfcPositiveLengthMeasure / LENGTHUNIT	The chamfer in the corners of the precast element. The chamfer is presumed to be equal in both directions.
ManufacturingToleranceClass	IfcLabel	Classification designation of the manufacturing tolerances according to local standards.
FormStrippingStrength	IfcPressureMeasure / PRESSUREUNIT	The minimum required compressive strength of the concrete at form stripping time.
LiftingStrength	IfcPressureMeasure / PRESSUREUNIT	The minimum required compressive strength of the concrete when the concrete element is lifted.
ReleaseStrength	IfcPressureMeasure / PRESSUREUNIT	The minimum required compressive strength of the concrete when the tendon stress is released. This property applies to prestressed concrete elements only.

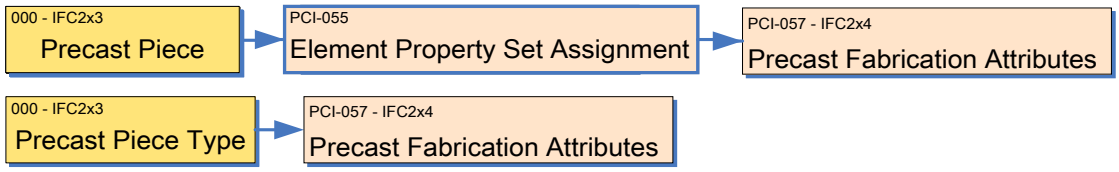
MinimumAllowableSupportLength	IfcPositiveLengthMeasure / LENGTHUNIT	The minimum allowable support length.
InitialTension	IfcPressureMeasure / PRESSUREUNIT	The initial stress of the tendon. This property applies to prestressed concrete elements only.
TendonRelaxation	IfcPositiveRatioMeasure	The maximum allowable relaxation of the tendon (usually expressed as %/1000 h).This property applies to prestressed concrete elements only.
TransportationStrength	IfcPressureMeasure / PRESSUREUNIT	The minimum required compressive strength of the concrete required for transportation.
SupportDuringTransportDescription	IfcText	Textual description of how the concrete element is supported during transportation.
SupportDuringTransportDocReference	IfcExternalReference	Reference to an external document defining how the concrete element is supported during transportation.
HollowCorePlugging	IfcLabel	A descriptive label for how the hollow core ends are treated: they may be left open, closed with a plug, or sealed with cast concrete. Values would be, for example: 'Unplugged', 'Plugged', 'SealedWithConcrete'. This property applies to hollow core slabs only.
CamberAtMidspan	IfcRatio Measure	The camber deflection, measured from the midpoint of a cambered face of a piece to the midpoint of the chord joining the ends of the same face, as shown in the figure below, divided by the original (nominal) straight length of the face of the piece.
BatterAtStart	IfcPlaneAngleMeasure	The angle, in radians, by which the formwork at the starting face of a piece is to be rotated from the vertical in order to compensate for the rotation of the face that will occur once the piece is stripped from its form, inducing camber due to eccentric prestressing.
BatterAtEnd	IfcPlaneAngle Measure	The angle, in radians, by which the formwork at the ending face of a piece is to be rotated from the vertical in order to compensate for the rotation of the face that will occur once the piece is stripped from its form, inducing camber due to eccentric prestressing.
Twisting	IfcPlaneAngle Measure	The angle, in radians, through which the end face of a precast piece is rotated with respect to its starting face, along its longitudinal axis, as a result of non-aligned supports. This measure is also termed the 'warping' angle.
Shortening	IfcRatio Measure	The ratio of the distance by which a precast piece is shortened after release from its form (due to compression induced by prestressing) to its original (nominal) length.
PieceMark	IfcLabel	Defines a unique piece for production purposes. All pieces with the same piece mark value are identical and interchangeable. The piece mark may be composed of sub-parts that have specific locally defined meaning (e.g. B-1A may denote a beam, of generic type '1' and specific shape 'A').
DesignLocationNumber	IfcLabel	For a 'precast piece' this must defines a unique location within a structure, the 'slot' for which the piece was designed. For a 'precast piece type' this must have a null or 'Not Applicable' value.
ElementSurfaceArea	IfcArea Measure	The gross surface area of the precast concrete element. Usually expressed in square metres (m^2).
ElementFormedSurface Area	IfcArea Measure	The net surface area of the precast concrete element that is in contact with a form. Usually expressed in square metres (m^2).

IFC Release Specific Concept Description (IFC 2x3**)**

Precast Fabrication Attributes

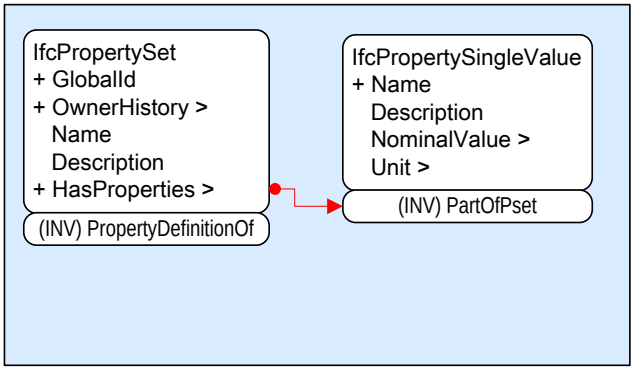
Reference	PCI-057	**Version**	1.1	**Status**	Draft
Relationships	Precast fabrication attributes assigned to precast piece or precast piece type.				
History	v.1.0 8-Aug-09; reviewed 21 November, 2012				
Authors	Rafael Sacks (cvsacks@technion.ac.il)				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram

General Precast Properties



Implementation agreements

IfcPropertySet

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Must be “Precast Concrete Element Fabrication Properties”
Description	<Open>
HasProperties	Must point to the full list of properties defined in the table below; one IfcPropertySingleValue must appear for each property listed in the able

IfcPropertySingleValue

Name	Must be from the table below
Description	<Open>
NominalValue	Must be from the table below
IfcUnit	Must be from the table below

The following property set definition is provided in IFC 2x4:

PropertySet Definition:

PropertySet Name	Pset_PrecastConcreteElementFabrication
Applicable Entities	IfcBeam IfcBuildingElementPart IfcBuildingElementProxy IfcColumn IfcCovering IfcCurtainWall ~~IfcDoor~~ IfcFooting IfcMember IfcPile IfcRailing IfcRamp IfcRampFlight IfcRoof IfcSlab IfcStair IfcStairFlight IfcWall IfcWallStandardCase
Applicable Type Value	
Definition	Definition from IAI: Fabrication related properties common to different types of precast concrete elements. The Pset can be used by a number of subtypes of IfcBuildingElement. If the precast concrete element is a sandwich wall panel each structural layer or shell represented by an IfcBuildingElementPart may be attached to a separate Pset of this type, if needed. Some of the properties apply only for specific types of precast concrete elements; their values may be left blank where inapplicable.

Property Definitions:

Name	Data Type	Definition
TypeDesignator	IfcLabel	Type designator for the precast concrete element. The content depends on local standards. For instance in Finland it usually a one-letter acronym, e.g. P=Column, K=reinforced concrete beam,etc.
ElementWeight	IfcMassMeasure / MASSUNIT	The weight of the concrete element. Usually expressed in kg.
ElementGrossVolume	IfcVolumeMeasure / VOLUMEUNIT	The gross volume of concrete element. Usually expressed in cubic metre (m^3).
ElementNetVolume	IfcVolumeMeasure / VOLUMEUNIT	The net volume of concrete element. Openings, voids, chamfers, etc. are subtracted from the gross volume. Usually expressed in cubic metre (m^3).
TransportationStrength	IfcPressureMeasure / PRESSUREUNIT	The minimum required compressive strength of the concrete required for transportation.
SupportDuringTransportDescription	IfcText	Textual description of how the concrete element is supported during transportation.
SupportDuringTransportDocReference	IfcExternalReference	Reference to an external document defining how the concrete element is supported during transportation.
PieceMark	IfcLabel	Defines a unique piece for production purposes. All pieces with the same piece mark value are identical and interchangeable. The piece mark may be composed of sub-parts that have specific locally defined meaning (e.g. B-1A may denote a beam, of generic type '1' and specific shape 'A').

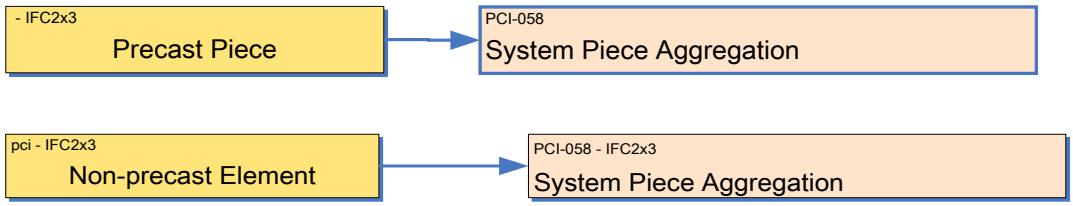
AsBuiltLocationNumber	IfcLabel	Defines a unique location within a structure, the 'slot' into which the piece was installed. Where pieces share the same piece mark, they can be interchanged. The value is only known after erection.
ActualProductionDate	IfcTimeStamp	Production date (stripped from form).
ActualErectionDate	IfcTimeStamp	Date erected.
ElementSurfaceArea	IfcArea Measure	The gross surface area of the precast concrete element. Usually expressed in square metres (m^2).
ElementFormedSurface Area	IfcArea Measure	The net surface area of the precast concrete element that is in contact with a form. Usually expressed in square metres (m^2).

IFC Release Specific Concept Description (IFC Release 2x3)

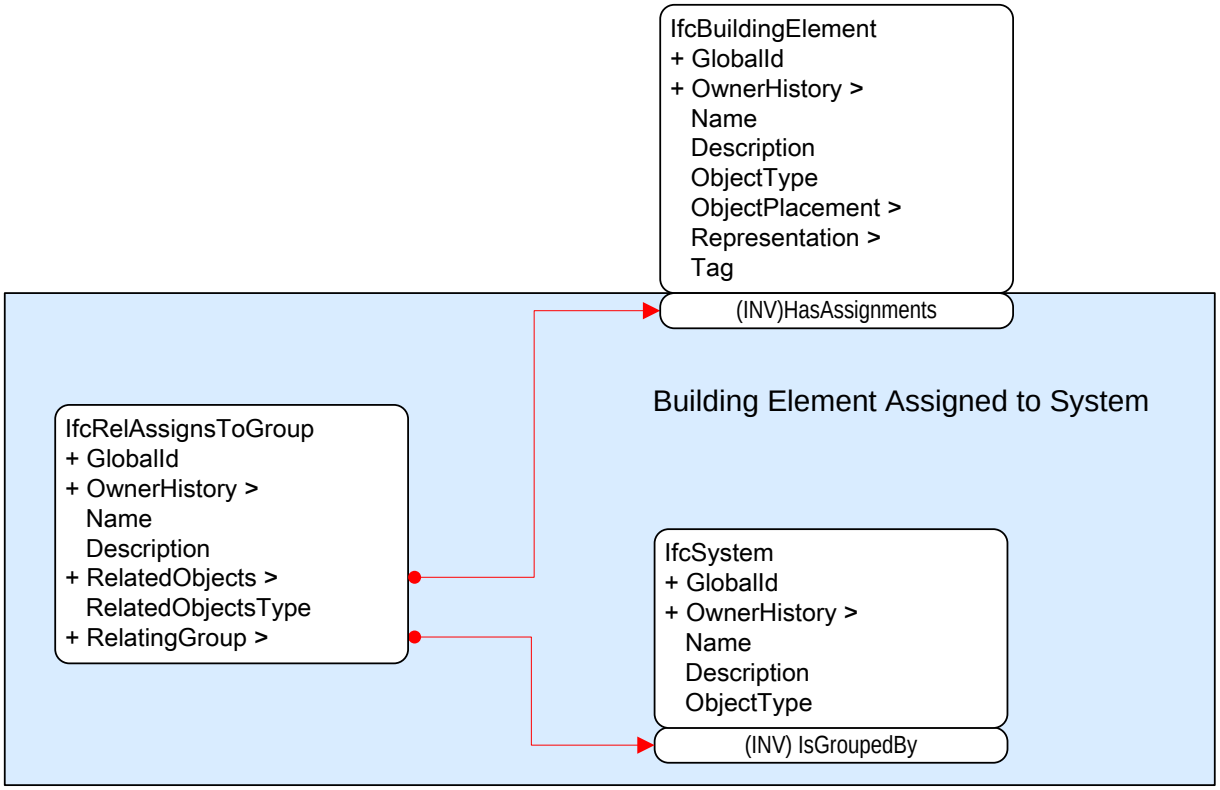
System Piece Aggregation

Reference	PCI-058	**Version**	1.1	**Status**	Draft
Relationships					
History	Reviewed and updated November 19, 2012				
Authors	Ivan Panushev/Shiva Aram, Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelAssignsToGroup:

Attribute	Implementation agreements

GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedObjects	References each precast component that is aggregated into a system. Precast element types must aggregate into precast systems. Non-precast elements must aggregate into non-precast systems. Structural elements are grouped into Structural system
RelatedObjectsType	Shall in this case always have the value 'PRODUCT'
RelatingGroup	Refers to a IfcSystem which could precast or non-precast system. IfcSystem will be defined at later stage and may include spatially disjoint pieces that belong to a building system (e.g. precast core of a building, non-precast system such as structural steel)

IfcSystem:

Attribute	**Implementation agreements**
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Identifies with Label the type of system this group represents. For our purposes, it should be 'PRECAST', 'STRUCTURAL' 'ELECTRICAL', 'MECHANICAL' or 'OTHER'

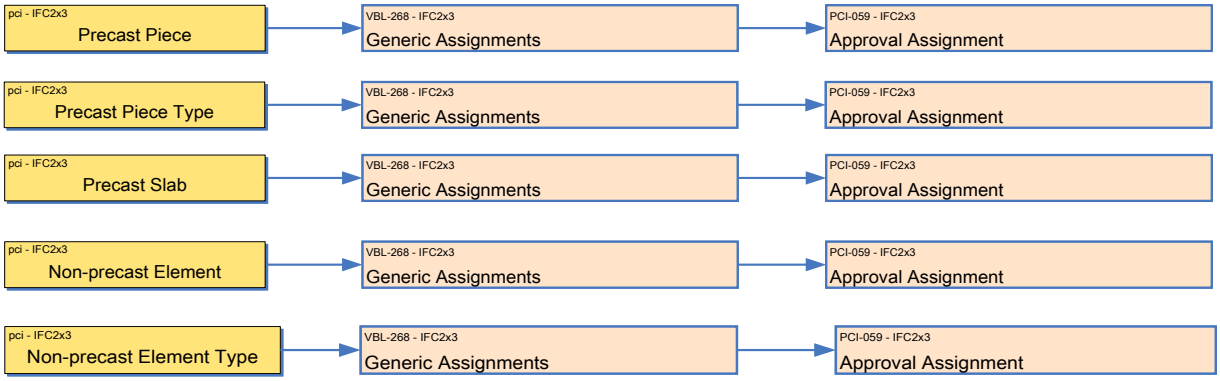
Example: Part21 file

IFC Release Specific Concept Description (<IFC Release 2x3>)

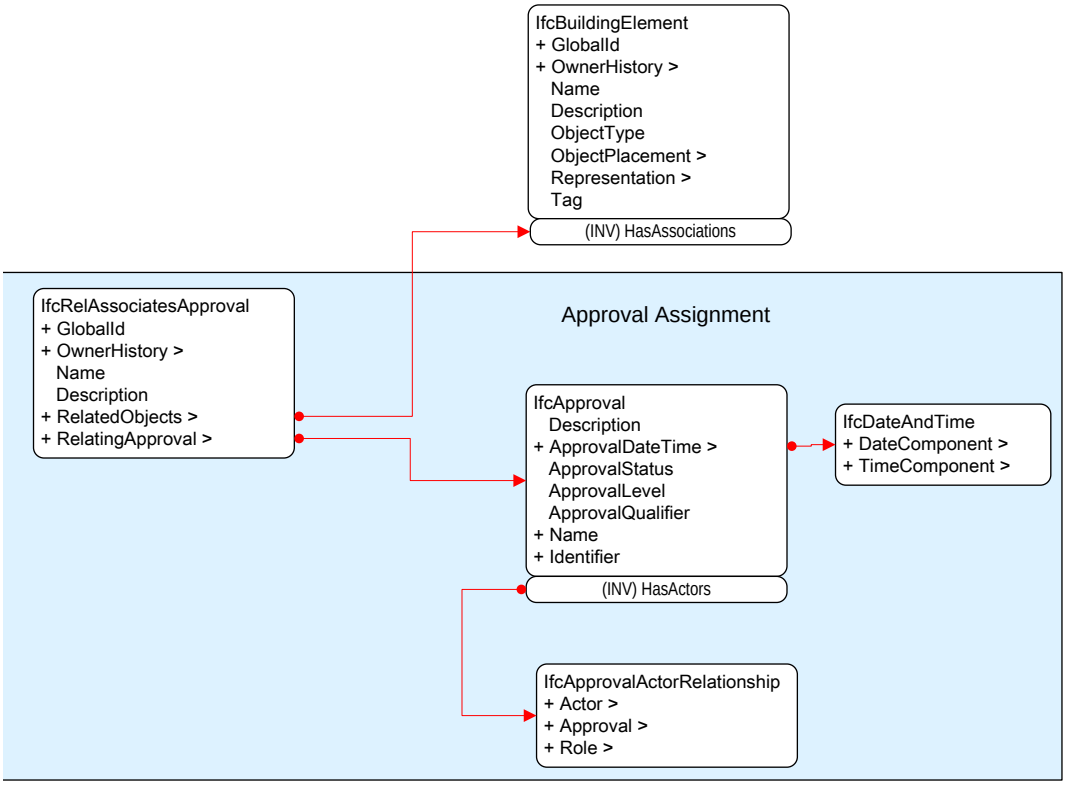
Precast Slab Aggregation

Reference	PCI-059	**Version**	1.1	**Status**	Draft
Relationships	Provides information about approval process like date and status for both precast and non-precast products and product types.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcApproval:

Attribute	Implementation agreements
Description	<Open>
ApprovalDateTime	Must be one of the select types of IfcDateTimeSelect.
ApprovalStatus	Must be provided.
ApprovalLevel	<Open>
Name	Must be provided
ApprovalQualifier	<Open>
Identifier	<Open>

IfcApprovalActorRelationship:

Attribute	Implementation agreements
Actor	Must be one of the select types IfcActorSelect.
Approval	Must be an IfcApproval.
Role	<Open>

IfcRelAssociatesApproval:

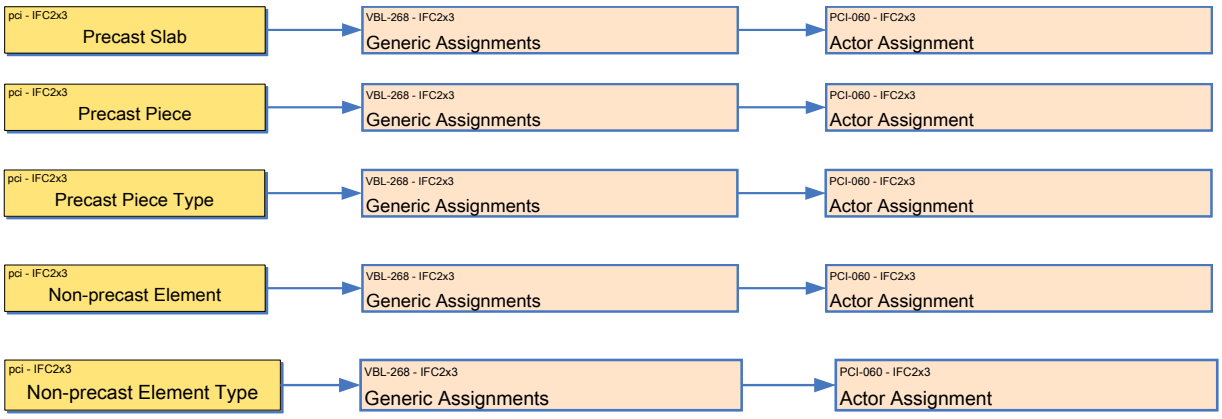
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data.
Name	<Open>
Description	<Open>
RelatedObjects	Must be one of the subtypes of IfcBuildingElement.
RelatingApproval	Must be IfcApproval.

IFC Release Specific Concept Description (<IFC Release 2x3>)

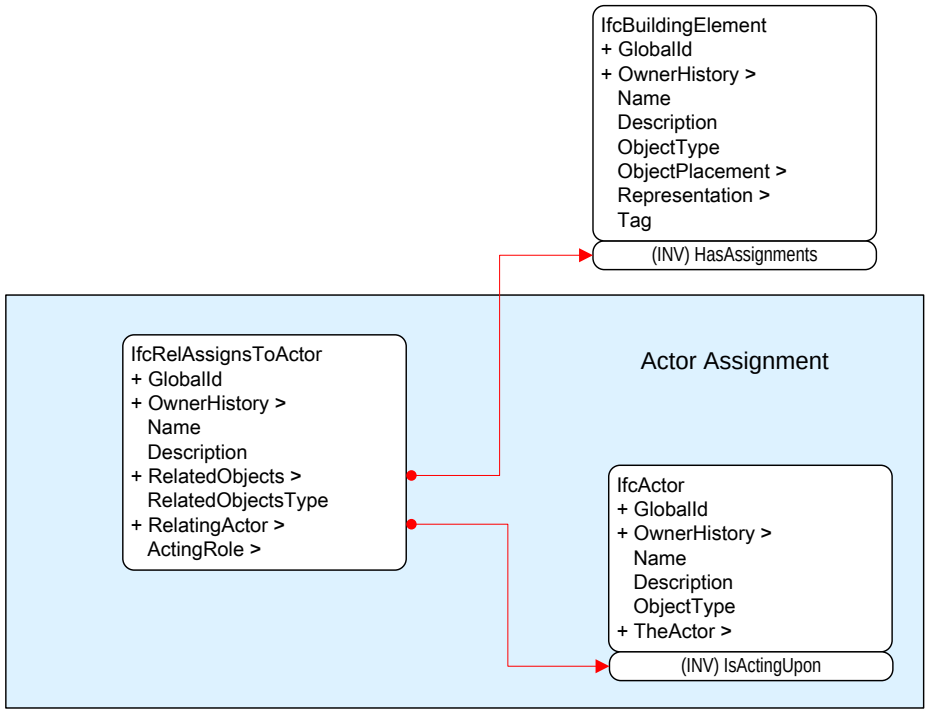
Actor Assignment

Reference	PCI-060	**Version**	1.1	**Status**	Draft
Relationships	Provides a reference to a person or an organization for both precast and non-precast products and product types.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcActor:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
TheActor	Must be one of the select types IfcActorSelect.

IfcRelAssignsToActor

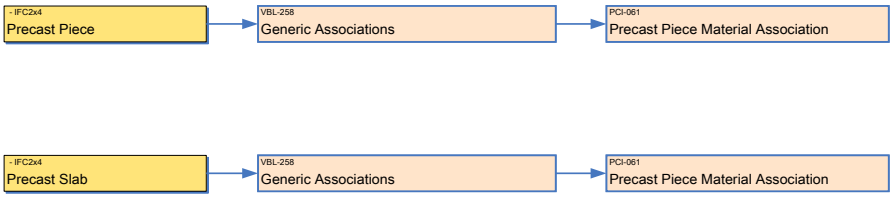
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data.
Name	<Open>
Description	<Open>
RelatingObject	Must be one of the subtypes of IfcBuildingElement.
RelatedObjectsType	<Open>
RelatingActor	Must be IfcActor or one of its select types.

IFC Release Specific Concept Description (Release 2x3**)**

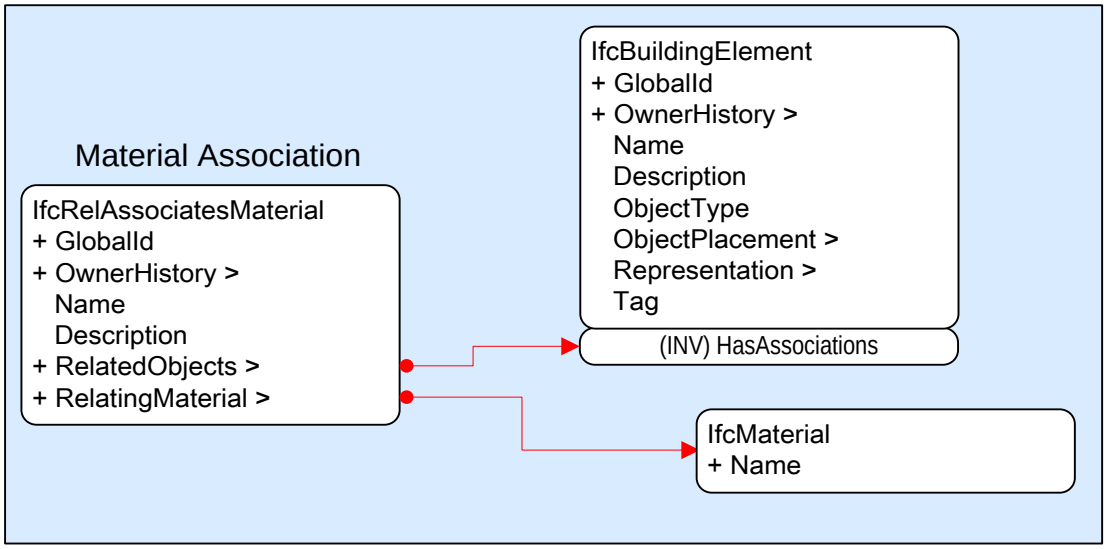
Precast Piece Material Association

Reference	PC-061	**Version**	1.1	**Status**	Draft
Relationships	Assigns material to either precast or non-precast elements.				
History	Developed Fall, 2009, revised for submission 12 November, 2012				
Authors	Ivan Panushev, Chuck Eastman (chuck.eastman@coa.gatech.edu)				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelAssociatesMaterial

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedObjects	Must be subtype of IfcBuildingElement.
RelatingMaterial	Must be a sub-type of IfcMaterial

IfcMaterial

Attribute	Implementation agreements
Name	<Open>

Example: Part21 file

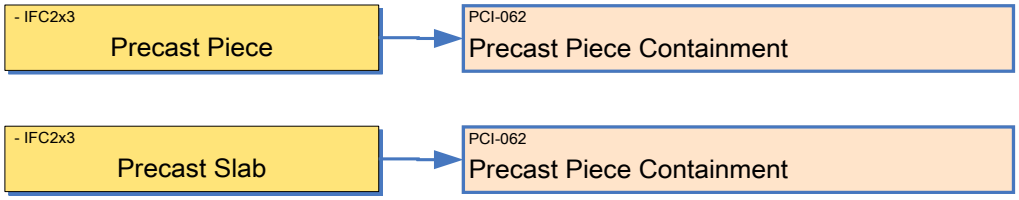
```
#400= IFCMATERIAL('CONCRETE',$,$);
#423=
IFCBEAM('1A0gmi0000yZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(2
00X1200)',#410,#419,'TS_2628');
#3418=
IFCRELASSOCIATESMATERIAL('3$I9WKOi13bu_AGccPjPTG',#20,$,$,(#3353,#3314,#3275
,#3232,#3197,#3134,#2973,#2905,#2711,#2617,#2069,#1649,#1571,#1532,#1493,#14
54,#1415,#1337,#1259,#1181,#1103,#1025,#928,#579,#540,#501,#462,#423,#341),#
400);
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

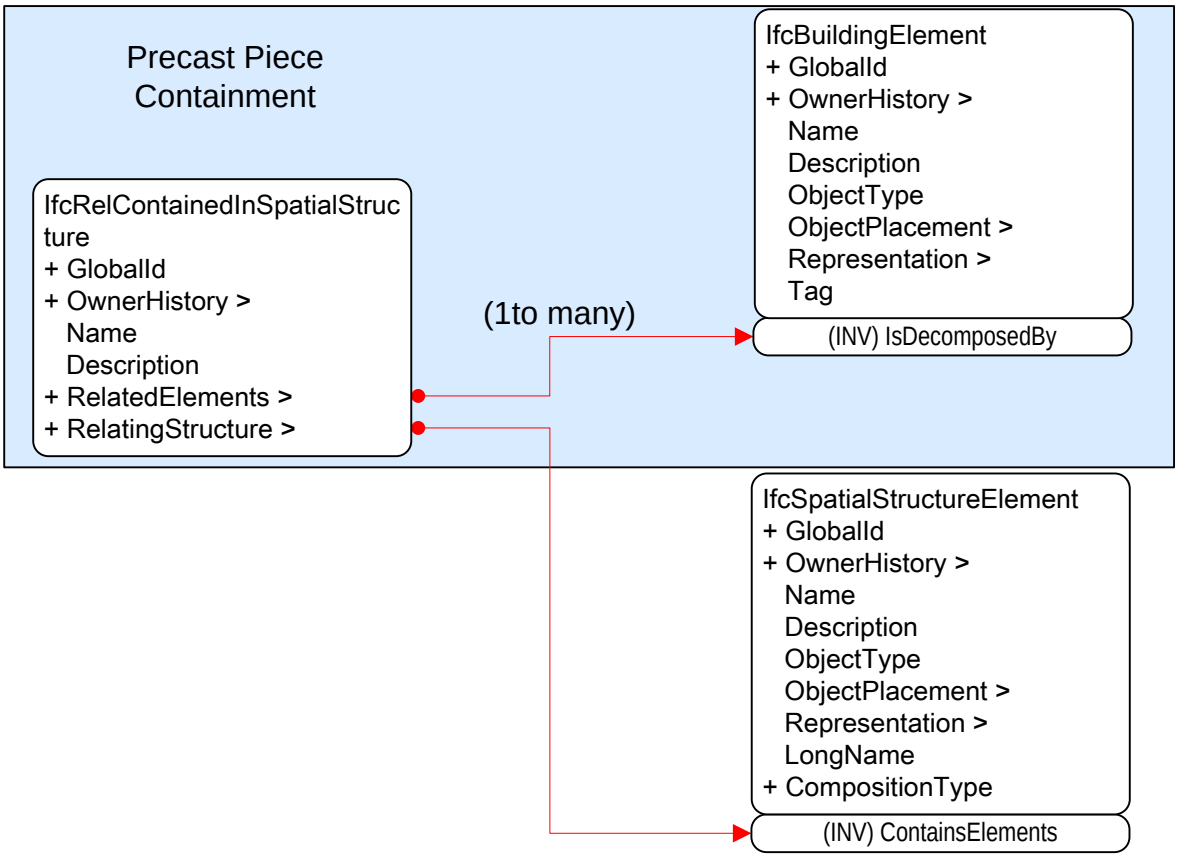
Precast Piece Containment

Reference	PCI-062	**Version**	1.1	**Status**	Draft
Relationships	Assigns piece to IFC spatial containment hierarchy				
History	Revised Nov 18, 2012				
Authors	Manu Venugopal (manu.menon@gatech.edu); Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

If there are building elements and/or other elements directly related to the *IfcBuilding* (like a curtain wall spanning several stories), they are associated with the *IfcBuilding* by using the objectified relationship *IfcRelContainedInSpatialStructure*.

IfcRelContainedInSpatialStructure

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedElements	Must be a subtype of IfcBuildingElement
RelatingStructure	Must be a subtype ofIfcSpatialStructureElement (IfcSite, IfcBuilding, IfcBuildingStorey, IfcSpace)

Example: Part21 file (Precast Pieces contained in Building Storey)

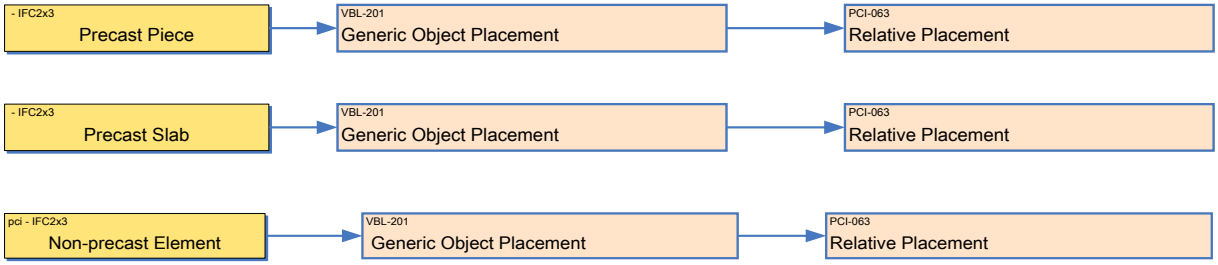
```
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);

#3378=
IFCRELCONTAINEDINSPATIALSTRUCTURE('1R760Euj51FQHbiAdnFr7L',#20,$,$,(#3353,#3314,#3275,#3232,#3197,#3134,#2973,#2905,#2711,#2617,#2069,#1649,#1610,#1571,#1532,#1493,#1454,#1415,#1376,#1337,#1298,#1259,#1220,#1181,#1142,#1103,#1064,#1025,#986,#928,#741,#579,#540,#501,#462,#423,#341),#82);
```

IFC Release Specific Concept Description (IFC 2x3)

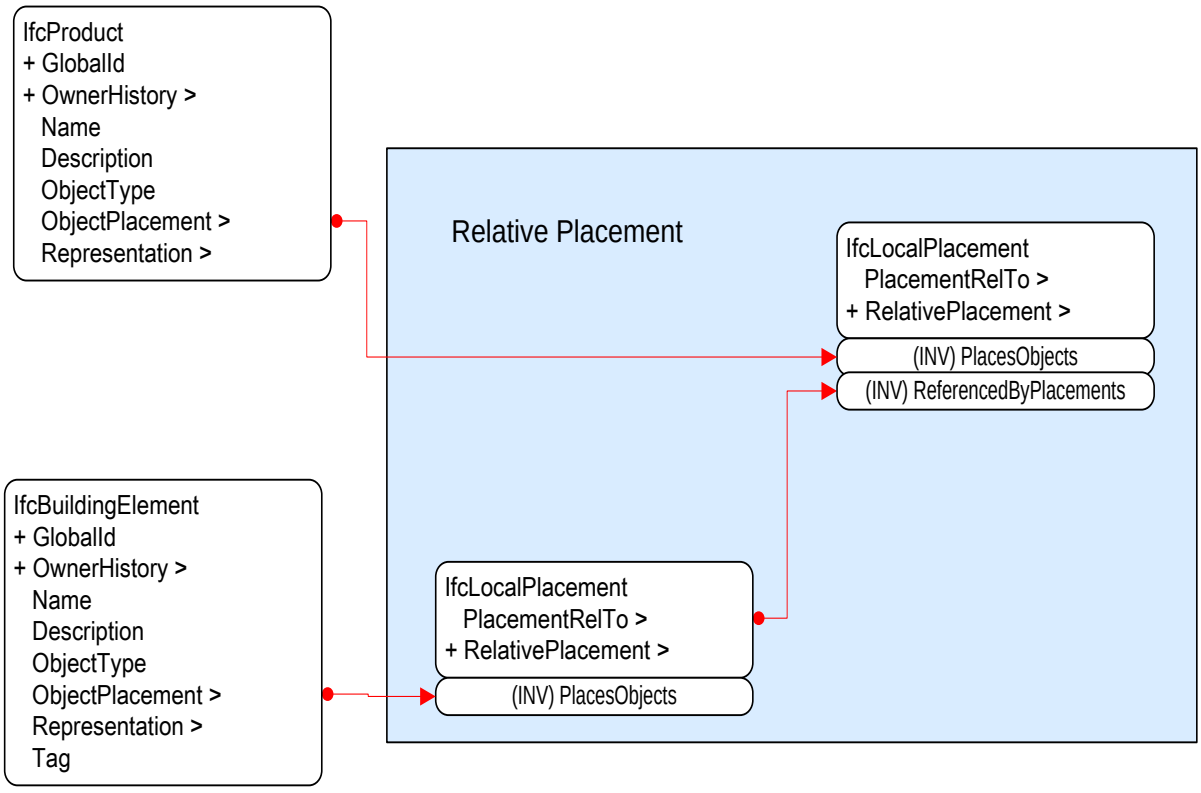
Relative Placement

Reference	PCI-063	**Version**	1.1	**Status**	Draft
Relationships	Placement of precast or non-precast elements relative to another element.				
History	Reviewed November 19, 2012				
Authors	Ivan Panushev /Shiva (vahideh) Aram Chuck Eastman(chuck.eastman@gatech.edu)				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcLocalPlacement

The implementation conventions regarding how placements are defined for Building Containment and for composition with other Elements, described in IfcLocalPlacement are to be followed.

Attribute	Implementation agreements
PlacementRelTo	Could be related to another local placement
RelativePlacement	Must be provided, but may contain dummy data
(INV)PlacesObject	Must be inversely related to a subtype of IfcSpatialElement
(INV)ReferencedByPlacement	Must be inversely related to IfcLocalPlacement

IfcLocalPlacement

Attribute	Implementation agreements
PlacementRelTo	Must be related to local placement
RelativePlacement	Must be related to IfcAxis2Placement3D
(INV) PlacesObjects	Must be subtype of IfcBuildingElement

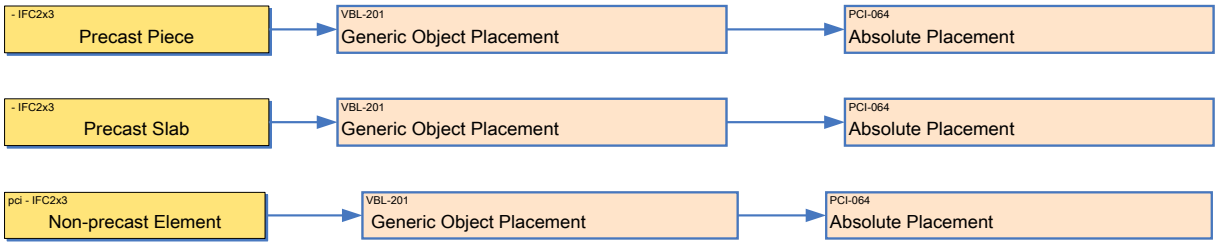
Example: Part 21 File

IFC Release Specific Concept Description (IFC 2x3)

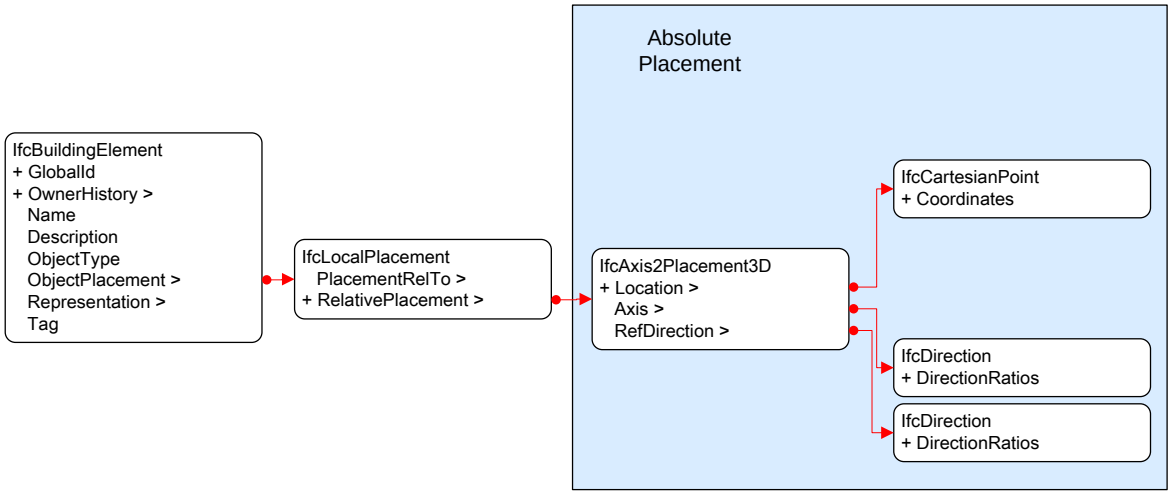
Absolute Placement

Reference	PCI-064	Version	1.1	Status	Draft
Relationships	Placement of a building element in absolute project coordinates.				
History	Last reviewed November 16, 2012				
Authors	Ivan Panushev / Shiva Aram (shiva.aram@gatech.edu), Chuck Eastman				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

Precast piece must be subtype of IfcBuildingElement

Example: Part21 file for Absolute placement of IfcBeam

```
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#423=
IFCBEAM('1A0gmi0000yZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#410,#419,'TS_2628');
#442= IFCCARTESIANPOINT((220.,3012.5,2300.));
#446= IFCAXIS2PLACEMENT3D(#442,#33,#25);
#449= IFCLOCALPLACEMENT(#79,#446);
```

PCI NBIMS Examples - 1.ifc

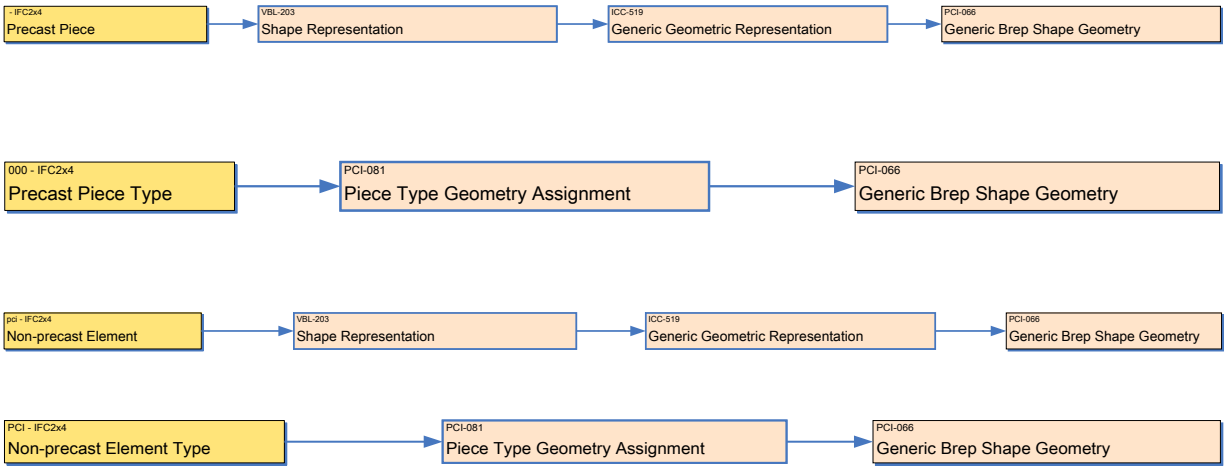
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (<IFC Release 2x3>)

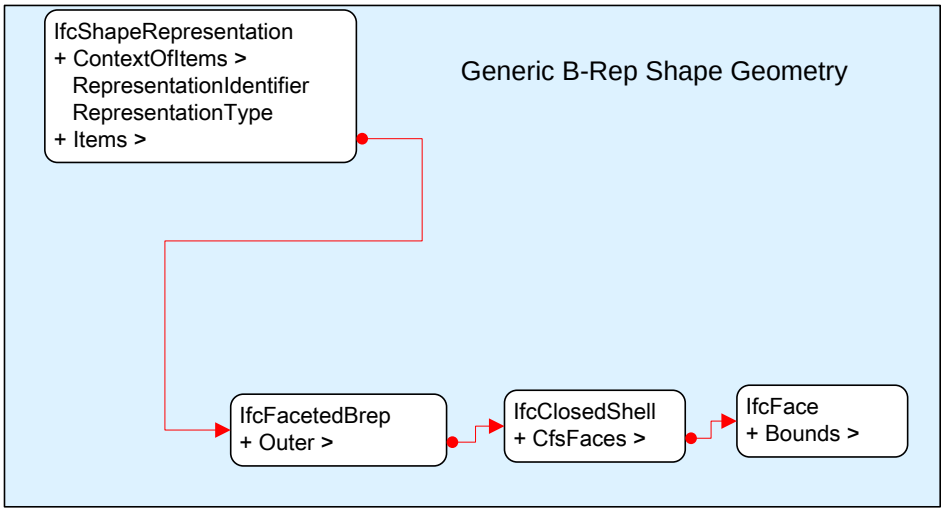
Generic Brep Shape Geometry

Reference	PCI-066	**Version**	1.1	**Status**	Draft
Relationships	Provides Brep geometry both for precast and non-precast types and instances				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcFacetedBrep:

Attribute	Implementation agreements
Outer	It must be an IfcClosedShell.

Part 21 Example: B-rep geometry

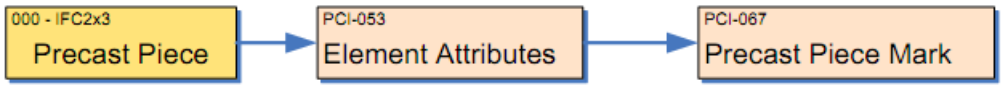
```
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');

#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

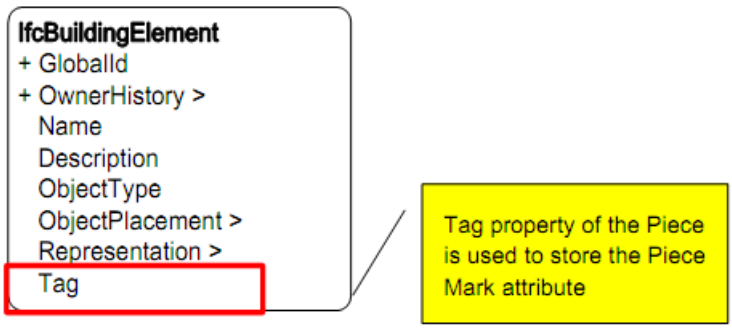
Precast Piecemark

Reference	PCI-067	**Version**	1.1	**Status**	Draft
Relationships	Element attributes assigned to precast building elements.				
History	v.1.0 8-Aug-09				
Authors	Rafael Sacks (cvsacks@techunix.technion.ac.il)				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	The instance types of IfcBuildingElement in this case should be assigned according to the Appendix A on page **Error! Bookmark not defined.**.
ObjectPlacement	Should carry the location of the precast piece. See different placement methods
Representation	Should carry the geometric representation of the precast piece.
Tag	**Should carry the Piece Mark of the precast piece (e.g. TS_4201 in the example below).**

Example: Part21 file for piece mark value of an IfcBeam representing a

#341= IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'SLAB_PART','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');

This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)

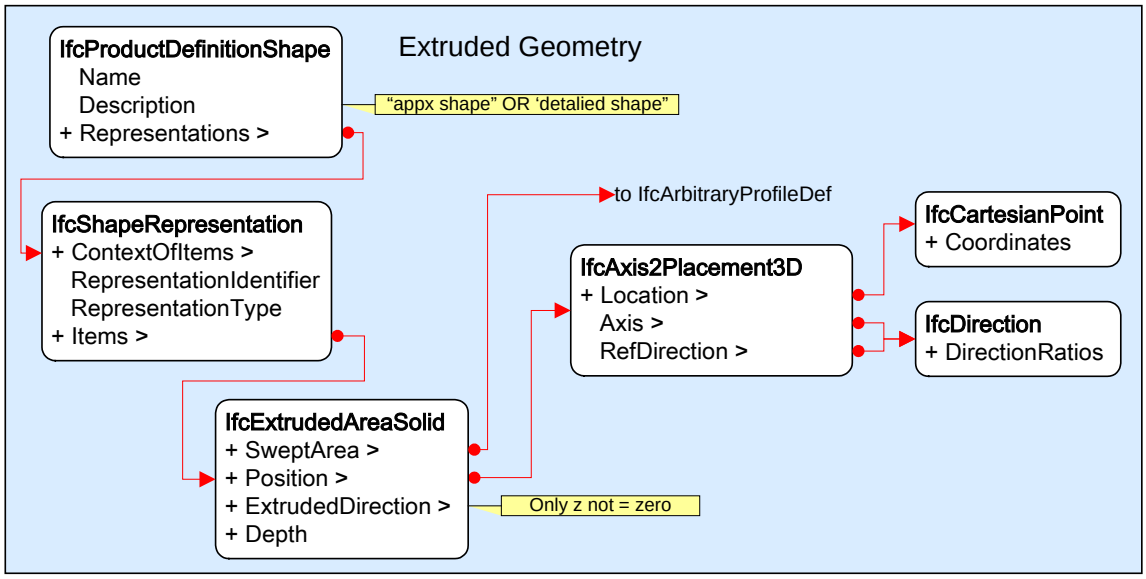
IFC Release Specific Concept Description (<IFC Release 2x3>)

Extruded Geometry

Reference	PCI-068	**Version**	1.1	**Status**	Draft
Relationships					
History	Derived from VBL-278; defined 28 June 2009; reviewed 16 November, 2012				
Authors	Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcProductDefinitionShape:

Name:	N/A
Description:	Must be either "ApproximateShape" OR "DetailedProfile"
Representations:	Must be IfcShapeRepresentation

IfcShapeRepresentation:

ContextOfItems:	N/A
RepresentationIdentifier:	Must be "Body"
RepresentationType:	Must be "SweptSolid"
Items:	Must be ExtrudedAreaSolid

IfcExtrudedAreaSolid:

SweptArea:	references profile that will be swept along ExtrudedDirection
Position:	identifies coordinate system for extrusion profile (x-y plane; default is down z-axis)
ExtrudedDirection:	Vector indicating direction from position for sweep (default: 0,0,1)
Depth:	length of extrusion

Instance Example:

```
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#410));
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341=
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_420
1');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410=IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,'PLT10',#309);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,765.2);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
#419= IFCPRODUCTDEFINITIONSHAPE('','DetailedProfile',(#414);
```

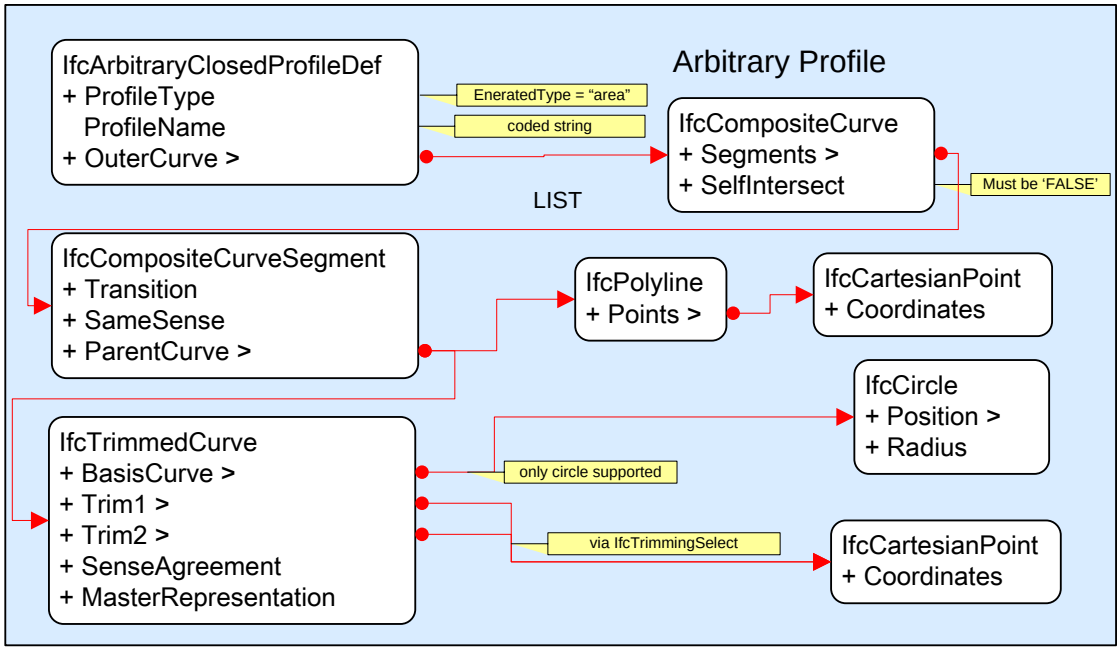
IFC Release Specific Concept Description (<IFC Release 2x3>)

Arbitrary Profile

Reference	PCI-069	**Version**	1.1	**Status**	Draft
Relationships	Used to define section profile at both approximate and detailed level of accuracy				
History	Adapted from VBL-338; Defined 7/1/2009; Revised 15 November 2012				
Authors	Chuck Eastman (chuck.eastman@coa.gatech.edu)				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcArbitraryClosedProfileDef:

ProfileType:	Must be .AREA.
ProfileName:	Used to carry producer's profile name as string
OuterCurve:	Must be IfcCompositeCurve

IfcCompositeCurve:

Segments:	Must be LIST of one or more references to IfcCompositeCurveSegment
SelfIntersect:	Must be .FALSE.

IfcCompositeCurveSegment:

Transition:	Defines transition type from this segment to next on list. Must be one of enumeration of IfcTransitionCode; Must not be .DISCONTINUOUS.
SameSense:	BOOLEAN whether segment sense of direction is same as parent curve
ParentCurve:	References profile curve; If IfcProductDefinitionShape.description = "appx shape", then this should be a single IfcPolyline;

	If IfcProductDefinitionShape.description = “detail shape”, then this can be any mixture of IfcPolyline and IfcTrimmedCurve;
IfcTrimmedCurve:	
BasisCurve:	Must be reference to IfcCircle
Trim1:	Must be IfcPoint coincident to circle
Trim2:	Must be IfcPoint coincident to circle
SenseAgreement	.BOOLEAN. whether segment sense of direction is same as parent curve
MasterRepresentation	Must be .CARTESIAN.

Instance Example (appx shape):

```
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#99= IFCLOCALPLACEMENT(#79,#96);
#268= IFCCARTESIANPOINT((-5.,-4.));
#249= IFCCARTESIANPOINT((5.,-4.));
#230= IFCCARTESIANPOINT((5.,4.));
#211= IFCCARTESIANPOINT((4.,4.));
#192= IFCCARTESIANPOINT((4.,-3.));
#193= IFCCARTESIANPOINT((-4.,-3.));
#194= IFCCARTESIANPOINT((-4.,4.));
#195= IFCCARTESIANPOINT((-5.,4.));
#309= IFCPOLYLINE((#268,#249,#230,#211,#192,#193,#194,#195,#268));
#310= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#309);
#311= IFCCOMPOSITECURVE(.CONTINUOUS.,.T.,(#310));
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#410));
#337= IFCPRODUCTDEFINITIONSHAPE('','appx shape',(#331));
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410=IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,’PLT10’,#311);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,765.2);
#414= IFCSHAPEREPRESENTATION(#40,’Body’,’SweptSolid’,(#413));
```

Instance Example (detail shape):

```
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#99= IFCLOCALPLACEMENT(#79,#96);
#268= IFCCARTESIANPOINT((-4.75,-4.));
#249= IFCCARTESIANPOINT((4.75,-4.));
#230= IFCCARTESIANPOINT((5.,-3.75));
#211= IFCCARTESIANPOINT((5.,4.));
#192= IFCCARTESIANPOINT((4.,4.));
#193= IFCCARTESIANPOINT((4.,-2.75));
#194= IFCCARTESIANPOINT((3.75,-3.));
```

```
#195= IFCCARTESIANPOINT((-3.75,-3.));
#196= IFCCARTESIANPOINT((-4.,-2.75));
#197= IFCCARTESIANPOINT((-4.,4.));
#198= IFCCARTESIANPOINT((-5.,4.));
#199= IFCCARTESIANPOINT((-5.,-3.75));
#200= IFCCARTESIANPOINT((-4.75,-3.75));
#201= IFCCARTESIANPOINT((4.75,-3.75));
#202= IFCCARTESIANPOINT((-3.75,-2.75));
#203= IFCCARTESIANPOINT((3.75,-2.75));

#309= IFCPOLYLINE((#268,#249));
#310= IFCPOLYLINE((#230,#211,#192,#193));
#311= IFCPOLYLINE((#194,#195));
#312= IFCPOLYLINE((#196,#197,#198,#199));
#320= IFCCIRCLE(#201,0.25);
#321= IFCCIRCLE(#200,0.25);
#322= IFCCIRCLE(#202,0.25);
#323= IFCCIRCLE(#203,0.25);

#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#410));
#337= IFCPRODUCTDEFINITIONSHAPE('','detail shape',(#331));
#350= IFCTRIMMEDCURVE(#320,#249,#230,.T.,.CARTESIAN.);
#351= IFCTRIMMEDCURVE(#321, #193,#194,.F.,.CARTESIAN.);
#352= IFCTRIMMEDCURVE(#322,#195,#196,.F.,.CARTESIAN.);
#353= IFCTRIMMEDCURVE(#323, #199,#268,.T.,.CARTESIAN.);

#370= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#309);
#371= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#350);
#372= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#310);
#373= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#351);
#374= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#311);
#375= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#352);
#376= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#312);
#377= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#353);

#361= IFCCOMPOSITECURVE(.CONTINUOUS.,.T.,(#370,#371,#372,#373,#374,#375,#376,#377));

#410=IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,'PLT10',#361);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,765.2);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
```

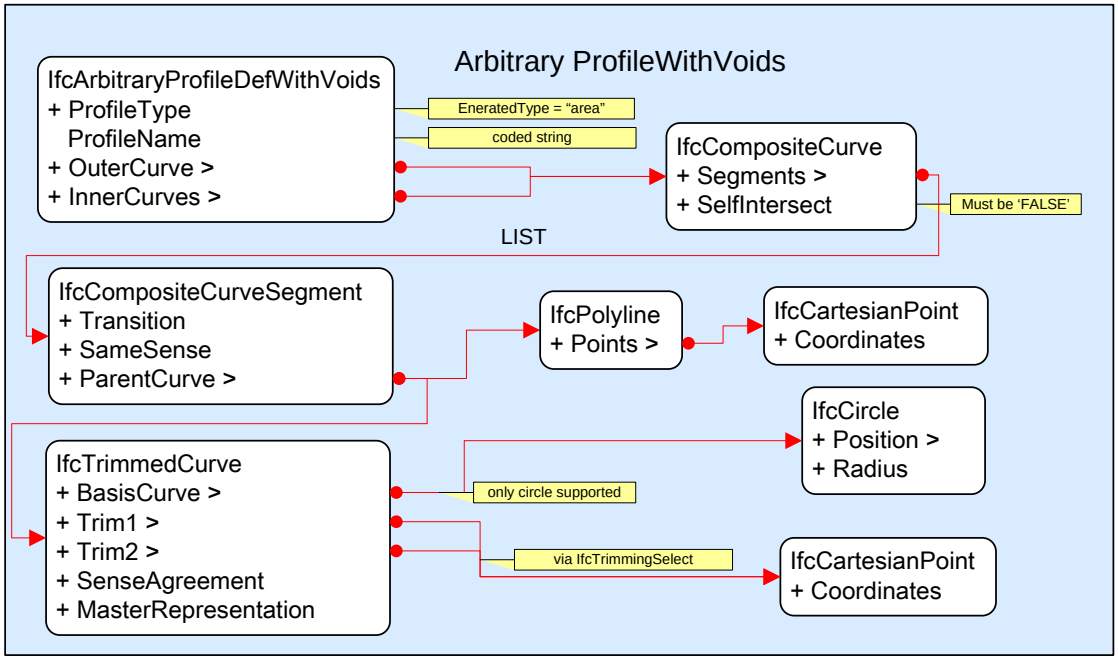
IFC Release Specific Concept Description (<IFC Release 2x3>)

Arbitrary Profile with Voids

Reference	PCI-070	**Version**	1.1	**Status**	Draft
Relationships	Used to define section profile at both approximate and detailed level of accuracy				
History	Adapted from VBL-338; Defined 7/1/2009; reviewed 16 November, 2012				
Authors	Chuck Eastman (chuck.eastman@coa.gatech.edu)				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcArbitraryProfileDefWithVoids:

ProfileType:	Must be .AREA.
ProfileName:	Used to carry producer's profile name as string
OuterCurve:	Must be IfcCompositeCurve
InnerCurves	Must be IfcCompositeCurve

IfcCompositeCurve:

Segments:	Must be LIST of one or more references to IfcCompositeCurveSegment
SelfIntersect:	Must be .FALSE.

IfcCompositeCurveSegment:

Transition:	Defines transition type from this segment to next on list. Must be one of enumeration of IfcTransitionCode; Must not be .DISCONTINUOUS.

SameSense:	BOOLEAN whether segment sense of direction is same as parent curve
ParentCurve:	References profile curve; If IfcProductDefinitionShape.description = “appx shape”, then this should be a single IfcPolyline; If IfcProductDefinitionShape.description = “detail shape”, then this can be any mixture of IfcPolyline and IfcTrimmedCurve;
IfcTrimmedCurve:	
BasisCurve:	Must be reference to IfcCircle
Trim1:	Must be IfcPoint coincident to circle
Trim2:	Must be IfcPoint coincident to circle
SenseAgreement	.BOOLEAN. whether segment sense of direction is same as parent curve
MasterRepresentation	Must be .CARTESIAN.

Instance Example (appx shape):

```
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#99= IFCLOCALPLACEMENT(#79,#96);
#268= IFCCARTESIANPOINT((-5.,-4.));
#249= IFCCARTESIANPOINT((5.,-4.));
#230= IFCCARTESIANPOINT((5.,4.));
#211= IFCCARTESIANPOINT((-5.,4.));
#192= IFCCARTESIANPOINT((4.,-3.));
#193= IFCCARTESIANPOINT((-4.,-3.));
#194= IFCCARTESIANPOINT((-4.,3.));
#195= IFCCARTESIANPOINT((-4.,3.));
#308= IFCPOLYLINE((#268,#249,#230,#211,#268));
#309= IFCPOLYLINE((#192,#193,#194,#195,#192));
#310= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#308);
#311= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#309);
#312= IFCCOMPOSITECURVE(.CONTINUOUS.,.T.,(#310,#311));
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#410));
#337= IFCPRODUCTDEFINITIONSHAPE('','appx shape',(#331));
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410=IFCARBITRARYPROFILEDEFWITHVOIDS(.AREA.,’PLT10’,#310,(#311));
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,765.2);
#414= IFCSHAPEREPRESENTATION(#40,’Body’,’SweptSolid’,(#413));
```

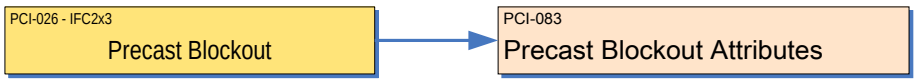
Instance Example (detail shape):

```
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#99= IFCLOCALPLACEMENT(#79,#96);
#268= IFCCARTESIANPOINT((-4.75,-4.));
```

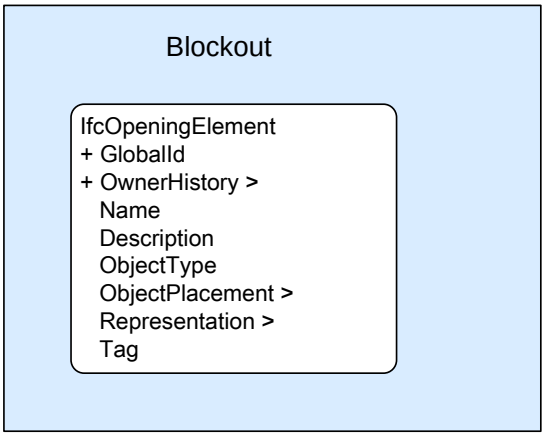
```
#249= IFCCARTESIANPOINT((4.75,-4.));
#230= IFCCARTESIANPOINT((5.,-3.75));
#211= IFCCARTESIANPOINT((5.,4.));
#212= IFCCARTESIANPOINT((-5.,4.));
#193= IFCCARTESIANPOINT((-5.,-3.75));

#194= IFCCARTESIANPOINT((3.75,-3.));
#195= IFCCARTESIANPOINT((-3.75,-3.));
#196= IFCCARTESIANPOINT((-4.,-2.75));
#197= IFCCARTESIANPOINT((-4.,3.));
#198= IFCCARTESIANPOINT((4.,3.));
#199= IFCCARTESIANPOINT((4.,-2.75));

#200= IFCCARTESIANPOINT((-4.75,-3.75));
#201= IFCCARTESIANPOINT((4.75,-3.75));
#202= IFCCARTESIANPOINT((-3.75,-2.75));
#203= IFCCARTESIANPOINT((3.75,-2.75));

#309= IFCPOLYLINE((#268,#249));
#310= IFCPOLYLINE((#230,#211,#212,#193));
#311= IFCPOLYLINE((#194,#195));
#312= IFCPOLYLINE((#196,#197,#198,#199));
#320= IFCCIRCLE(#201,0.25);
#321= IFCCIRCLE(#200,0.25);
#322= IFCCIRCLE(#202,0.25);
#323= IFCCIRCLE(#203,0.25);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#410));
#337= IFCPRODUCTDEFINITIONSHAPE('','detail shape',(#331));
#350= IFCTRIMMEDCURVE(#320,#249,#230,.T.,.CARTESIAN.);
#351= IFCTRIMMEDCURVE(#321,#193,#268,.F.,.CARTESIAN.);
#352= IFCTRIMMEDCURVE(#322,#195,#196,.F.,.CARTESIAN.);
#353= IFCTRIMMEDCURVE(#323,#199,#194,.T.,.CARTESIAN.);
#370= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#309);
#371= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#350);
#372= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#310);
#373= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#351);
#374= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#311);
#375= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#352);
#376= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#312);
#377= IFCCOMPOSITECURVESEGMENT(.CONTINUOUS.,.T.,#352);
#361= IFCCOMPOSITECURVE(.CONTINUOUS.,.T.,(#370,#371,#372,#373,#374,#375,#376,#377));
#410=IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,'PLT10',#361);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,765.2);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
```

IFC Release Specific Concept Description (IFC 2x3) Blockout Attributes					
Reference	PCI-071	**Version**	1.1	**Status**	Draft
Relationships	PCI-085, PCI-074				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

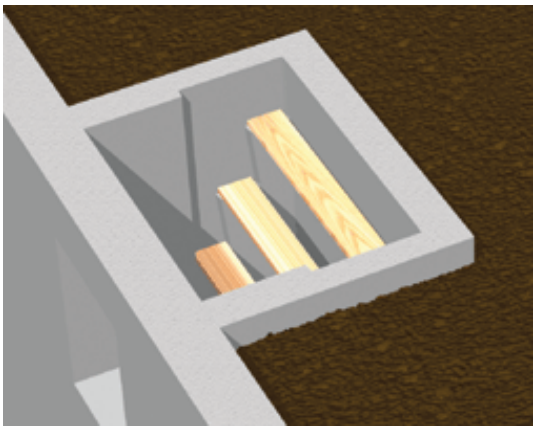
IfcOpeningElement

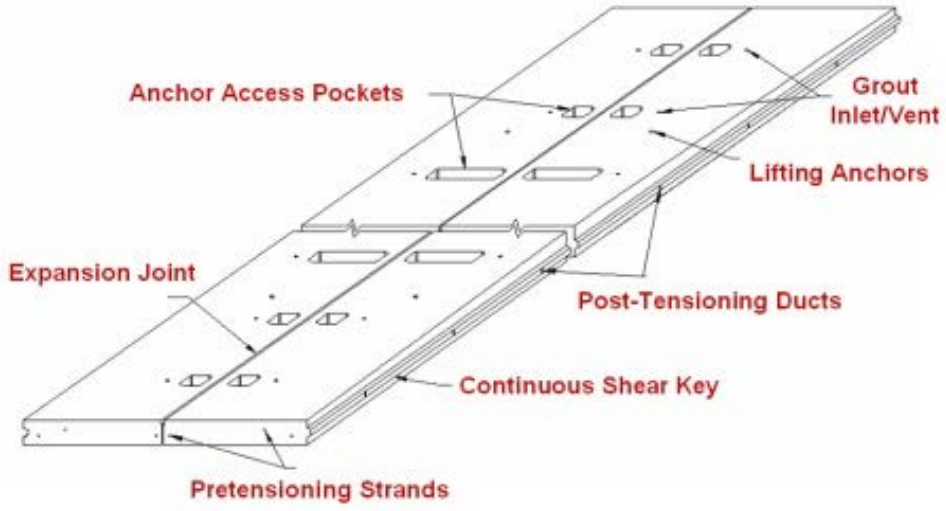
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be provided. Should specify the functionality of the blockout like 'Hole for railing-pipe', or 'Cutout for ladder/step' or 'Anchor access Pockets/Recess' etc
ObjectPlacement	Inversely related to the concept Relative Placement through PlacesObject.
Representation	Inversely related to IfcProductDefinitionShape through ShapeOfProduct.

Tag	<Open>

Example:

- Pockets
- Pier blockout
- Ladder blockout
- Steps etc





Part21 file showing a precast blockout in a slab

```
#42=IFCOWNERHISTORY(#41,#2,$,.NOCHANGE.,$,$,$,0);
#45=IFCBUILDING('1e1pw9a0nDbhFnmT4WjXgb',#42,$,$,$,#34,$,$,.ELEMENT.,$,$,#44);
#46=IFCAXIS2PLACEMENT3D(#3,$,$);
#47=IFCLOCALPLACEMENT(#34,#46);
#48=IFCBUILDINGSTOREY('2JF4e6axWHqu3u0C1FZlmi',#42,'Level 1',$,$,#47,$,$,.ELEMENT.,0.);
#49=IFCCARTESIANPOINT((0.,0.,10.));
#50=IFCAXIS2PLACEMENT3D(#49,$,$);
#58=IFCCARTESIANPOINT((60.24530467461261,53.32976377895601));
#59=IFCAXIS2PLACEMENT2D(#58,#14);
#60=IFCRECTANGLEPROFILEDEF(.AREA.,$,#59,20.,50.);
#61=IFCCARTESIANPOINT((85.24530467461261,-43.32976377895601,1.));
#62=IFCAXIS2PLACEMENT3D(#61,#10,#6);
#63=IFCEXTRUDEDAREASOLID(#60,#62,#9,1.);
#64=IFCCOLOURRGB($,0.5019607843137255,0.5019607843137255,0.5019607843137255);
#65=IFCSURFACESTYLERENDERING(#64,0.,$,$,$,$,IFCNORMALISEDRATIOMEASURE(0.00390625),IFCSPECULAREXPONENT(10.),
```

```
.NOTDEFINED.);
#66=IFCSURFACESTYLE('Default Floor',.BOTH.,(#65));
#67=IFCPRESENTATIONSTYLEASSIGNMENT((#66));
#68=IFCSTYLEDITEM(#63,(#67),$);
#69=IFCSHAPEREPRESENTATION(#36,'Body','SweptSolid',(#63));
#70=IFCPRODUCTDEFINITIONSHAPE($,$,(#69));
#71=IFCSLAB('0$xNU6XhTBl9NZIwWjuP2M',#42,'Floor:Generic - 12":137385',$,'Floor:Generic - 12"',#57,#70,'137385',.FLOOR.);
#72=IFCCARTESIANPOINT((82.73870785149919,45.38945015580823));
#73=IFCAXIS2PLACEMENT2D(#72,#11);
#74=IFCCIRCLEPROFILEDEF(.AREA.,$,#73,0.5);
#75=IFCCARTESIANPOINT((85.24530467461261,-43.32976377895601,1.));
#76=IFCAXIS2PLACEMENT3D(#75,#10,#6);
#77=IFCEXTRUDEDAREASOLID(#74,#76,#9,1.);
#78=IFCPRESENTATIONSTYLEASSIGNMENT((#66));
#79=IFCSTYLEDITEM(#77,(#78),$);
#80=IFCSHAPEREPRESENTATION(#36,'Body','SweptSolid',(#77));
#81=IFCPRODUCTDEFINITIONSHAPE($,$,(#80));
#83=IFCOPENINGELEMENT('3Yq_gqLM1DexERZhmy0pCs',#42,$,$,'Opening',#82,#81,'137482');
#84=IFCRELVOIDSELEMENT('0r8YLQV9T7E9SDx_Z$n28Z',#42,$,$,#71,#83);
```

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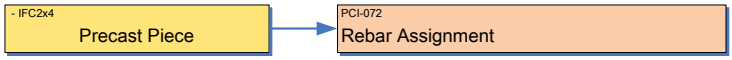
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (IFC 2x3) Precast Rebar Assignment					
Reference	PCI-072	**Version**	1.1	**Status**	Draft
Relationships	PCI-086, PCI-088, PCI-090, PCI-104				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

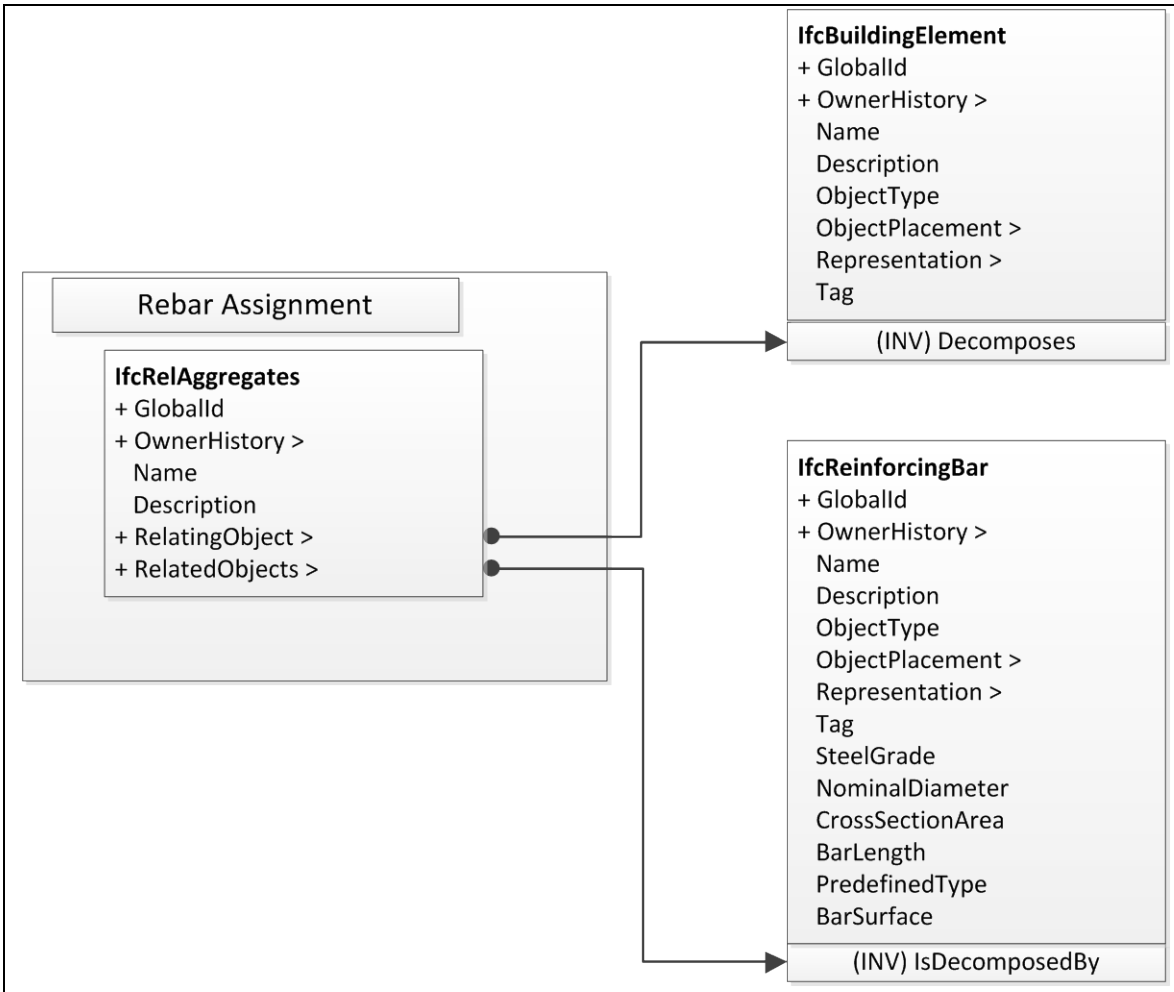
Usage in view definition diagram



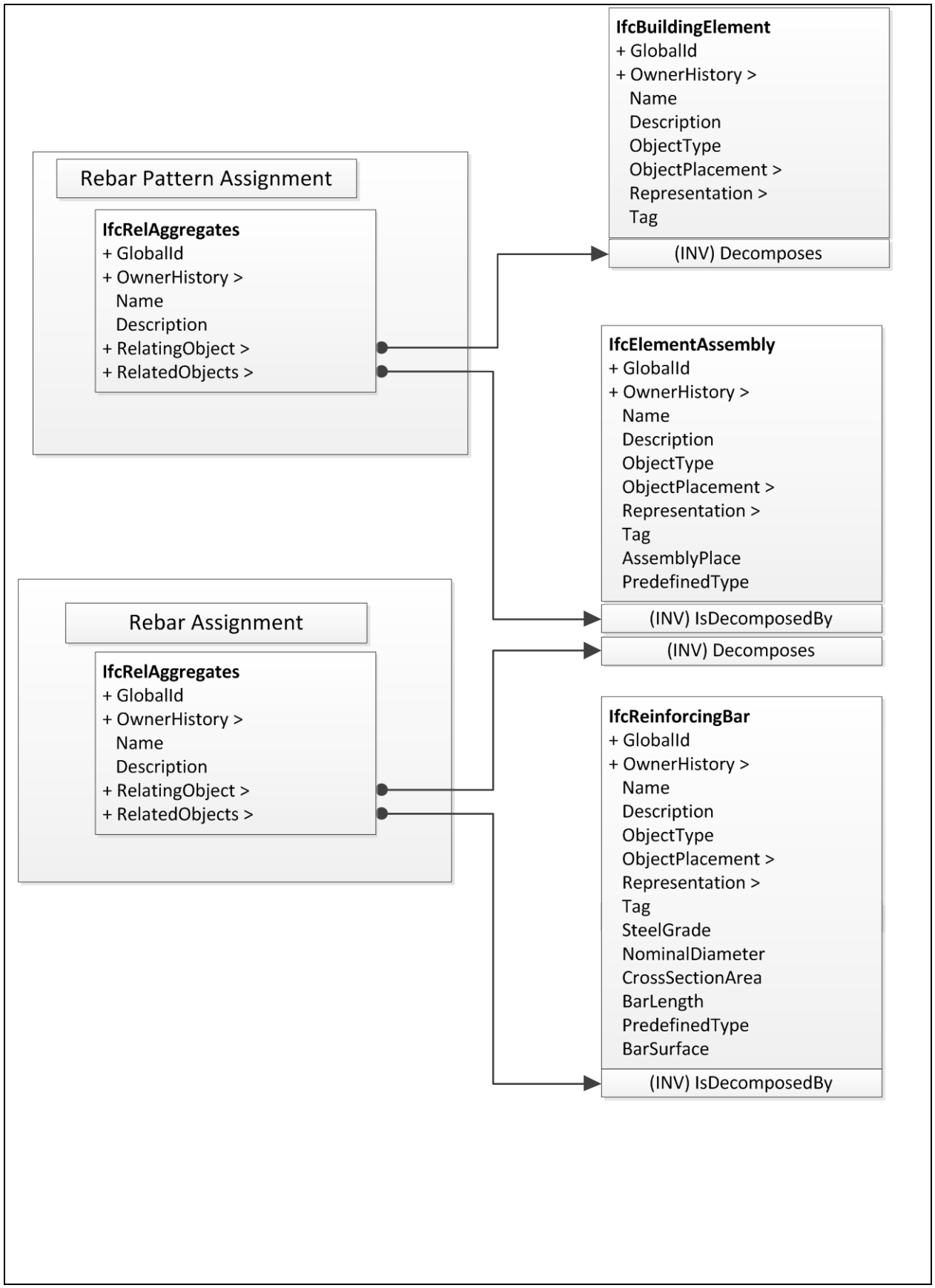
Instantiation diagram

Reinforcing bar uses IfcReinforcingBar for individual reinforcing bars and IfcElementAssembly for reinforcement units made from several reinforcement bars, such as column rebar cage. Relationship between structural element (beam, column) and rebar is established by IfcRelAggregates (case 1). Rebar can aggregated into an element assembly (cage or mesh) using the relationship IfcRelAggregates. In this case, individual instances of rebar should not carry the aggregation to the structural element; it should be provided through the element assembly entity as shown in Case 2 below. A rebar assembly entity may be aggregated within more than one building element.

Case 1)


IfcBuildingElement
+ GlobalId
+ OwnerHistory >
Name
Description
ObjectType
ObjectPlacement >
Representation >
Tag
(INV) Decomposes
Rebar Assignment
IfcRelAggregates
+ GlobalId
+ OwnerHistory >
Name
Description
+ RelatingObject >
+ RelatedObjects >
IfcReinforcingBar
+ GlobalId
+ OwnerHistory >
Name
Description
ObjectType
ObjectPlacement >
Representation >
Tag
SteelGrade
NominalDiameter
CrossSectionArea
BarLength
PredefinedType
BarSurface
(INV) IsDecomposedBy

Case 2)


IfcBuildingElement
+ GlobalId
+ OwnerHistory >
Name
Description
ObjectType
ObjectPlacement >
Representation >
Tag
(INV) Decomposes
Rebar Pattern Assignment
IfcRelAggregates
+ GlobalId
+ OwnerHistory >
Name
Description
+ RelatingObject >
+ RelatedObjects >
IfcElementAssembly
+ GlobalId
+ OwnerHistory >
Name
Description
ObjectType
ObjectPlacement >
Representation >
Tag
AssemblyPlace
PredefinedType
(INV) IsDecomposedBy
(INV) Decomposes
Rebar Assignment
IfcRelAggregates
+ GlobalId
+ OwnerHistory >
Name
Description
+ RelatingObject >
+ RelatedObjects >
IfcReinforcingBar
+ GlobalId
+ OwnerHistory >
Name
Description
ObjectType
ObjectPlacement >
Representation >
Tag
SteelGrade
NominalDiameter
CrossSectionArea
BarLength
PredefinedType
BarSurface
(INV) IsDecomposedBy

Implementation agreements

IfcRelAggregates

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedObjects	Must be subtype of IfcDiscreteAccessory. See precast embed or precast embed type concept bindings for rules about appropriate subtype selection.
RelatingType	Must be a sub-type of IfcBuildingElement.

IfcReinforcingBar

Attribute	Implementation agreements
GUID	Must be provided. (IfcGloballyUniqueId)
OwnerHistory	Must be provided, but may contain dummy data (IfcOwnerHistory)
Name	The Name attribute has to be provided for the rebar (IfcLabel).
Description	Optional description may be provided (IfcText)
ObjectType	Optional. (IfcLabel).
ObjectPlacement	Must be provided. Should be a subtype of IfcObjectPlacement
Representation	Must be provided only if there is no type defined. Should be a subtype of IfcProductRepresentation implemented using extruded IfcSweptDiskSolid.
Tag	Optional.
SteelGrade	NULL. If needed, the nominal steel grade defined according to local standards can be provided as a property set at type level, if type is present.
NominalDiameter	NULL. The cross-section size of the reinforcing bar must be attached as a property set at type level, if type is present or else at the individual bar level.
CrossSectionArea	NULL.Should be attached as a property set at type level, if type is present

Barlength	NULL. The total length of the reinforcing bar. The total length of bended bars are calculated according to local standards with corrections for the bends. Should be attached as a property set at type level. Rebar of same type are interchangeable.
BarRole	NULL
BarSurface	NULL .Indicating whether the bar is plain or textured. This should also be attached as a property set at type level, if type is present.

Example: Part21 file for Aggregation Reinforcing Bar in to a Cage

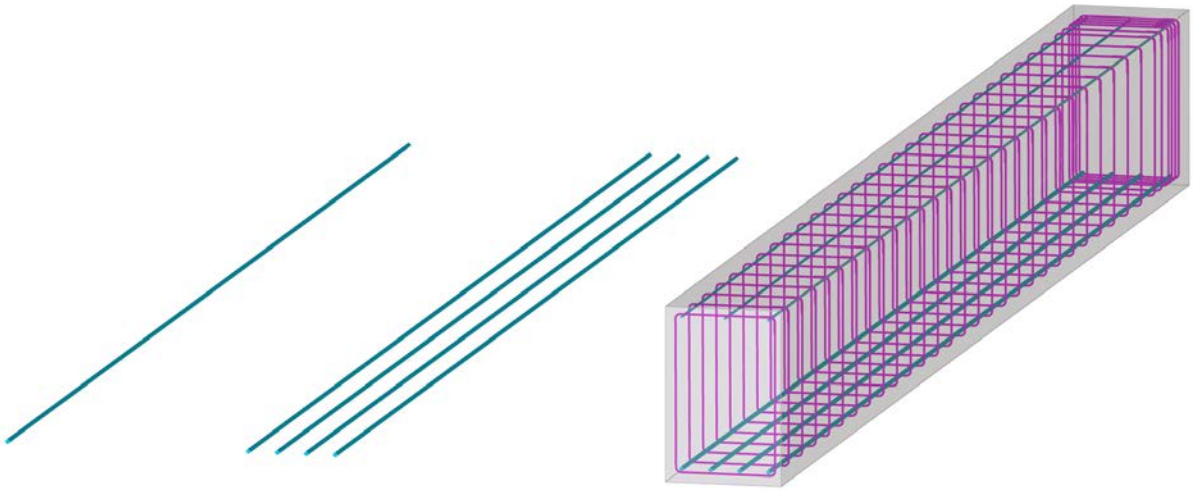
```
/* Swept disk solid reinforcing bar */
#88= IFCCARTESIANPOINT((65493.9,18573.988,-746.1245));
#89= IFCAXIS2PLACEMENT3D(#88,#9,#32);
#90= IFCLOCALPLACEMENT(#29,#89);
#91= IFCCOLOURRGB('Dark Green',0.40000001,0.69803923,0.2);
#92=
IFCSURFACESTYLERENDERING(#91,0.,$,$,$,$,IFCNORMALISEDRATIOMEASURE(0.00390625),IFCSPECULAREXPONENT(10.),.NOTDEFINED.);
#93= IFCSURFACESTYLE($,.POSITIVE.,(#92));
#94= IFCPRESENTATIONSTYLEASSIGNMENT((#93));
#95= IFCVECTOR(#7,1.);
#96= IFCLINE(#6,#95);
#97=
IFCTRIMMEDCURVE(#96,(IFCPARAMETERVALUE(0.)),(IFCPARAMETERVALUE(14325.6)),.T.,.PARAMETER.);

#98= IFCSWEPTDISKSOLID(#97,14.2875,$,0.,14325.6);
#99= IFCSTYLEDITEM(#98,(#94),$);
#100= IFCCARTESIANPOINT((0.,-342.423999999999,0.));
#101= IFCCARTESIANTRANSFORMATIONOPERATOR3D($,$,#100,$,$);
#102= IFCAXIS2PLACEMENT3D(#6,#9,#7);
#103= IFCSHAPEREPRESENTATION(#12,'Body','AdvancedSweptSolid',(#98));
#104= IFCREPRESENTATIONMAP(#102,#103);

/* First Instance */
#304= IFCREINFORCINGBAR('1FElfirstXJ4pCZanDpCq',#5,'REBAR',$,$,$,$,,$,$,$,$,.NOTDEFINED.,$);

/* Second Instance */
#305=
IFCREINFORCINGBAR('1FEl3secondsXJ4pCZanDpCq',#5,'REBAR',$,$,$,$,$,$,$,$,$,.NOTDEFINED.,$);


/* Assembly of bottom rebar */
#310= IFCELEMENTASSEMBLY('1FEI3U000bottomZanDJ8o',#5,'Bottom Rebar Assembly','Assembly of Bottom reinforcing bars',$,#90,$,$,.FACTORY.,.REINFORCEMENT_UNIT.);
#359= IFCRELAGGREGATES('2whnkWmanu7g6aeArkTlH9',#5,$,$,#310,(#304,#305));
```



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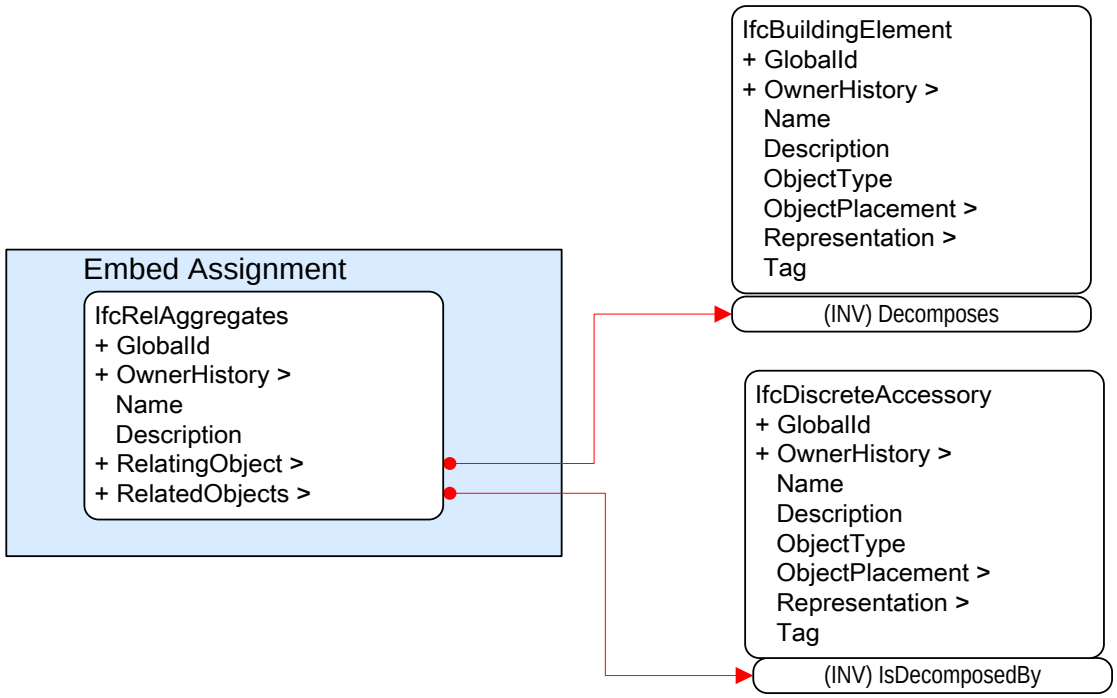
IFC Release Specific Concept Description (IFC 2x3**)** Precast Embed Assignment					
Reference	PCI-073	**Version**	1.1	**Status**	Draft
Relationships	PCI-102				
History	Revised Nov 13, 2012				
Authors	Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcRelAggregates

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>

Description	<Open>
RelatedObjects	Must be subtype of IfcDiscreteAccessory. See precast embed or precast embed type concept bindings for rules about appropriate subtype selection.
RelatingType	Must be a sub-type of IfcBuildingElement.

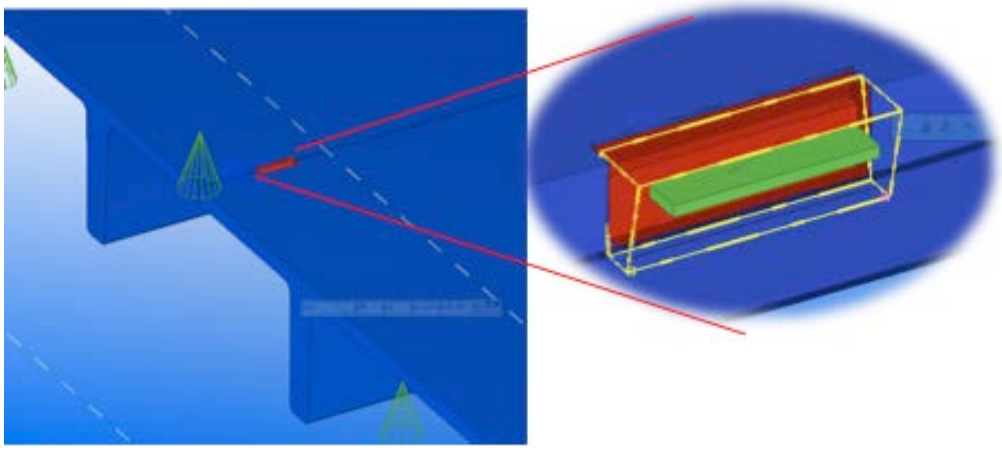
IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

Example: Part21 file for Aggregation of Embed in Beam

```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
```

#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341= IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#409,10.,160.);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,780.);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#414);
#421= IFCDISCRETEACCESSORY('1A0gmi1112rZ4oD34sE3au',#20,'EMBED-PLATE',$,$,#99,#419,$);
#422= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#341,(#421));



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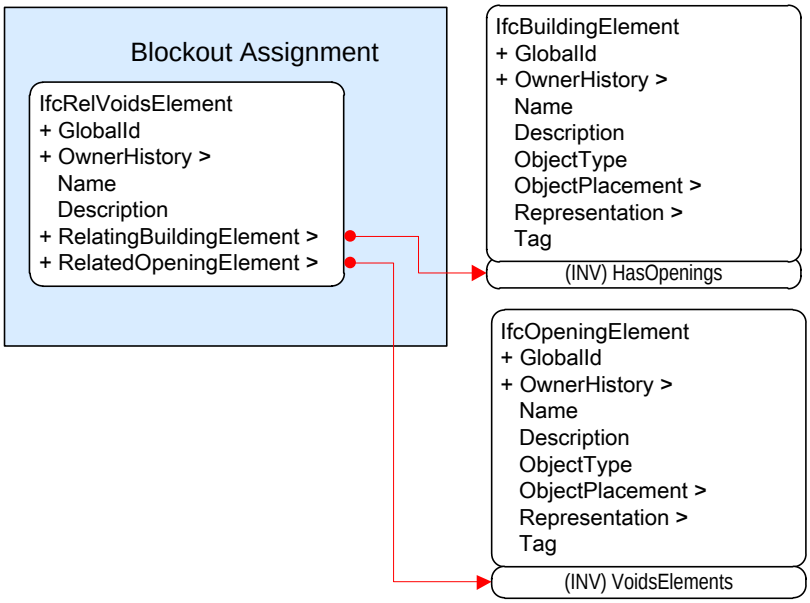
IFC Release Specific Concept Description (IFC 2x3) Precast Blockout Assignment					
Reference	PCI-074	**Version**	1.1	**Status**	Draft
Relationships	PCI-071				
History	Revised Nov 13, 2012				
Authors	Ivan Panushev, Manu Venugopal				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcRelVoidsElement

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingBuildingElement	Inversely related to the hosting building element (IfcBuildingElement) through
RelatedOpeningElement	Inversely related to the blockout element (IfcOpeningElement/

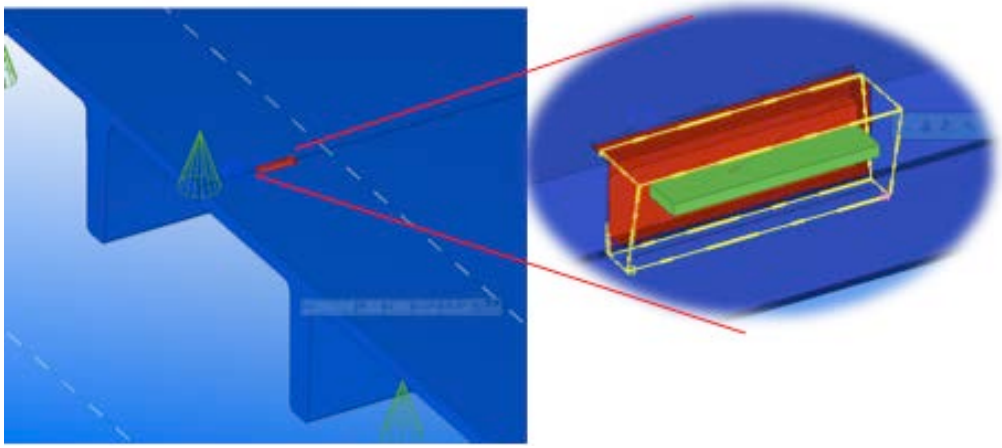
IfcOpeningElement

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be provided. Should specify the functionality of the blockout like 'Hole for railing-pipe', or 'Cutout for ladder/step' or 'Anchor access Pockets/Recess' etc
ObjectPlacement	Inversely related to the concept Relative Placement through PlacesObject.
Representation	Inversely related to IfcProductDefinitionShape through ShapeOfProduct.
Tag	<Open>

Example: Part21 file showing blockout assignment in a slab

```
#42=IFCOWNERHISTORY(#41,#2,$,.NOCHANGE.,$,$,$,0);
#45=IFCBUILDING('1e1pw9a0nDbhFnmT4WjXgb',#42,$,$,$,#34,$,$,.ELEMENT.,$,$,#44);
#46=IFCAXIS2PLACEMENT3D(#3,$,$);
#47=IFCLOCALPLACEMENT(#34,#46);
#48=IFCBUILDINGSTOREY('2JF4e6axWHqu3u0C1FZlmi',#42,'Level 1',$,$,#47,$,$,.ELEMENT.,0.);
#49=IFCCARTESIANPOINT((0.,0.,10.));
#50=IFCAXIS2PLACEMENT3D(#49,$,$);
#57= IFCLOCALPLACEMENT(#47,#50);
#58=IFCCARTESIANPOINT((60.24530467461261,53.32976377895601));
#59=IFCAXIS2PLACEMENT2D(#58,#14);
#60=IFCRECTANGLEPROFILEDEF(.AREA.,$,#59,20.,50.);
#61=IFCCARTESIANPOINT((85.24530467461261,-43.32976377895601,1.));
#62=IFCAXIS2PLACEMENT3D(#61,#10,#6);
#63=IFCEXTRUDEDAREASOLID(#60,#62,#9,1.);
#64=IFCCOLOURRGB($,0.5019607843137255,0.5019607843137255,0.5019607843137255);
#65=IFCSURFACESTYLERENDERING(#64,0.,$,$,$,$,IFCNORMALISEDRATIOMEASURE(0.00390625),IFCSPE
CULAREXPONENT(10.),.NOTDEFINED.);
#66=IFCSURFACESTYLE('Default Floor',.BOTH.,(#65));
#67=IFCPRESENTATIONSTYLEASSIGNMENT((#66));
#68=IFCSTYLEDITEM(#63,(#67),$);
#69=IFCSHAPEREPRESENTATION(#36,'Body','SweptSolid',(#63));
#70=IFCPRODUCTDEFINITIONSHAPE($,$,(#69));
#71=IFCSLAB('0$xNU6XhTBl9NZlwWjuP2M',#42,'Floor:Generic - 12":137385',$,'Floor:Generic -
12"',#57,#70,'137385',.FLOOR.);
#72=IFCCARTESIANPOINT((82.73870785149919,45.38945015580823));
#73=IFCAXIS2PLACEMENT2D(#72,#11);
#74=IFCCIRCLEPROFILEDEF(.AREA.,$,#73,0.5);
#75=IFCCARTESIANPOINT((85.24530467461261,-43.32976377895601,1.));
#76=IFCAXIS2PLACEMENT3D(#75,#10,#6);
#77=IFCEXTRUDEDAREASOLID(#74,#76,#9,1.);
#78=IFCPRESENTATIONSTYLEASSIGNMENT((#66));
#79=IFCSTYLEDITEM(#77,(#78),$);
#80=IFCSHAPEREPRESENTATION(#36,'Body','SweptSolid',(#77));
#81=IFCPRODUCTDEFINITIONSHAPE($,$,(#80));
```

#82= IFCLOCALPLACEMENT(#57,#75);
#83=IFCOPENINGELEMENT('3Yq_gqLM1DexERZhmy0pCs',#42,$,$,'Opening',#82,#81,'137482');
#84=IFCRELVOIDSELEMENT('0r8YLQV9T7E9SDx_Z$n28Z',#42,$,$,#71,#83);



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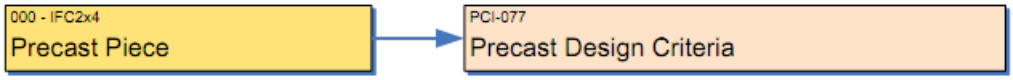
IFC Release Specific Concept Description (<IFC Release 2x3>)

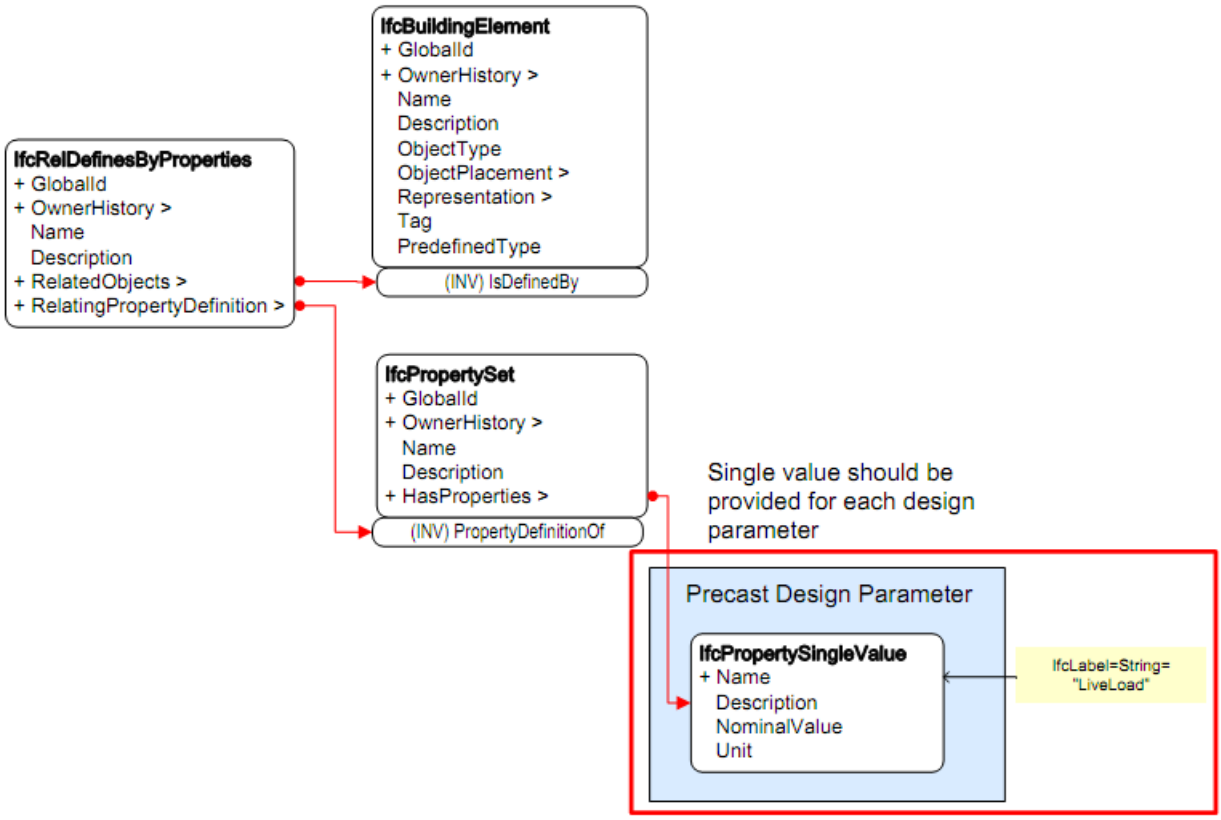
Precast Design Criteria

Reference	PCI-077	**Version**	1.1	**Status**	Draft
Relationships	Provides the design criteria for precast pieces based on analysis outputs.				
History	Revised 16 November, 2012				
Authors	Ivan Panushev/ Chuck Eastman (chuck.eastman@coa.gatech.edu)				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

Attribute	Implementation agreements

Name	IfcLabel = String =	Live Load Seismic Load Snow Load Maximum allowed displacement Maximum wind load Thermal resistance Maximum creep Maximum shrinkage Acoustic isolation Maximum weight Maximum length
Description	<Open>	
NominalValue	Must be Provided	
Unit	Units shall be provided per table below.	

Name	Data Type	Definition
Live Load	IfcNamedUnit	Load units typically in Pascal (SI).
Seismic Load	IfcNamedUnit	Load units typically in Pascal (SI).
Snow Load	IfcNamedUnit	Load units typically in Pascal (SI).
Maximum allowed displacement	IfcNamedUnit	Displacement units typically in Meters (SI).
Maximum wind load	IfcNamedUnit	Load units typically in Pascal (SI).
Thermal resistance	IfcNamedUnit	Thermal resistance typically in R-value (Imperial) or dC/M/s (SI).
Maximum creep	IfcNamedUnit	Fraction or percentage.
Maximum shrinkage	IfcNamedUnit	Fraction or percentage.
Acoustic isolation	IfcNamedUnit	Acoustic insulation units.
Maximum weight	IfcNamedUnit	Wight units typically in kg (SI).
Maximum length	IfcNamedUnit	Length units typically in m (SI).

Part 21 File Example:

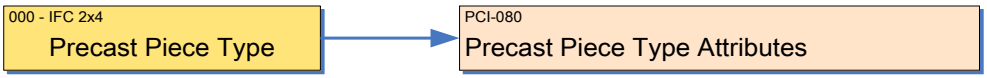
```
#300=IFCBUILDINGELEMENT
('14MYN1USRBAP8H0MGNBZLX',#43,'LIVELOAD',$,'LIVELOAD',#140,#160,'146545');

#350=IFCRELDEFINESBYPROPERTIES('8A6KE4DSH0JEPQKKHBXURB',#42,$,$,(#300),#360);

#360=IFCPROPERTYSET('8GJ9L$OBH4XHADW0W9GGED',#42,'PSET_PRECASTDESIGNCRITERIA',$,(#370))
;

#370=IFCPROPERTYSINGLEVALUE('LIVELOAD',$,IFCVALUE(100), IFCSIUNITNAME(PASCAL));
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

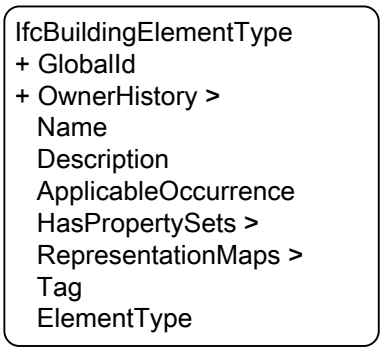
Precast Piece Type Attributes

Reference	PCI-080	**Version**	1.1	**Status**	Draft
Relationships	Piece type attributes of precast piece type				
History	June 10, 2009, reviewed 15 November, 2012				
Authors	Ivan Panushev/Chuck Eastman (chuck.eastman@gatech.edu)				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcBuildingElementType

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ApplicableOccurrence	Optional: Should carry IfcIdentifier
HasPropertySets	Should point to IfcPropertySetDefinition
RepresentationMaps	Should point to IfcRepresentationMap
Tag	<Open>
ElementType	Optional: should carry IfcLabel identifying the precast element type.

Example: Part21 file for IcfBeamType

```
#360=
```

```
IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDE
FINED.);
```

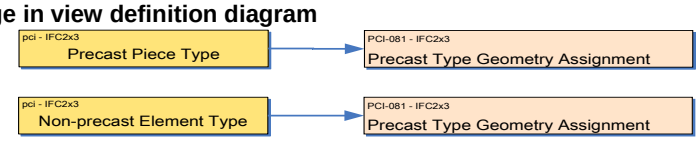
PCI NBIMS Examples - 1.ifc

IFC Release Specific Concept Description (<IFC Release 2x3>)

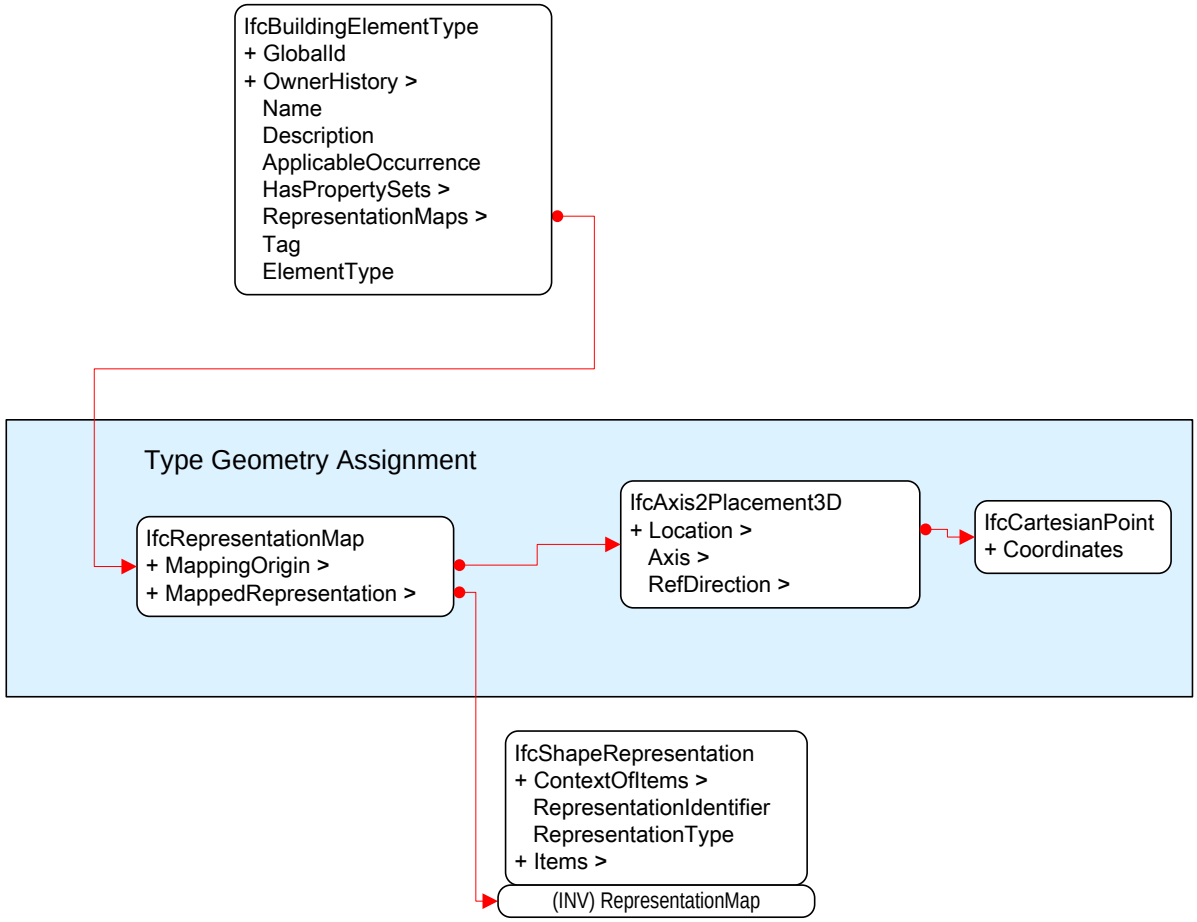
Piece Type Geometry Assignment

Reference	PCI-081	**Version**	1.1	**Status**	Draft
Relationships	Defines shape for a piece type.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRepresentationMap:

Attribute	Implementation agreements
MappingOrigin	It shall be the name of external reference file name.

IfcAxisToPlacement3D:
Used to define an origin for the piece type that is used in transforms to piece instances.

Attribute	Implementation agreements
Location	<Open>
Axis	Not used.
RefDirection	Not used.

IfcCartesianPoint:

Attribute	Implementation agreements
Coordinates	It is always (0,0,0). The placement of geometric block is done by the placement of the instance.

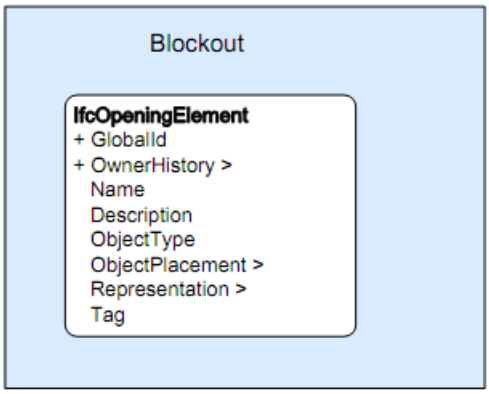
IFC Release Specific Concept Description (<IFC Release 2x3>)

Precast Blockout Attributes

Reference	PCI-083	**Version**	1.1	**Status**	Draft
Relationships	Related to Precast Piece through Precast Blockout Assignment				
History	v.1.0 8-Aug-09; Revised Nov 18, 2012				
Authors	Shiva Aram; Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



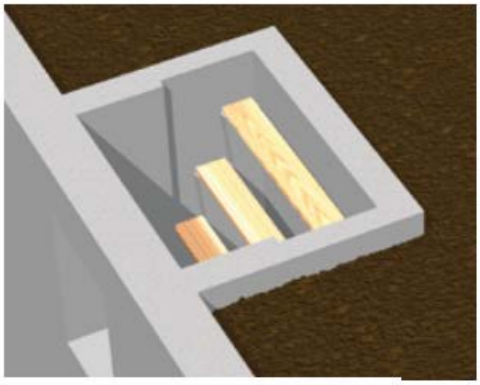
Implementation agreements

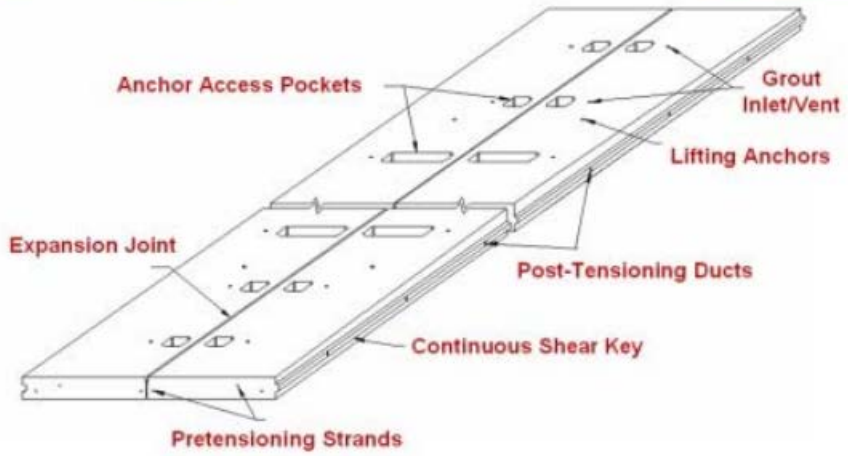
IfcOpeningElement

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be provided. Should specify the functionality of the blockout like 'Hole for railing-pipe', or 'Cutout for ladder/step' or 'Anchor access Pockets/Recess' etc
ObjectPlacement	Inversely related to the concept Relative Placement through PlacesObject.
Representation	Inversely related to IfcProductDefinitionShape through ShapeOfProduct.
Tag	<Open>

Example:

- Pockets
- Pier blockout
- Ladder blockout
- Steps etc





Example: Part21 file
Part21 file showing a precast blockout in a slab #42=IFCOWNERHISTORY(#41,#2,$,.NOCHANGE.,$,$,$,0);
#45=IFCBUILDING('1e1pw9a0nDbhFnmT4WjXgb',#42,$,$,$,#34,$,$,.ELEMENT.,$,$,#44);
#46=IFCAXIS2PLACEMENT3D(#3,$,$); #47=IFCLOCALPLACEMENT(#34,#46);
#48=IFCBUILDINGSTOREY('2JF4e6axWHqu3u0C1FZlmi',#42,'Level 1',$,$,#47,$,$,.ELEMENT.,0.);
#49=IFCCARTESIANPOINT((0.,0.,10.)); #50=IFCAXIS2PLACEMENT3D(#49,$,$);
#58=IFCCARTESIANPOINT((60.24530467461261,53.32976377895601)); #59=IFCAXIS2PLACEMENT2D(#58,#14);
#60=IFCRECTANGLEPROFILEDEF(.AREA.,$,#59,20.,50.); #61=IFCCARTESIANPOINT((85.24530467461261,-43.32976377895601,1.)); #62=IFCAXIS2PLACEMENT3D(#61,#10,#6);
#63=IFCEXTRUDEDAREASOLID(#60,#62,#9,1.);
#64=IFCCOLOURRGB($,0.5019607843137255,0.5019607843137255,0.5019607843137255);
#65=IFCSURFACESTYLERENDERING(#64,0.,$,$,$,$,IFCNORMALISEDRATIOMEASURE(0.00390625),IFCSPECULAREXPONENT(10.),.NOTDEFINED.); #66=IFCSURFACESTYLE('Default Floor',.BOTH.,(#65));
#67=IFCPRESENTATIONSTYLEASSIGNMENT((#66)); #68=IFCSTYLEDITEM(#63,(#67),$);
#69=IFCSHAPEREPRESENTATION(#36,'Body','SweptSolid',(#63)); #70=IFCPRODUCTDEFINITIONSHAPE($,$,(#69));
#71=IFCSLAB('0$xNU6XhTBl9NZIwWjuP2M',#42,'Floor:Generic - 12":137385',$,'Floor:Generic -

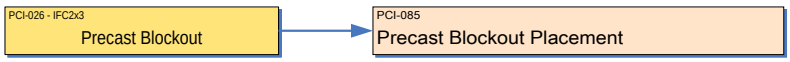
12'',#57,#70,'137385',.FLOOR.); #72=IFCCARTESIANPOINT((82.73870785149919,45.38945015580823));
#73=IFCAXIS2PLACEMENT2D(#72,#11); #74=IFCCIRCLEPROFILEDEF(.AREA.,$,#73,0.5);
#75=IFCCARTESIANPOINT((85.24530467461261,-43.32976377895601,1.)); #76=IFCAXIS2PLACEMENT3D(#75,#10,#6);
#77=IFCEXTRUDEDAREASOLID(#74,#76,#9,1.); #78=IFCPRESENTATIONSTYLEASSIGNMENT((#66));
#79=IFCSTYLEDITEM(#77,(#78),$); #80=IFCSHAPEREPRESENTATION(#36,'Body','SweptSolid',(#77));
#81=IFCPRODUCTDEFINITIONSHAPE($,$,(#80));
#83=IFCOPENINGELEMENT('3Yq_gqLM1DexERZhmy0pCs',#42,$,$,'Opening',#82,#81,'137482');
#84=IFCRELVOIDSELEMENT('0r8YLQV9T7E9SDx_Z$n28Z',#42,$,$,#71,#83);

IFC Release Specific Concept Description (<IFC Release 2x3>)

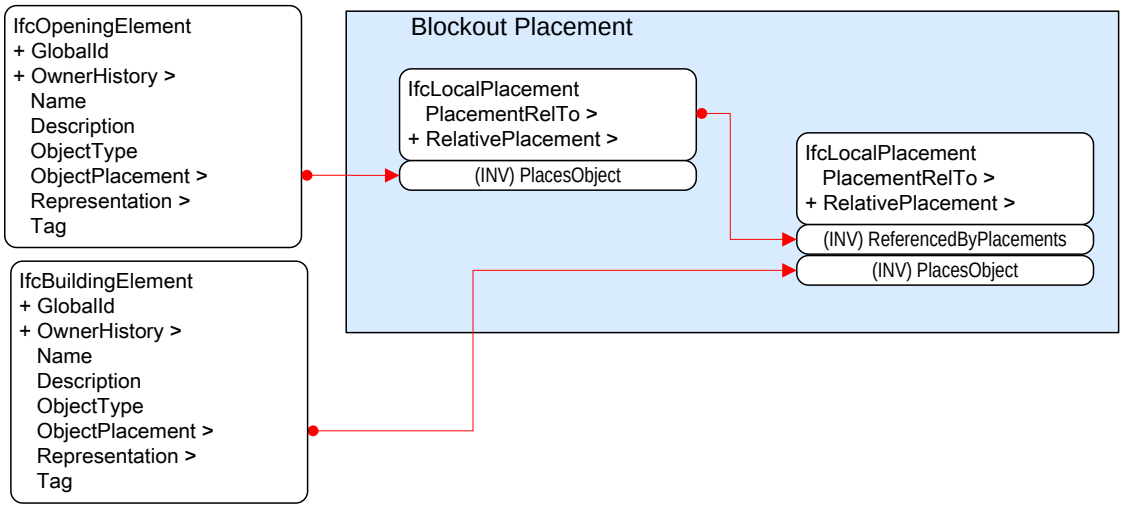
Blockout Placement

Reference	PCI-085	**Version**	1.1	**Status**	Draft
Relationships	Provides an opening through a precast piece for some function. IS a full typed object, not a feature of the one it is attached to.				
History	Revised Nov 18, 2012				
Authors	Ivan Panushev, Manu Venugopal, Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcOpeningElement

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be provided. Set to 'Opening' for an opening or 'Recess' for a recess or niche.

ObjectPlacement	Inversely related to the concept Relative Placement through PlacesObject.
Representation	Inversely related to IfcProductDefinitionShape through ShapeOfProduct.
Tag	<Open>

IfcLocalPlacement

Attribute	Implementation agreements
PlacementRelTo	Could be related to another local placement
RelativePlacement	Must be provided, but may contain dummy data
(INV)PlacesObject	Must be inversely related to a IfcOpeningElement
(INV)ReferencedByPlacement	Must be inversely related to IfcLocalPlacement

IfcLocalPlacement

Attribute	Implementation agreements
PlacementRelTo	Must be related to local placement
RelativePlacement	Must be related to IfcAxis2Placement3D
(INV) PlacesObjects	Must be subtype of IfcBuildingElement

Example: Part21 file showing blockout placement in a slab

```
#42=IFCOWNERHISTORY(#41,#2,$,.NOCHANGE.,$,$,$,0);
#45=IFCBUILDING('1e1pw9a0nDbhFnmT4WjXgb',#42,$,$,$,#34,$,$,.ELEMENT.,$,$,#44);
#46=IFCAXIS2PLACEMENT3D(#3,$,$);
#47=IFCLOCALPLACEMENT(#34,#46);
#48=IFCBUILDINGSTOREY('2JF4e6axWHqu3u0C1FZlmi',#42,'Level 1',$,$,#47,$,$,.ELEMENT.,0.);
#49=IFCCARTESIANPOINT((0.,0.,10.));
#50=IFCAXIS2PLACEMENT3D(#49,$,$);
#57= IFCLOCALPLACEMENT(#47,#50);
#58=IFCCARTESIANPOINT((60.24530467461261,53.32976377895601));
#59=IFCAXIS2PLACEMENT2D(#58,#14);
#60=IFCRECTANGLEPROFILEDEF(.AREA.,$,#59,20.,50.);
#61=IFCCARTESIANPOINT((85.24530467461261,-43.32976377895601,1.));
#62=IFCAXIS2PLACEMENT3D(#61,#10,#6);
#63=IFCEXTRUDEDAREASOLID(#60,#62,#9,1.);
#64=IFCCOLOURRGB($,0.5019607843137255,0.5019607843137255,0.5019607843137255);
#65=IFCSURFACESTYLERENDERING(#64,0.,$,$,$,$,IFCNORMALISEDRATIOMEASURE(0.00390625),IFCSPECULAREX
PONENT(10.),.NOTDEFINED.);
#66=IFCSURFACESTYLE('Default Floor',.BOTH.,(#65));
#67=IFCPRESENTATIONSTYLEASSIGNMENT((#66));
#68=IFCSTYLEDITEM(#63,(#67),$);
#69=IFCSHAPEREPRESENTATION(#36,'Body','SweptSolid',(#63));
#70=IFCPRODUCTDEFINITIONSHAPE($,$,(#69));
#71=IFCSLAB('0$xNU6XhTBI9NZIwWjuP2M',#42,'Floor:Generic - 12"':137385',$,'Floor:Generic -
```

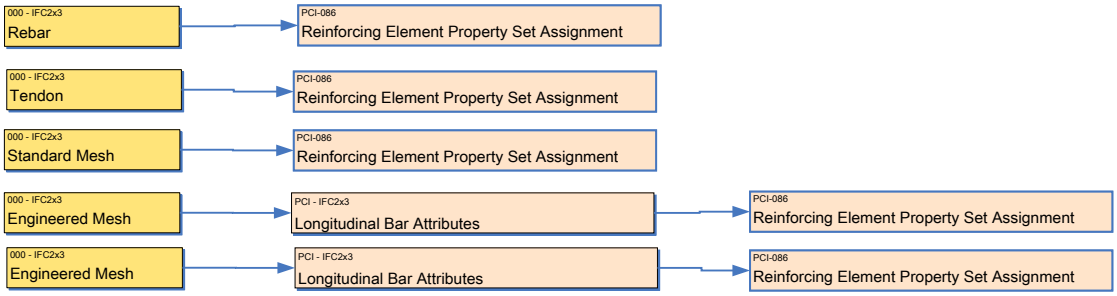
```
12'",#57,#70,'137385',.FLOOR.);
#72=IFCCARTESIANPOINT((82.73870785149919,45.38945015580823));
#73=IFCAXIS2PLACEMENT2D(#72,#11);
#74=IFCCIRCLEPROFILEDEF(.AREA.,$,#73,0.5);
#75=IFCCARTESIANPOINT((85.24530467461261,-43.32976377895601,1.));
#76=IFCAXIS2PLACEMENT3D(#75,#10,#6);
#77=IFCEXTRUDEDAREASOLID(#74,#76,#9,1.);
#78=IFCPRESENTATIONSTYLEASSIGNMENT((#66));
#79=IFCSTYLEDITEM(#77,(#78),$);
#80=IFCSHAPEREPRESENTATION(#36,'Body','SweptSolid',(#77));
#81=IFCPRODUCTDEFINITIONSHAPE($,$,(#80));
#82= IFCLOCALPLACEMENT(#57,#75);
#83=IFCOPENINGELEMENT('3Yq_gqLM1DexERZhmy0pCs',#42,$,$,'Opening',#82,#81,'137482');
#84=IFCRELVOIDSELEMENT('0r8YLQV9T7E9SDx_Z$n28Z',#42,$,$,#71,#83);
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

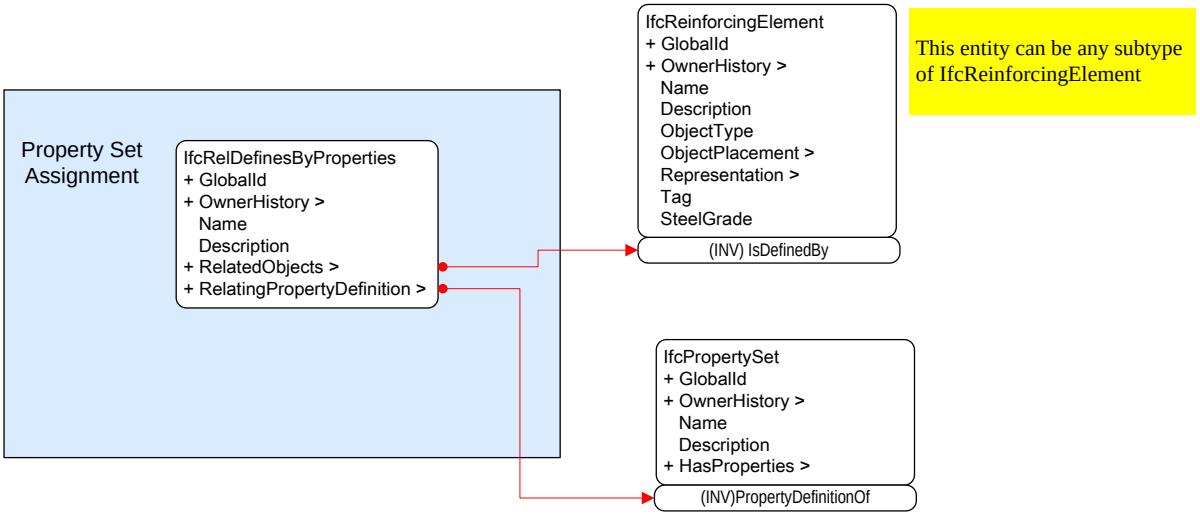
Reinforcing Element Property Set Assignment

Reference	PCI-086	**Version**	1.1	**Status**	Draft
Relationships	Assigns the physical attributes to all reinforcing elements and also assigns bending information to the reinforcing bars and debonding attributes to tendons.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelDefinesByProperties

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>

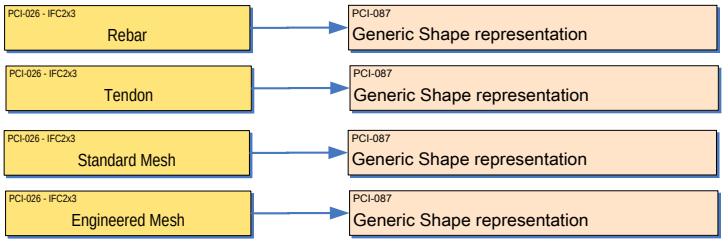
Description	<Open>
RelatedObjects	Must be a subtype of IfcReinforcingElement
RelatingPropertyDefinition	A property set which is assigned to the reinforcing element.

IFC Release Specific Concept Description (<IFC Release 2x3>)

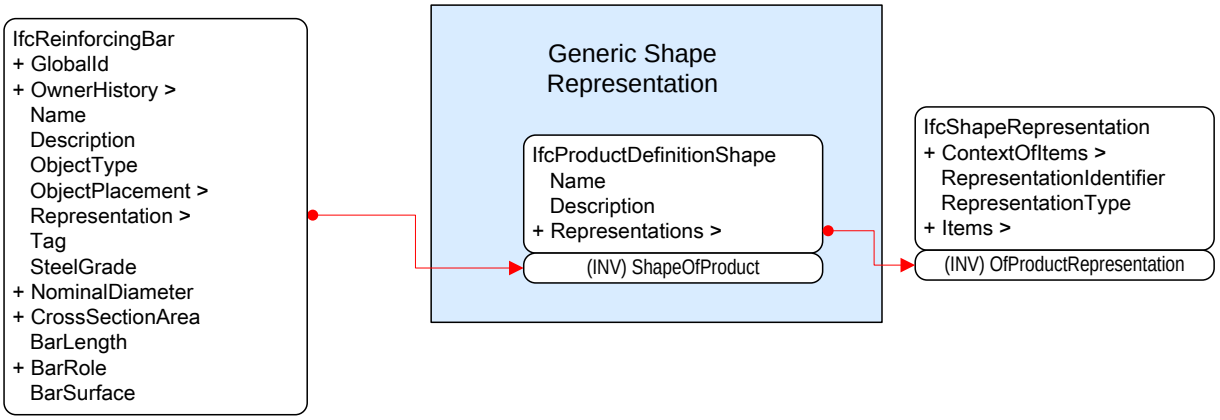
Generic Shape Representation

Reference	PCI-087	**Version**	1.1	**Status**	Draft
Relationships	Links building elements to their shape representation.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcReinforcingBar:
Tag: It should be a unique company specific label
NominalDiameter: It defines the cross-section size of the reinforcing bar.
BarSurface: Can be plain or textured.
Object Placement: Defines the origin to make the representation defenition compared to that origin.

IfcProductDefinitionShape:

Name: <Open>
Description: <Open>
Representations: Must be IfcShapeRepresentation

IfcShapeRepresentation:

ContextOfItems: Must be provided.

RepresentationIdentifier: Label:'FootPrint'
Items: <Open>

IfcCompositeCurve:
It defines a curve composed of segments that each is defined as a composite curve segment.

Example: Part21 file for Reinforcing Element Shape Representation:

#1762= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#1755));

#1768= IFCPRODUCTDEFINITIONSHAPE('','',(#1762));

#1770= IFCREINFORCINGBAR('1A0gmi1112rZ4oD34sE3au',#20,'REBAR',$,$,#99,#1768,$,'6','0' 0 1/2'",'0.45',$,'MAIN',$);

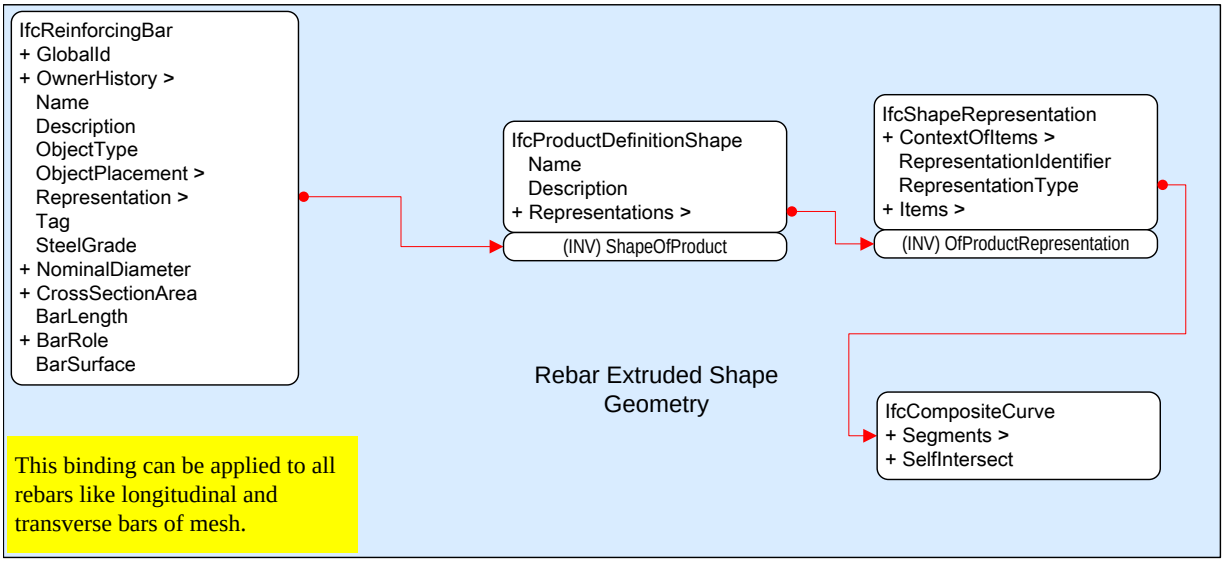
IFC Release Specific Concept Description (<IFC Release 2x3>)

Rebar Extruded Shape Geometry

Reference	PCI-088	**Version**	1.1	**Status**	Draft
Relationships	Defines the extruded shape geometry for all rebar, like the longitudinal and transverse bars of standard and engineered mesh.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcShapeRepresentation:

ContextOfItems: Must be provided.

RepresentationIdentifier: Label:'FootPrint'

RepresentationType: Label: 'CompositeCurve'

Items: <Open>

IfcCompositeCurve:

It defines a curve composed of segments that each is defined as a composite curve segment.

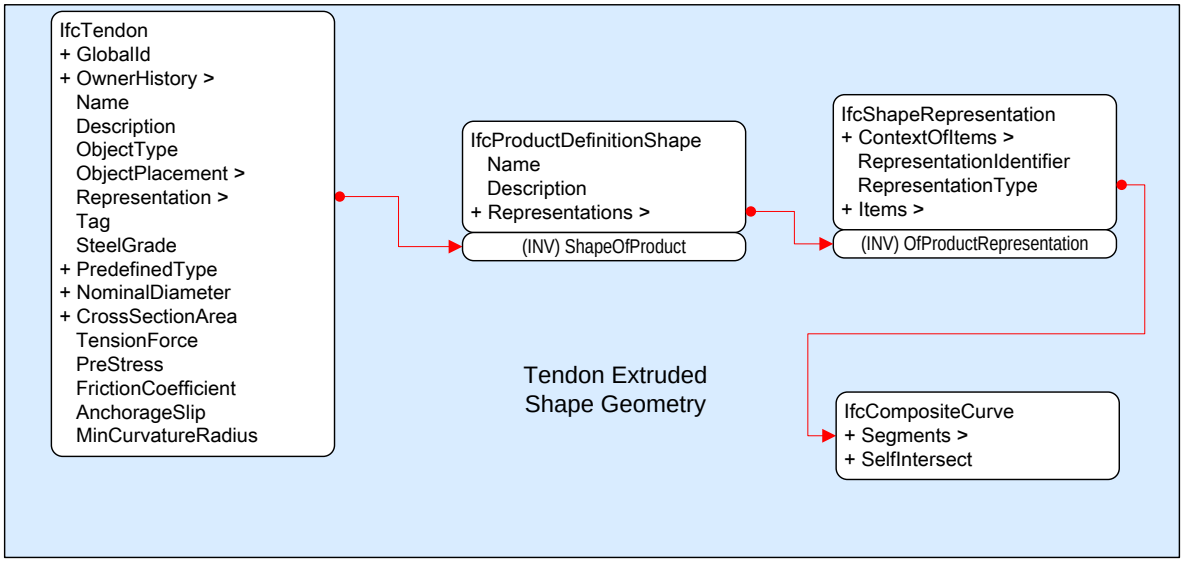
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Extruded Shape Geometry

Reference	PCI-089	**Version**	1.1	**Status**	Draft
Relationships	Defines the extruded shape geometry for tendon.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcShapeRepresentation:

ContextOfItems: Must be provided.

RepresentationIdentifier: Label:'FootPrint'

RepresentationType: Label: 'CompositeCurve'

Items: <Open>

IfcCompositeCurve:

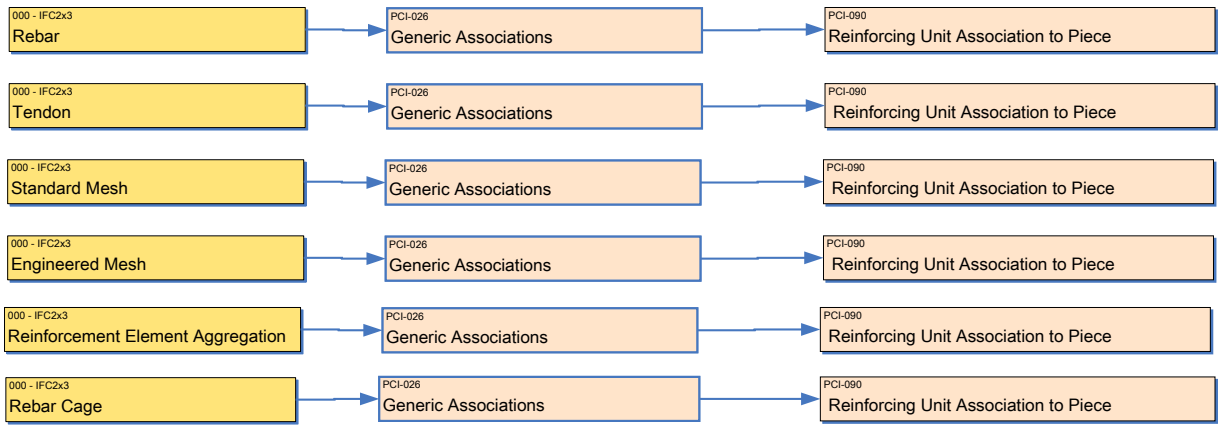
It defines a curve composed of segments that each is defined as a composite curve segment.

IFC Release Specific Concept Description (<IFC Release 2x3>)

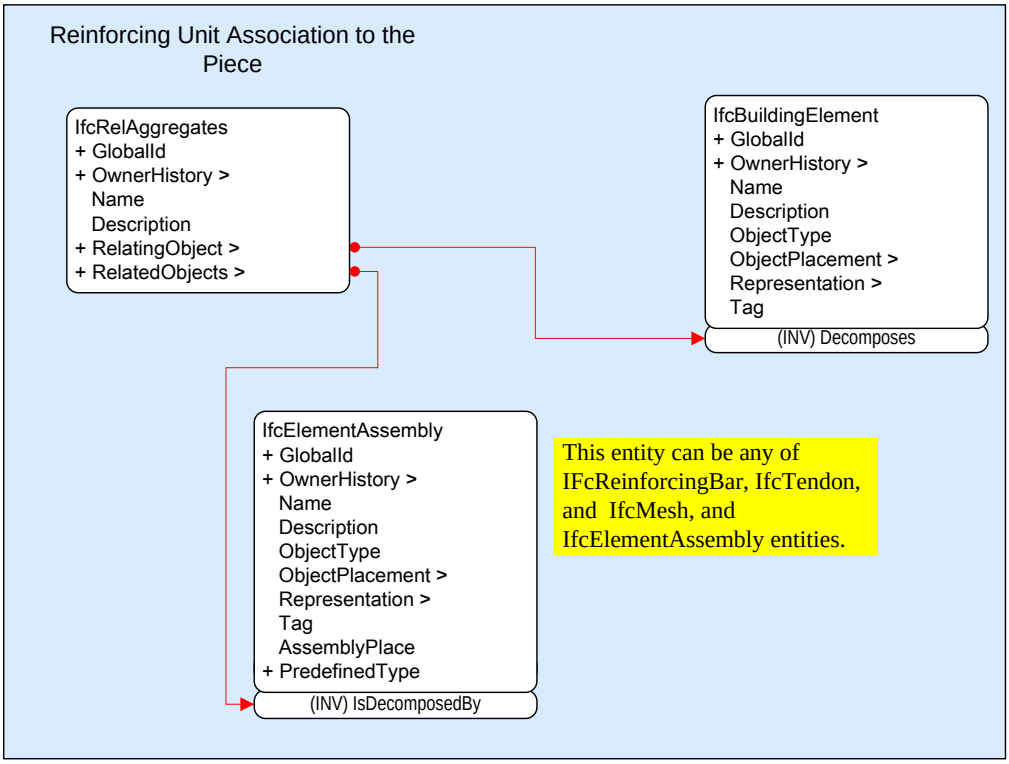
Reinforcing Unit Association to Piece

Reference	PCI-090	**Version**	1.1	**Status**	Draft
Relationships	It assigns the reinforcing elements, aggregations, assemblies, and rebar cages to the precast piece.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcElementAssembly:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
Tag	If we have aggregation of IfcReinforcingBar it must be the label: “Rebar Assembly”. If we have aggregation of IfcTendon it must be the label: “Tendon Group”. If we have aggregation of IfcMesh it must be the label: “Mesh Group”. If we have assembly of reinforcing element aggregation, it must be the label: “Rebar Cage”.
(INV) IsDecomposedBy	Reinforcing Element Aggregations which are aggregated into a precast piece.

IfcRelAggregates:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	Refers to the precast piece.
RelatedObjects	Refers to the reinforcing elements and reinforcing element assemblies in a precast piece.

Example: Part21 file for Reinforcing Element Association to Piece:

```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
```

```
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341=
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#409,10.,160.);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,780.);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#414);
#421= IFCREINFORCINGBAR('1A0gmi1112rZ4oD34sE3au',#20,'REBAR',$,$,#99,#419,$,'6','0'  0 1/2"','0.45',$,'MAIN',$);
#422= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#341,(#421));
```

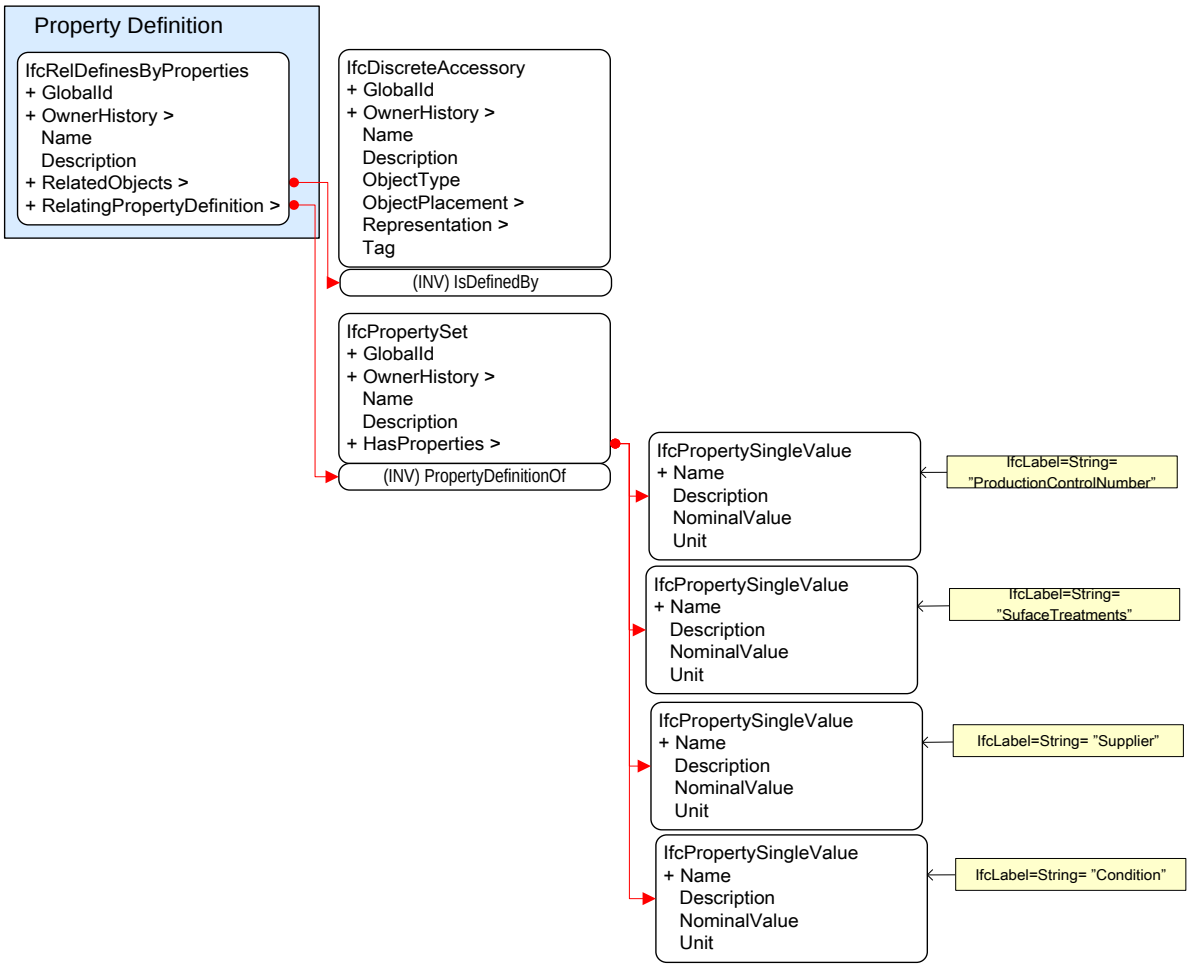
IFC Release Specific Concept Description (IFC 2x3)

Production Attributes

Reference	PCI-091	**Version**	1.1	**Status**	Draft
Relationships	Provides binding for property definition of production attributes				
History	Reviewed 18 November, 2012				
Authors	Manu Venugopal(manu.menon@gatech.edu), Chuck Eastman				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Production Control Number”
Description	Not used.
NominalValue	This is a STRING that documents the production control number.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Surface Treatments”
Description	Not used.
NominalValue	This is a STRING that documents the type of surface treatment provided.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements

Name	IfcLabel = STRING = “Supplier”
Description	Not used.
NominalValue	This is a STRING that documents the supplier information
Unit	Not used for this property

IfcPropertySingleValue

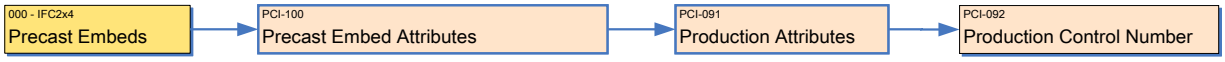
Attribute	**Implementation agreements**
Name	IfcLabel = STRING = “Condition”
Description	Not used.
NominalValue	This is a STRING that documents the condition of the accessory.
Unit	Not used for this property

IFC Release Specific Concept Description (IFC 2x2)

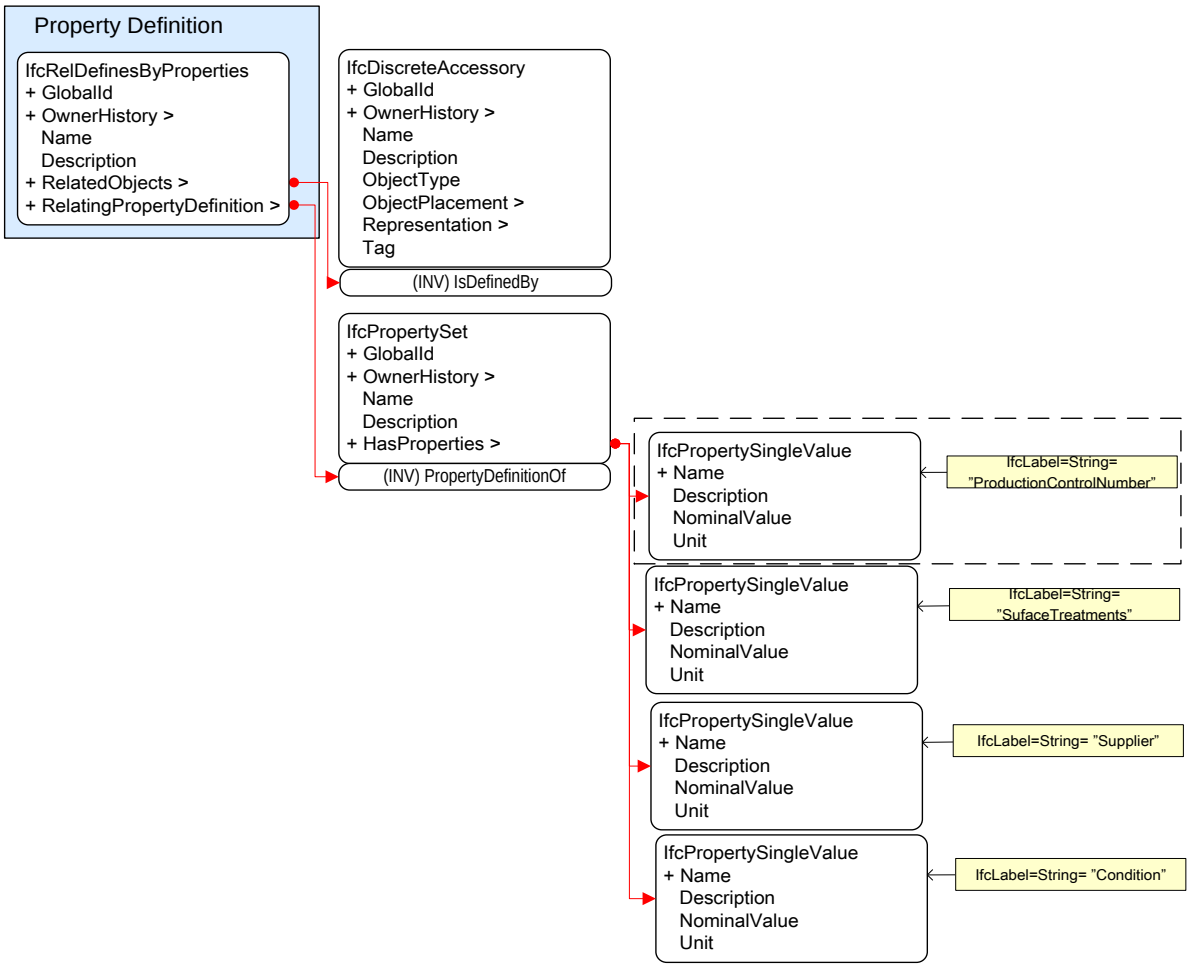
Production Control Number

Reference	PCI-092	**Version**	1.1	**Status**	Draft
Relationships	Provides binding for property definition of production attributes				
History	Reviewed 18 November, 2012				
Authors	Manu Venugopal, Chuck Eastman (manu.menon@gatech.edu)				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Production Control Number”
Description	Not used.
NominalValue	This is a STRING that documents the production control number.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Surface Treatments”
Description	Not used.
NominalValue	This is a STRING that documents the type of surface treatment provided.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements

Name	IfcLabel = STRING = “Supplier”
Description	Not used.
NominalValue	This is a STRING that documents the supplier information
Unit	Not used for this property

IfcPropertySingleValue

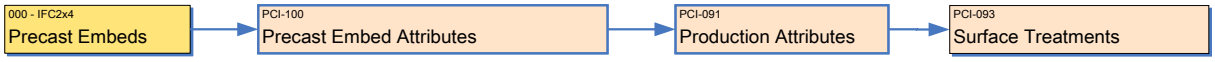
Attribute	**Implementation agreements**
Name	IfcLabel = STRING = “Condition”
Description	Not used.
NominalValue	This is a STRING that documents the condition of the accessory.
Unit	Not used for this property

IFC Release Specific Concept Description (IFC 2x3)

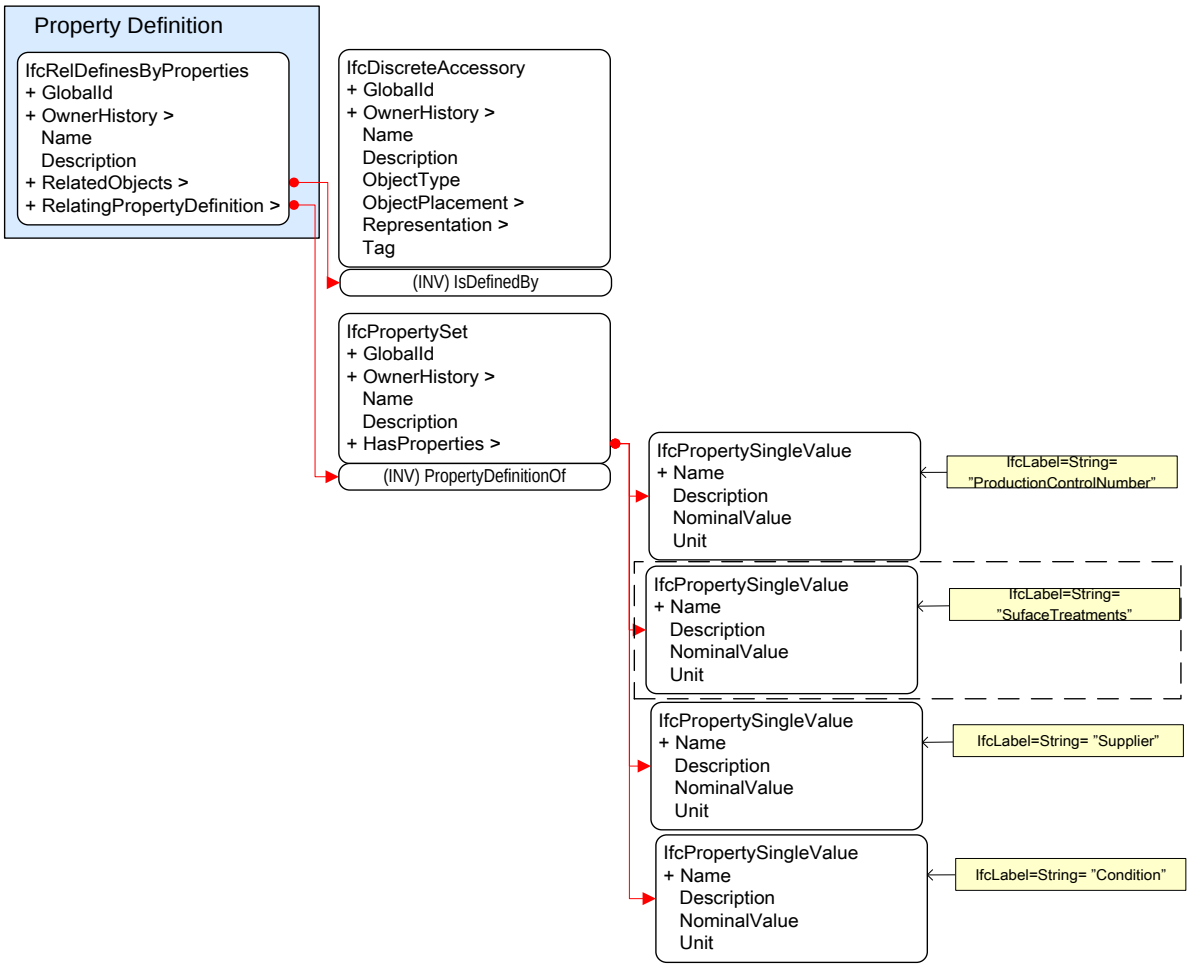
Surface Treatments

Reference	PCI-093	**Version**	1.1	**Status**	Draft
Relationships	Provides binding for property definition of production attributes				
History	Reviewed 18 November, 2012				
Authors	Manu Venugopal. Chuck Eastman(manu.menon@gatech.edu)				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Production Control Number”
Description	Not used.
NominalValue	This is a STRING that documents the production control number.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Surface Treatments”
Description	Not used.
NominalValue	This is a STRING that documents the type of surface treatment provided.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements

Name	IfcLabel = STRING = “Supplier”
Description	Not used.
NominalValue	This is a STRING that documents the supplier information
Unit	Not used for this property

IfcPropertySingleValue

Attribute	**Implementation agreements**
Name	IfcLabel = STRING = “Condition”
Description	Not used.
NominalValue	This is a STRING that documents the condition of the accessory.
Unit	Not used for this property

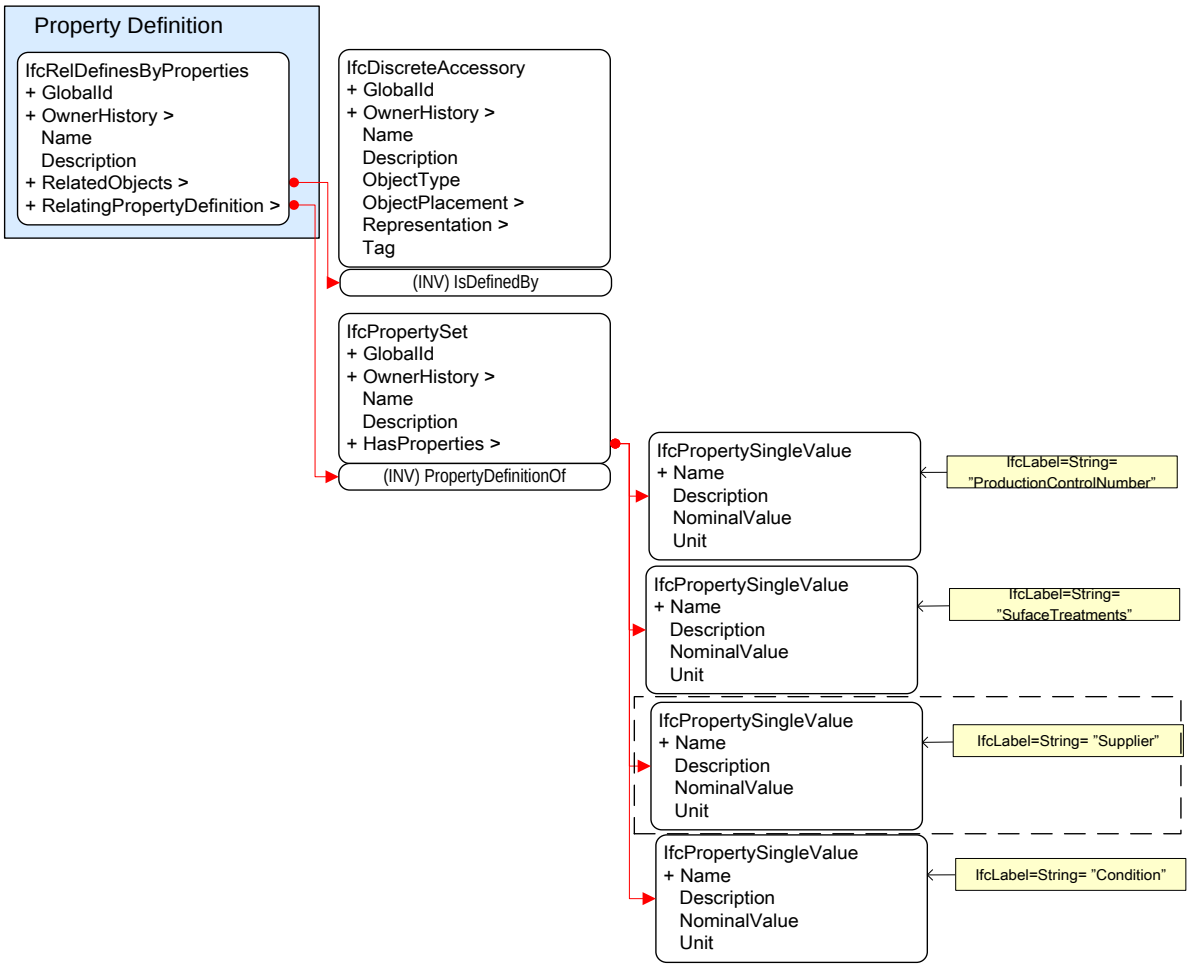
IFC Release Specific Concept Description (IFC 2x3)

Supplier

Reference	PCI-094	**Version**	1.1	**Status**	Draft
Relationships	Provides binding for property definition of production attributes				
History	Revised 18 November, 2012				
Authors	Manu Venugopal				
Document Owner	Precast/Prestressed Concrete Institute (manu.menon@gatech.edu)				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Production Control Number”
Description	Not used.
NominalValue	This is a STRING that documents the production control number.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Surface Treatments”
Description	Not used.
NominalValue	This is a STRING that documents the type of surface treatment provided.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements

Name	IfcLabel = STRING = “Supplier”
Description	Not used.
NominalValue	This is a STRING that documents the supplier information
Unit	Not used for this property

IfcPropertySingleValue

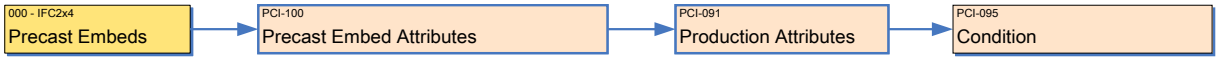
Attribute	**Implementation agreements**
Name	IfcLabel = STRING = “Condition”
Description	Not used.
NominalValue	This is a STRING that documents the condition of the accessory.
Unit	Not used for this property

IFC Release Specific Concept Description (IFC 2x3)

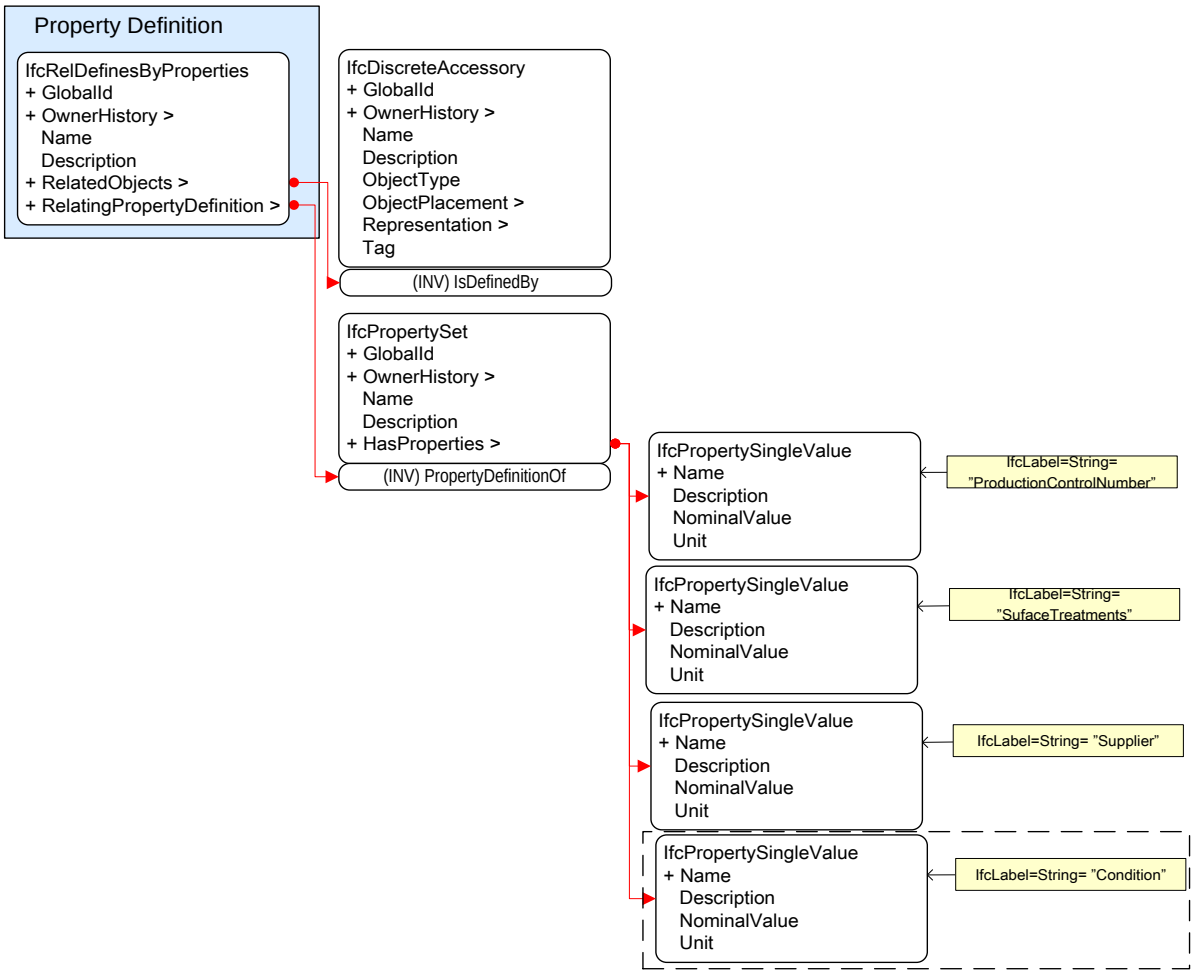
Condition

Reference	PCI-095	**Version**	1.1	**Status**	Draft
Relationships	Provides binding for property definition of production attributes				
History	Reviewed 18 November, 2012				
Authors	Manu Venugopal, Chuck Eastman				
Document Owner	Precast/Prestressed Concrete Institute (manu.menon@gatech.edu)				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Production Control Number”
Description	Not used.
NominalValue	This is a STRING that documents the production control number.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel = STRING = “Surface Treatments”
Description	Not used.
NominalValue	This is a STRING that documents the type of surface treatment provided.
Unit	Not used for this property

IfcPropertySingleValue

Attribute	Implementation agreements

Name	IfcLabel = STRING = “Supplier”
Description	Not used.
NominalValue	This is a STRING that documents the supplier information
Unit	Not used for this property

IfcPropertySingleValue

Attribute	**Implementation agreements**
Name	IfcLabel = STRING = “Condition”
Description	Not used.
NominalValue	This is a STRING that documents the condition of the accessory.
Unit	Not used for this property

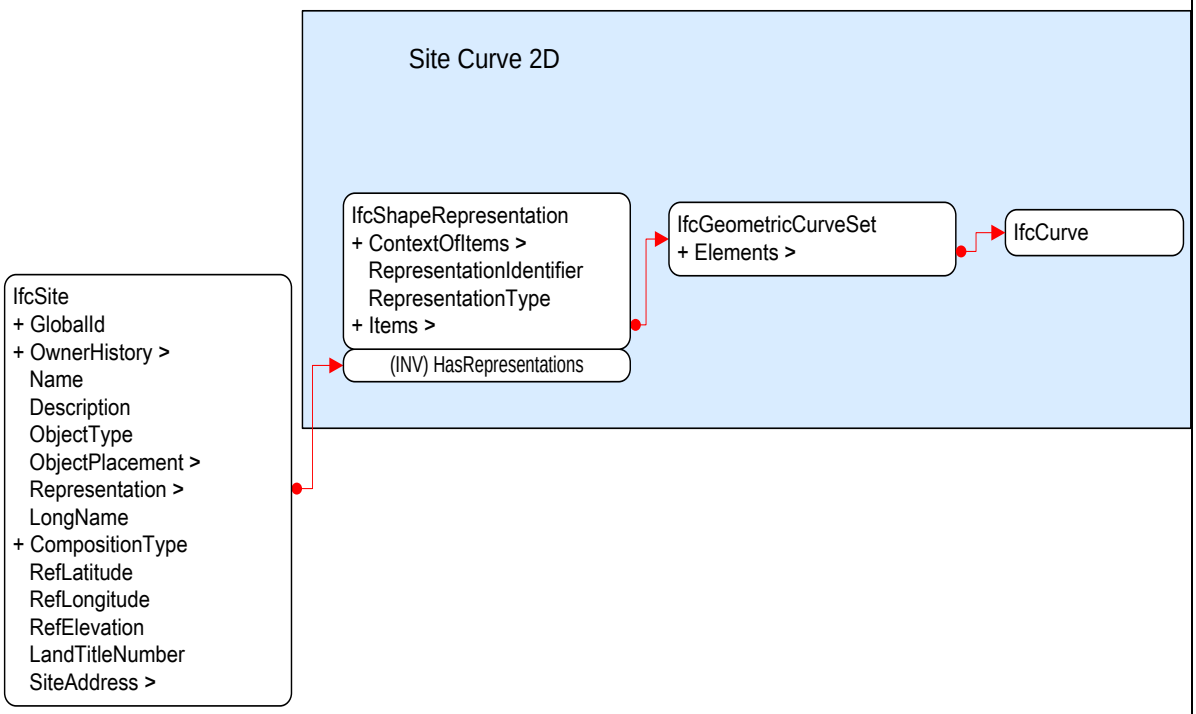
IFC Release Specific Concept Description (<IFC Release 2x3>)

Site Curve 2D

Reference	PCI-096	**Version**	1.1	**Status**	Draft
Relationships	Perimeter representation of building site.				
History	From ICC-468; Revised Nov 18, 2012				
Authors	Shiva Aram; Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcGeometricCurveSet

Attribute	Implementation agreements
Elements	The representation of IfcSite perimeter (footprint) is given by either a single 2D curve (such as IfcPolyline or IfcCompositeCurve), or by a list of 2D curves (in case of inner boundaries).

IfcCurve (IfcPolyline or IfcCompositeCurve)

Attribute	Implementation agreements
Points	LIST [2:?] OF IfcCartesianPoint

IfcShapeRepresentation

Attribute	Implementation agreements
ContextofItems	Must be provided. The context shall be of type IfcGeometricRepresentationContext
RepresentationIdentifier	Label :'FootPrint'.
RepresentationType	Label: 'GeometricCurveSet'. A representation type should be given to the shape representation.
Items	Proper 'Items' should be used according to RepresentationType

Example: Part 21 File for Site Perimeter

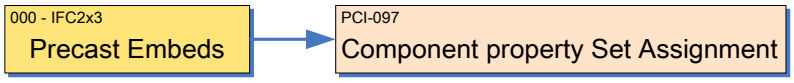
```
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#34= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#35= IFCCARTESIANPOINT((-40000.,31200.));
#36= IFCCARTESIANPOINT((-40000.,51200.));
#38= IFCCARTESIANPOINT((-60000.,51200.));
#39= IFCCARTESIANPOINT((-60000.,31200.));
#40= IFCPOLYLINE((#35,#36,#38,#39));
#41= IFCGEOMETRICREPRESENTATIONCONTEXT('Body','Model',3,1.0000000E-5,#34,$);
#43= IFCGEOMETRICREPRESENTATIONCONTEXT('BoundingBox','Model',3,1.0000000E-5,#34,$);
#46= IFCPROJECT('3AWw8wyvz14QTe3PMyD$a8',#20,'Project','Description','Object
type','LongName','Phase',(#41,#43),#18);
#47=IFCGEOMETRICCURVESET(40)
#53= IFCLOCALPLACEMENT($,#34);
#50=IFCSHAPEREPRESENTATION((#41,#43),'FootPrint', 'GeometricCurveSet',#47)
#56= IFCSITE('2$umvcgY11QPrba$dmh585',#20,'Undefined',$,$,#53,#50,$,.ELEMENT.,$,$,0.,$,$);
```

IFC Release Specific Concept Description (IFC 2x3**)**

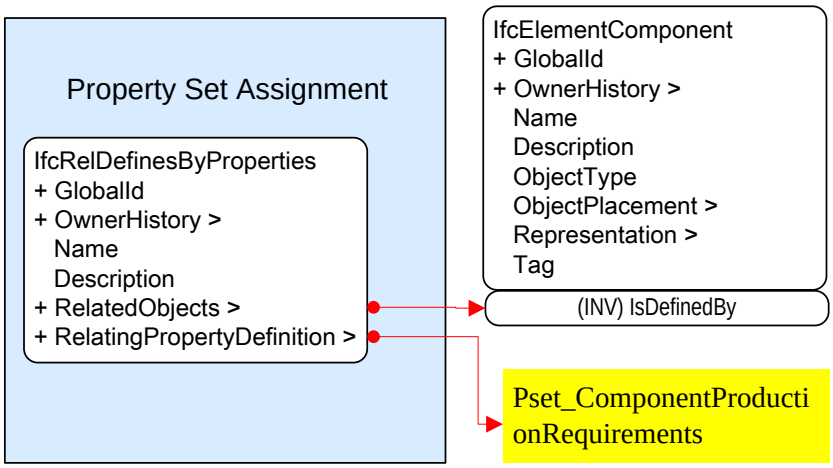
Component Property Set Assignment

Reference	PCI-097	**Version**	1.1	**Status**	Draft
Relationships					
History	Reviewed 18 November, 2012				
Authors	Manu Venugopal. (manu.menon@gatech.edu),Chuck Eastman				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelDefinesByProperties

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedObjects	Must be subtype of one of IfcFastener, IfcDiscreteAccessory, IfcBuildingElementPart. See IfcFastener, IfcDiscreteAccessory, IfcBuildingElementPart assignment concept bindings for rules about appropriate subtype selection.

RelatingPropertyDefinition	Pset_ComponentProductionRequirements. This pset is an addition proposed for Ifc 2x4. See relevant documentation for legal values

IfcElementComponent

Possible subtypes are IfcFastener, IfcDiscreteAccessory, IfcBuildingElementPart

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcFastener, IfcDiscreteAccessory, IfcBuildingElementPart is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcFastener, IfcDiscreteAccessory, IfcBuildingElementPart is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

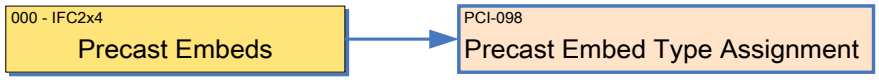
Example: Part21 file

IFC Release Specific Concept Description (IFC 2x3)

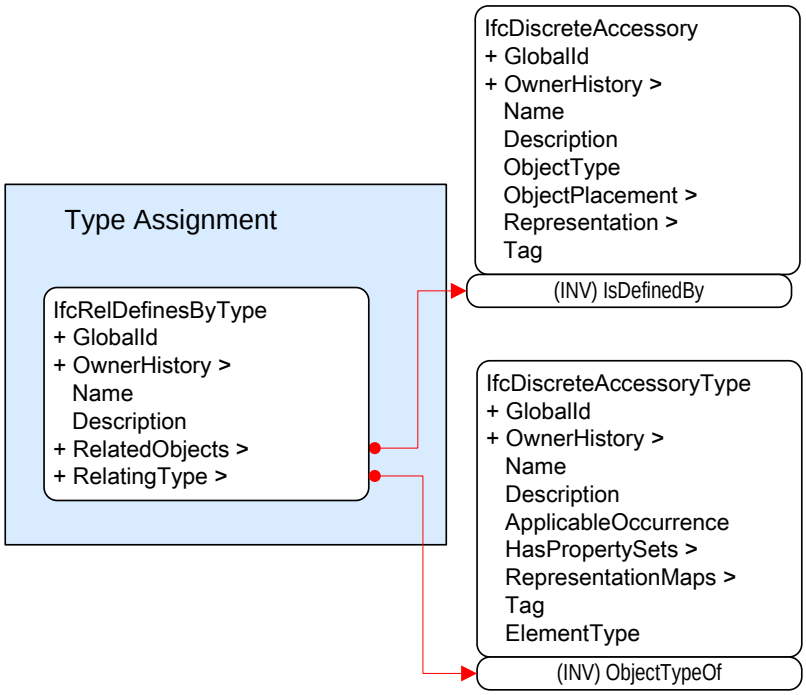
Embed Type Assignment

Reference	PCI-098	**Version**	1.1	**Status**	Draft
Relationships					
History	Reviewed 18 November, 2012				
Authors	Manu Venugopal				
Document Owner	Precast/Prestressed Concrete Institute (manu.menon@gatech.edu)				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelDefinesByType

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data

Name	<Open>
Description	<Open>
RelatedObjects	Must be a subtype of IfcDiscreteAccessory
RelatingType	Must be a subtype of IfcDiscreteAccessoryType

IfcDiscreteAccessoryType

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
Applicable Occurrence	<Open>
HasPropertySets	Optional. Should use IfcPropertySetDefinition
RepresentationMaps	Optional. Should use List of unique IfcRepresentationMap
Tag	The tag should be a unique, and company specific label.
ElementType	Optional Label

IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.

Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

Example: Part21 file

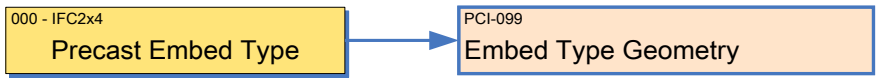
```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341=
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#410= IFCLOCALPLACEMENT(#99,#407);
#413= IFCSHAPEREPRESENTATION(#40,$,$,(#380));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#413));
#421= IFCDISCRETEACCESSORY('1A0gmi1112rZ4oD34sE3au',#20,'PLATE',$,$,#410,#419,$);
#422= IFCDISCRETEACCESSORYTYPE('1A0gmi2222rZ4oD34sE3au',#20,'EMBED-PLATE',$,$,$,$,$,$,$);
#472= IFCRELDEFINESBYTYPE('1abcTrJ3X67Ph$9b4UuEL6',#20,$,$,(#341),#360);
#473= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#341,(#421));
#474= IFCRELDEFINESBYTYPE('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,(#421),#422);
```


IFC Release Specific Concept Description (IFC 2x3)

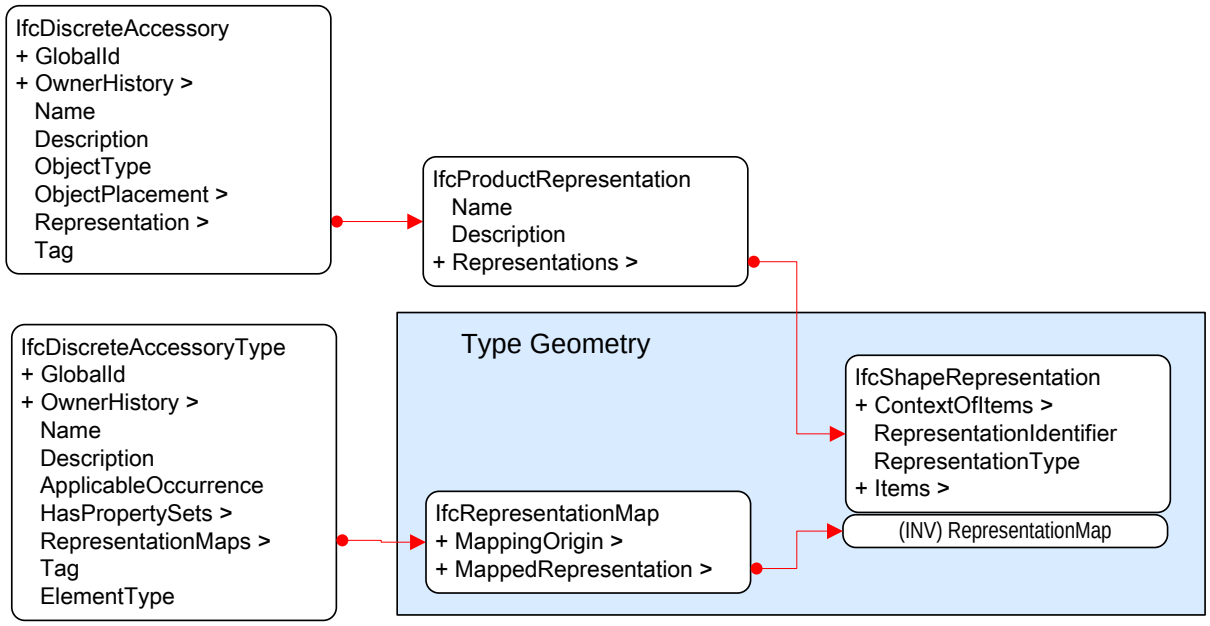
Embed Type Geometry

Reference	PCI-099	Version	1.1	Status	Draft
Relationships					
History	Reviewed 18 November, 2012				
Authors	Manu Venugopal				
Document Owner	Precast/Prestressed Concrete Institute (manu.menon@gatech.edu)				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcShapeRepresentation

Attribute	Implementation agreements
ContextOfItems	Must be provided
Representation Identifier	Must be provided, but may contain dummy data
Representation Type	<Open>
Items	<Open>

IfcProductRepresentation

Attribute	Implementation agreements

Name	Must be provided
Description	Must be provided, but may contain dummy data
Representations	Contained list of shape representations. Each member should define a valid representation of a particular type within a particular representation context

IfcRepresentationMap

Attribute	Implementation agreements
MappingOrigin	An axis2 placement that defines the position about which the mapped representation is mapped
MappedRepresentation	A representation that is mapped to at least one mapped item, IfcShapeRepresentation in this case

IfcDiscreteAccessoryType

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
Applicable Occurrence	<Open>
HasPropertySets	Optional. Should use IfcPropertySetDefinition
RepresentationMaps	Optional. Should use List of unique IfcRepresentationMap
Tag	The tag should be a unique, and company specific label.
ElementType	Optional Label

IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>

Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

Example: Part21 file

```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341=
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#410= IFCLOCALPLACEMENT(#99,#407);
#413= IFCSHAPEREPRESENTATION(#40,$,$,(#380));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#413));
#421= IFCDISCRETEACCESSORY('1A0gmi1112rZ4oD34sE3au',#20,'PLATE',$,$,#410,#419,$);
#422= IFCDISCRETEACCESSORYTYPE('1A0gmi2222rZ4oD34sE3au',#20,'EMBED-PLATE',$,$,$,$,$,$,$);
#472= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#341,(#421));
```

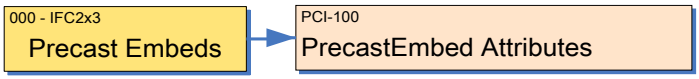
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (IFC 2x3**)**

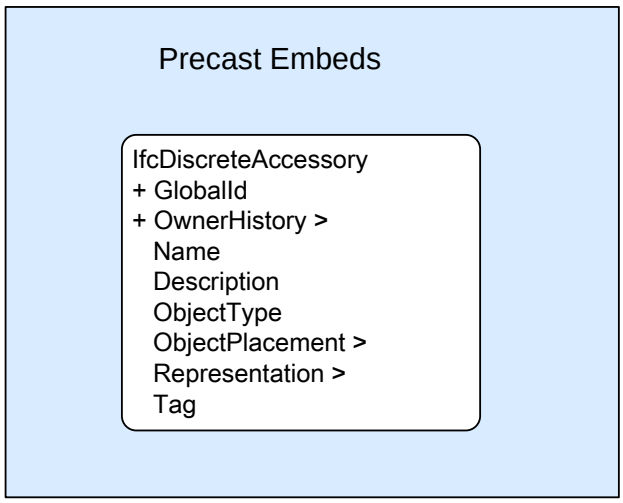
Precast Embed Attributes

Reference	PCI-100	**Version**	1.1	**Status**	Draft
Relationships	Related to Precast Piece through Precast Embed Assignment				
History					
Authors	Manu Venugopal				
Document Owner	Precast/Prestressed Concrete Institute (manu.menon@gatech.edu)				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

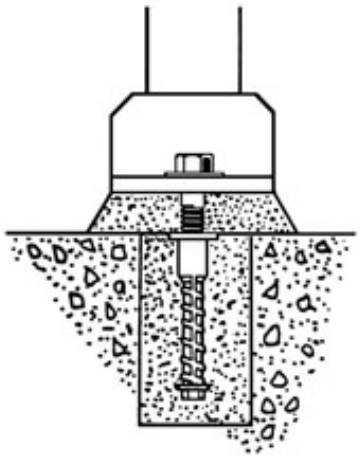
IfcDiscreteAccessory

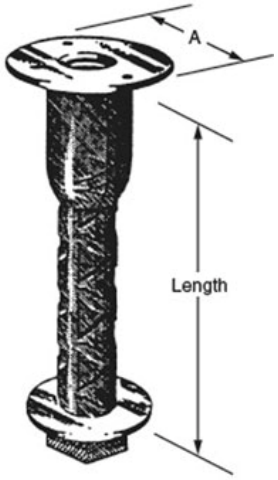
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement

	of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.

Example:

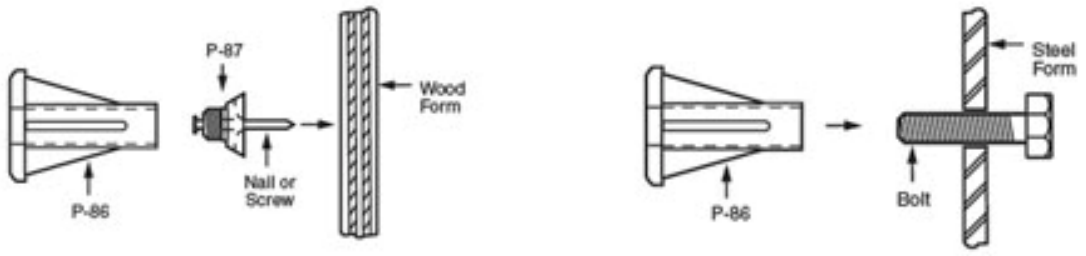
Embeds





Lifting Devices

Connection Components



Part 21 File for Embed

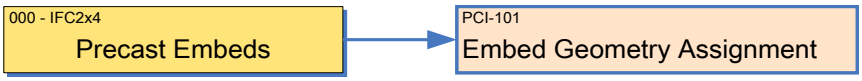
```
#309= IFCCARTESIANPOINT((206.,6.8212103E-13,3210.));
#313= IFCAXIS2PLACEMENT3D(#309,#33,#25);
#316= IFCLOCALPLACEMENT(#79,#313);
#319= IFCCOLOURRGB('Light Gray',0.60000002,0.60000002,0.60000002);
#320=
IFCSURFACESTYLERENDERING(#319,0.,$,$,$,$,IFCNORMALISEDRATIOMEASURE(0.00390625),IFCSPECULAREXPONENT(10.),.NOTDEFINED.);
#321= IFCSURFACESTYLE('',.POSITIVE.,(#320));
#323= IFCPRESENTATIONSTYLEASSIGNMENT((#321));
#325= IFCAXIS2PLACEMENT2D(#104,#108);
#328= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#325,10.,160.);
#329= IFCCARTESIANPOINT((0.,0.,780.));
#333= IFCAXIS2PLACEMENT3D(#329,#120,#25);
#336= IFCEXTRUDEDAREASOLID(#328,#333,#33,780.);
#339= IFCSTYLEDITEM(#336,(#323),'Name');
#343= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#336));
#349= IFCPRODUCTDEFINITIONSHAPE('','',(#343));
#353= IFCDISCRETEACCESSORY
('1AH7uO0000834oD3OmC3Cn',#20,'PLATE','PLT10*160','PLT10*160',#316,#349,'TS_1443');
```

IFC Release Specific Concept Description (IFC 2x3**)**

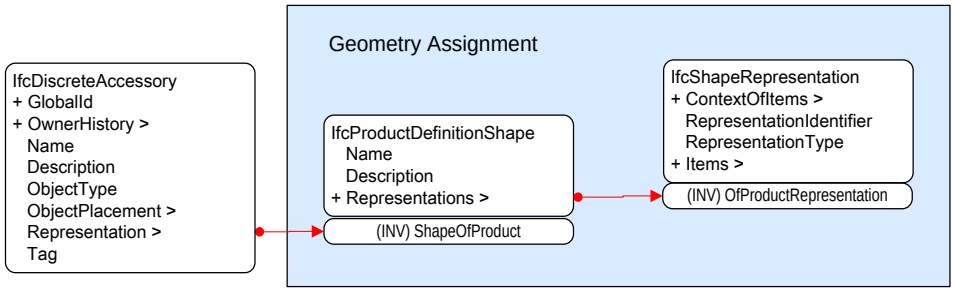
Embed Geometry Assignment

Reference	PCI-101	**Version**	1.1	**Status**	Draft
Relationships					
History	VBL-203, ICC-465; reviewed 18 November, 2012				
Authors	Manu Venugopal				
Document Owner	Precast/Prestressed Concrete Institute (manu.menon@gatech.edu)				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcDiscreteAccessory

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	If the IfcDiscreteAccessory is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
Representation	The geometric representation of IfcDiscreteAccessory is given by the IfcProductDefinitionShape, allowing multiple geometric representations.

Tag	The tag should be a unique, and company specific label.

IfcProductDefinitionShape

Attribute	Implementation agreements
Name	<Open>
Description	<Open>
Representations	Inversely related to the relating physical element (IfcDiscreteAccessory)

Example: Part21 file for Shape Representation of Embeds

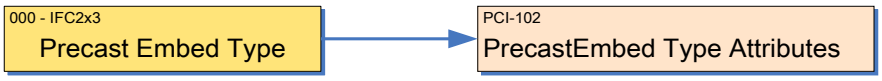
```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#409,10.,160.);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,780.);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#414);
#421= IFCDISCRETEACCESSORY('1A0gmi1112rZ4oD34sE3au',#20,'EMBED-PLATE',$,$,#99,#419,$);
#422= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#341,(#421));
```

IFC Release Specific Concept Description (IFC 2x3**)**

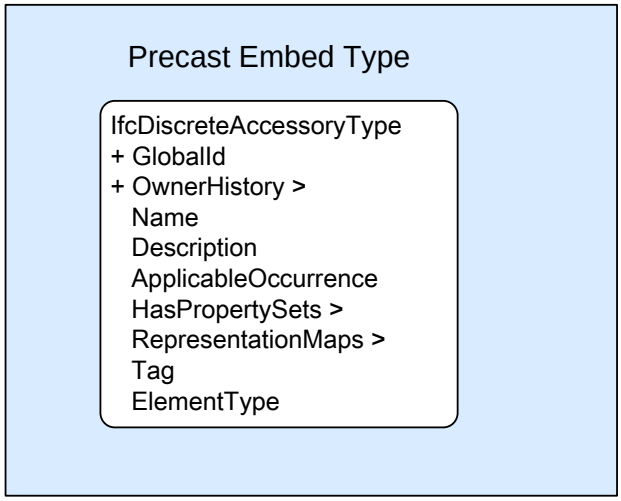
Precast Embed Type Attributes

Reference	PCI-102	**Version**	1.1	**Status**	Draft
Relationships	Related to Precast Piece through Precast Embed Assignment				
History					
Authors	Manu Venugopal				
Document Owner	Precast/Prestressed Concrete Institute (manu.menon@gatech.edu)				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

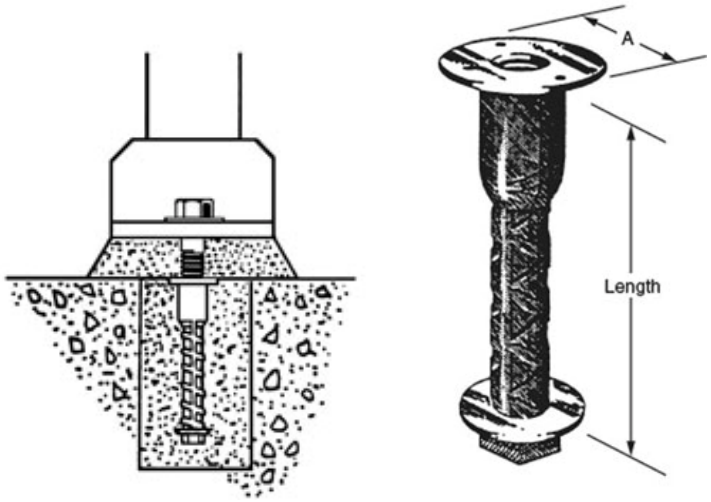
IfcDiscreteAccessoryType

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ApplicableOccurrence	<Open>

HasPropertySets	If the IfcDiscreteAccessoryType is assigned to an IfcBuildingElement, and this element defines its own local placement, then the PlacementRelTo relationship of IfcLocalPlacement shall point (if given) to the local placement of the IfcBuildingElement.
RepresentationMaps	The geometric representation of IfcDiscreteAccessoryType is given by the IfcProductDefinitionShape, allowing multiple geometric representations.
Tag	The tag should be a unique, and company specific label.
ElementType	

Example:

Embeds



Lifting Devices

Connection Components

Part 21 File for Embed Type

```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341=
IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#410= IFCLOCALPLACEMENT(#99,#407);
#413= IFCSHAPEREPRESENTATION(#40,$,$,(#380));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#413));
#421= IFCDISCRETEACCESSORY('1A0gmi1112rZ4oD34sE3au',#20,'PLATE',$,$,#410,#419,$);
#422= IFCDISCRETEACCESSORYTYPE('1A0gmi2222rZ4oD34sE3au',#20,'EMBED-PLATE',$,$,$,$,$,$,$);
#472= IFCRELDEFINESBYTYPE('1abcTrJ3X67Ph$9b4UuEL6',#20,$,$,(#341),#360);
#473= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#341,(#421));
#474= IFCRELDEFINESBYTYPE('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,(#421),#422);
```

This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

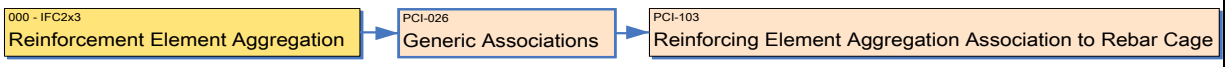
IFC Release Specific Concept Description (<IFC Release 2x3>)

Reinforcing Element Aggregation Association to

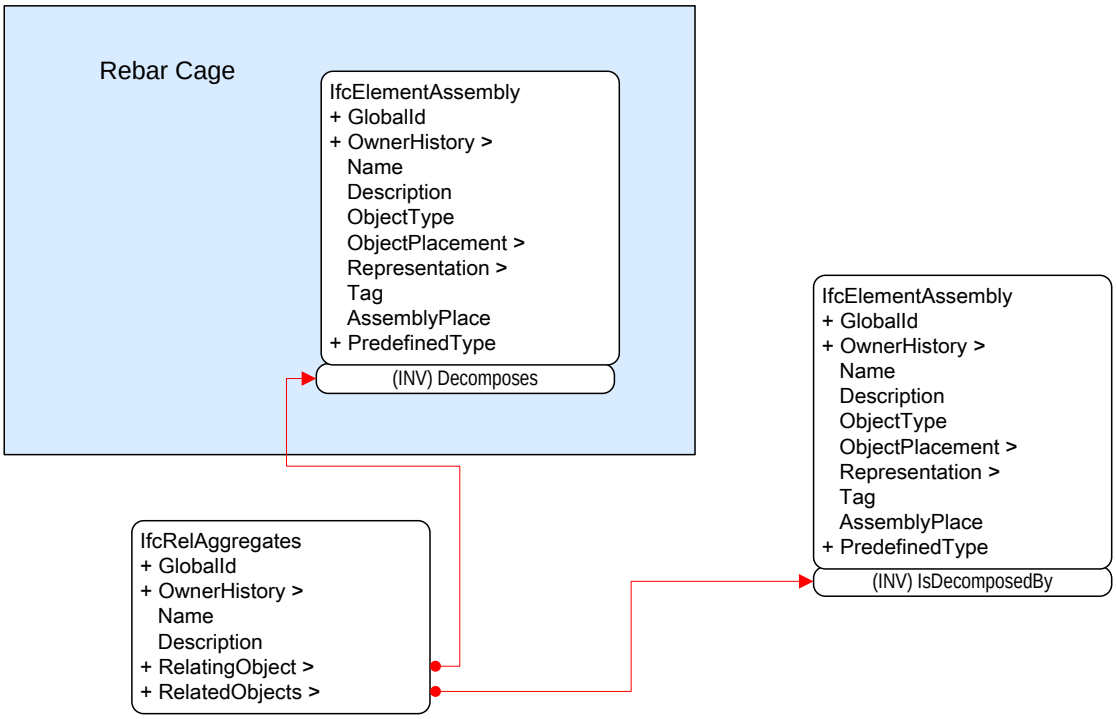
Rebar Cage

Reference	PCI-103	**Version**	1.1	**Status**	Draft
Relationships	Assigns a reinforcing element aggregations usually a rebar assembly to a higher level composition, usually a rebar cage.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram; Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcElementAssembly:

Attribute	Implementation agreements
GlobalId	Must be provided

OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
Tag	Label: “Rebar Cage”
(INV) Decomposes	Decomposes an assembly to its reinforcement element aggregation constituents, which is usually a rebar assembly.

IfcElementAssembly:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
Tag	If we have aggregation of IfcReinforcingBar it must be the label: “Rebar Assembly”. If we have aggregation of IfcTendon it must be the label: “Tendon Group”. If we have aggregation of IfcMesh it must be the label: “Mesh Group”.
(INV) IsDecomposedBy	Reinforcing Element Aggregations which are aggregated into higher level assemblies which usually is a rebar cage.

IfcRelAggregates:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	A rebar cage which is a higher level assembly of rebar assemblies.
RelatedObjects	Refers to Reinforcing Element Aggregation which are usually rebar assemblies.

Example: Part21 file for Aggregation of Reinforcing Element into Rebar Cage:

```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
```

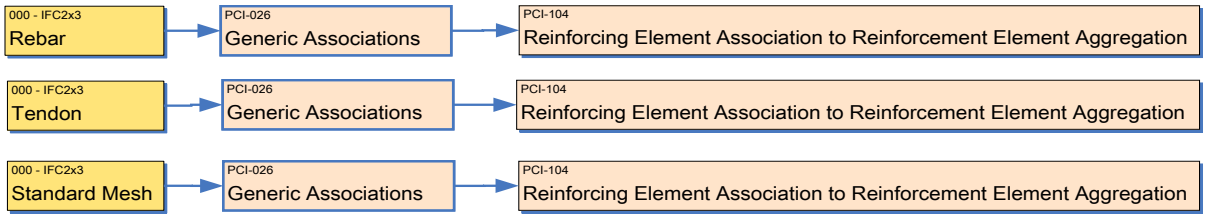
```
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341=IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_42
01');
#343= IFCELEMENTASSEMBLY('2JSdo2Lp9309Sv6zKzNTMZ',#20,'','',
'Rebar Cage',#99,#337,'','FACTORY','REINFORCEMENT_UNIT');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#409,10.,160.);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,780.);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#414);
#421= IFCELEMENTASSEMBLY('1A0gmi1112rZ4oD34sE3au',#20,'','',
'Rebar Assembly',#99,#419,'','FACTORY','REINFORCEMENT_UNIT');
#422= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#343,(#421));
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

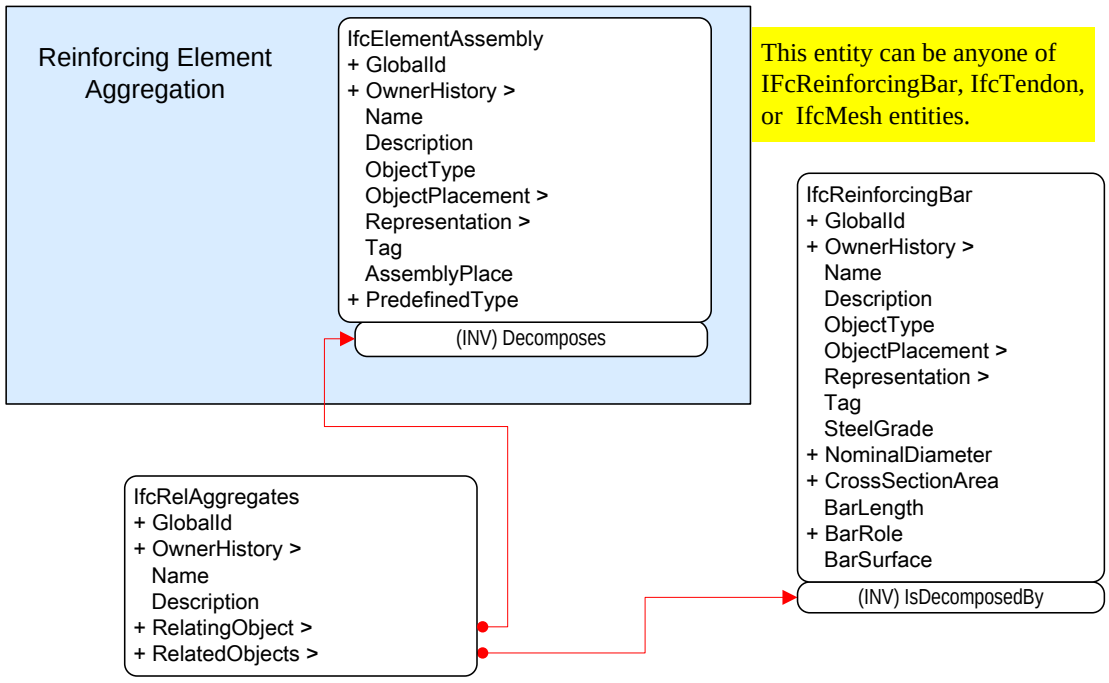
Reinforcing Element Association to Reinforcing Element Aggregation

Reference	PCI-104	**Version**	1.1	**Status**	Draft
Relationships	Assigns a reinforcing bar, tendon, and standard mesh to a higher level composition, usually an assembly of rebar or a group of tendons or meshes.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcElementAssembly:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
Tag	If we have aggregation of IfcReinforcingBar it must be the label: “Rebar Assembly”. If we have aggregation of IfcTendon it must be the label: “Tendon Group”. If we have aggregation of IfcMesh it must be the label: “Mesh Group”.
(INV) Decomposes	Decomposes an assembly to its rebar, tendon or mesh constituents. It makes an inverse relationship with RelatingObject attribute of IfcRelAggregates

IfcRelAggregates:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	An assembly of rebars or a group of tendons or meshes.
RelatedObjects	Refers to rebars, tendons, or meshes that are aggregated into an reinforcing element assembly.

Example: Part21 file for Reinforcing Element Association to Reinforcing Element Aggregation:

```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
```

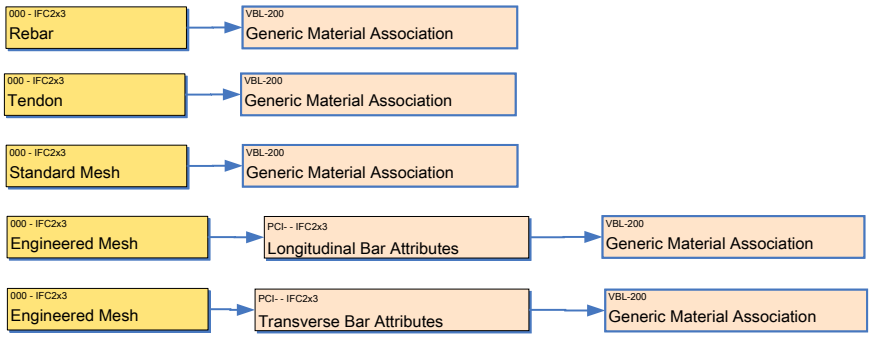
```
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341=IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_42
01');
#343= IFCELEMENTASSEMBLY('2JSdo2Lp9309Sv6zKzNTMZ',#20,'','',
'Reinforcing Array',#99,#337,'','FACTORY','REINFORCEMENT_UNIT');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#409,10.,160.);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,780.);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#414);
#421= IFCREINFORCINGBAR('1A0gmi1112rZ4oD34sE3au',#20,'REBAR',$,$,#99,#419,$,'6',
'0'  0 1/2"','0.45',$,'MAIN',$);
#422= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#343,(#421));
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

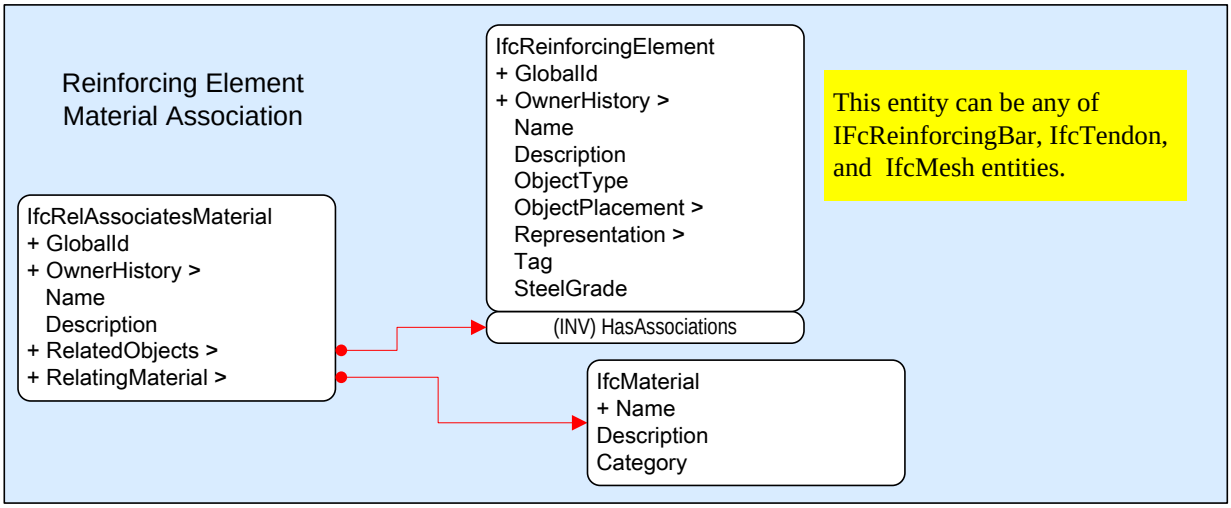
Reinforcing Element Generic Material Association

Reference	PCI-105	**Version**	1.1	**Status**	Draft
Relationships	Associates base steel material or coating material to the reinforcing element.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelAssociatesMaterial

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>

RelatedObjects	Must be subtype of IfcReinforcingElement
RelatingMaterial	Must be a sub-type of IfcMaterial

IfcMaterial

Attribute	Implementation agreements
Name	<Open>
Description	<Open>
Category	<Open>

Example: Part21 file

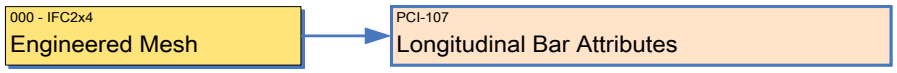
```
#400= IFCMATERIAL('STEEL',$,$);
#423= IFCREINFORCINGBAR('1A0gmi1112rZ4oD34sE3au',#20,'REBAR',$,$,#99,#419,$,'6',
'0'  0 1/2"','0.45',$,'MAIN',$);
#3418=
IFCRELASSOCIATESMATERIAL('3$I9WKOi13bu_AGccPjPTG',#20,$,$,(#3353,#3314,#3275,#3232,#3197,#3134,#2973,#2905,#2711,#2617,#2069,#1649,#1571,#1532,#1493,#1454,#1415,#1337,#1259,#1181,#1103,#1025,#928,#579,#540,#501,#462,#423,#341),#400);
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

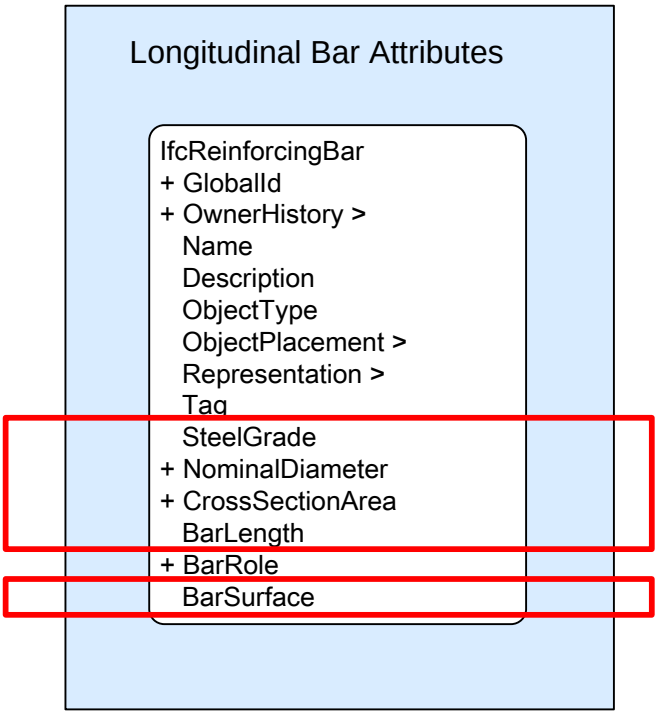
Longitudinal Bar Attributes

Reference	PCI-107	**Version**	1.1	**Status**	Draft
Relationships	Different attributes of longitudinal rebar needed to design and fabricate engineered mesh like steel grade, nominal diameter and so on.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcReinforcingBar

Attribute	Implementation agreements
SteelGrade	Must be provided; The nominal steel grade defined according to local standards.
NominalDiameter	Must be provided, the cross-section size of the reinforcing bar.
CrossSectionArea	Must be provided.
Barlength	Must be provided. The total length of the reinforcing bar. The total length of bended bars are calculated according to local standards with corrections for the bends.

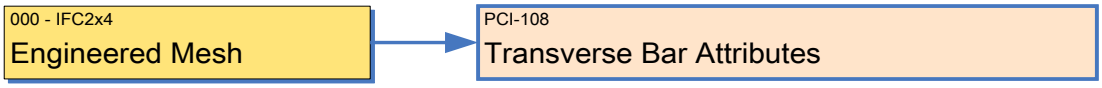
BarRole	<Optional>
BarSurface	<Open> Indicating whether the bar is plain or textured

IFC Release Specific Concept Description (<IFC Release 2x3>)

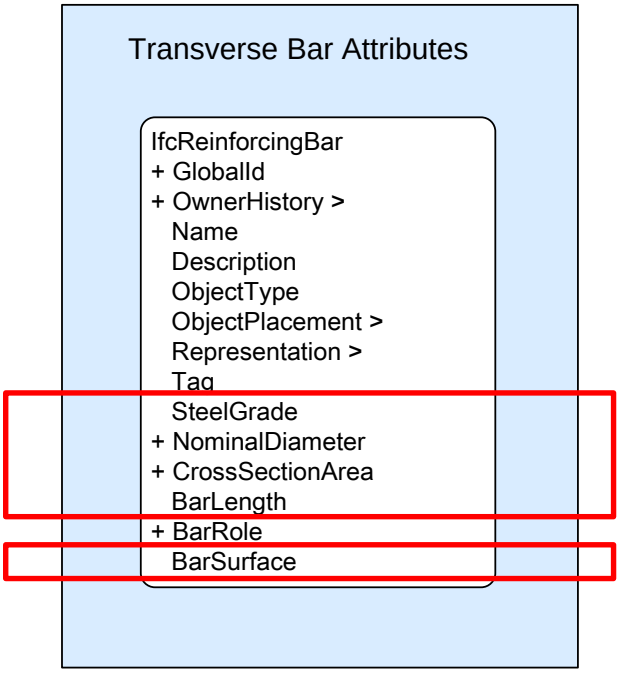
Transverse Bar Attributes

Reference	PCI-108	**Version**	1.1	**Status**	Draft
Relationships	Different attributes of transverse rebar needed to design and fabricate engineered mesh like steel grade, nominal diameter and so on				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcReinforcingBar

Attribute	Implementation agreements
SteelGrade	Must be provided; The nominal steel grade defined according to local standards.

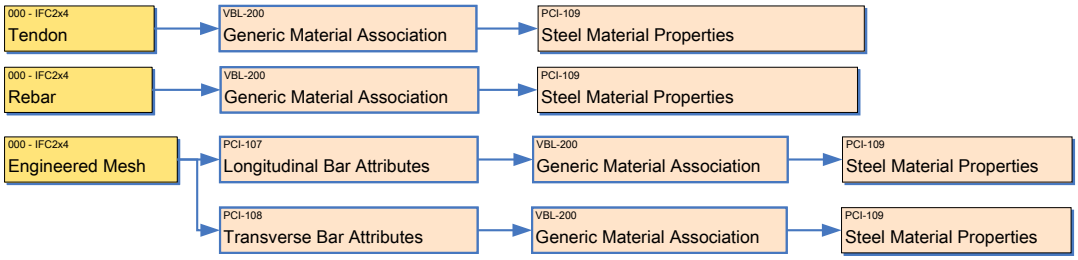
NominalDiameter	Must be provided, the cross-section size of the reinforcing bar.
CrossSectionArea	Must be provided.
Barlength	Must be provided. The total length of the reinforcing bar. The total length of bended bars are calculated according to local standards with corrections for the bends.
BarRole	<Optional>
BarSurface	<Open> Indicating whether the bar is plain or textured

IFC Release Specific Concept Description (<IFC Release 2x3>)

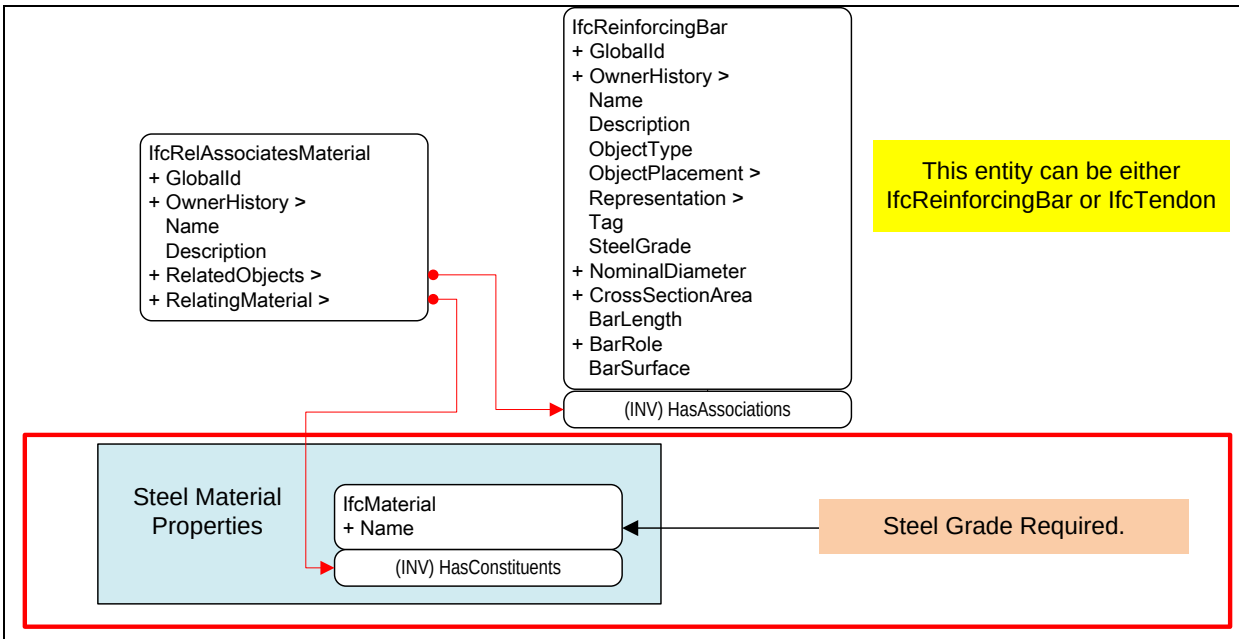
Steel Material Properties

Reference	PCI-109	**Version**	1.1	**Status**	Draft
Relationships	Provides the steel material properties for rebars and tendons				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelAssociatesMaterial

Attribute	Implementation agreements
Name	Must be provided and must contain the text “Reinforcing Steel or Tendon material definition”

IfcMaterial

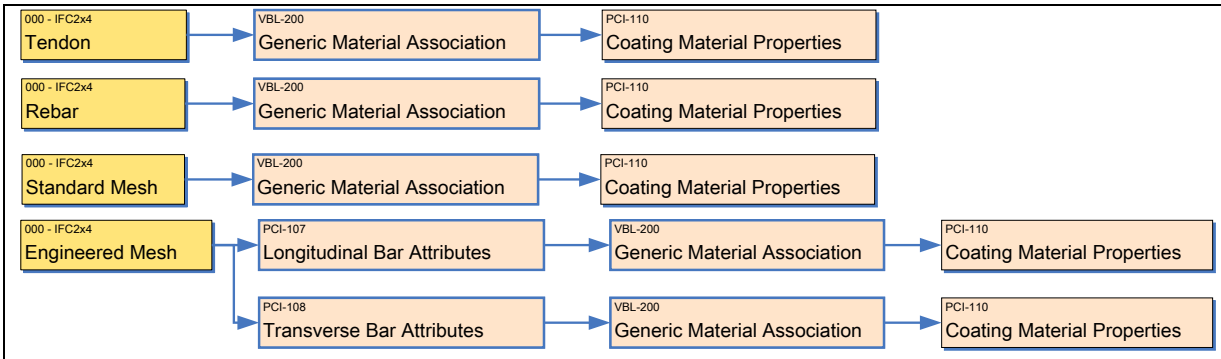
Attribute	Implementation agreements
Name	Must be provided and must define the steel grade used with a name that refers to CSRI (Concrete Steel Reinforcing Institute) or other standards.

IFC Release Specific Concept Description (<IFC Release 2x3>)

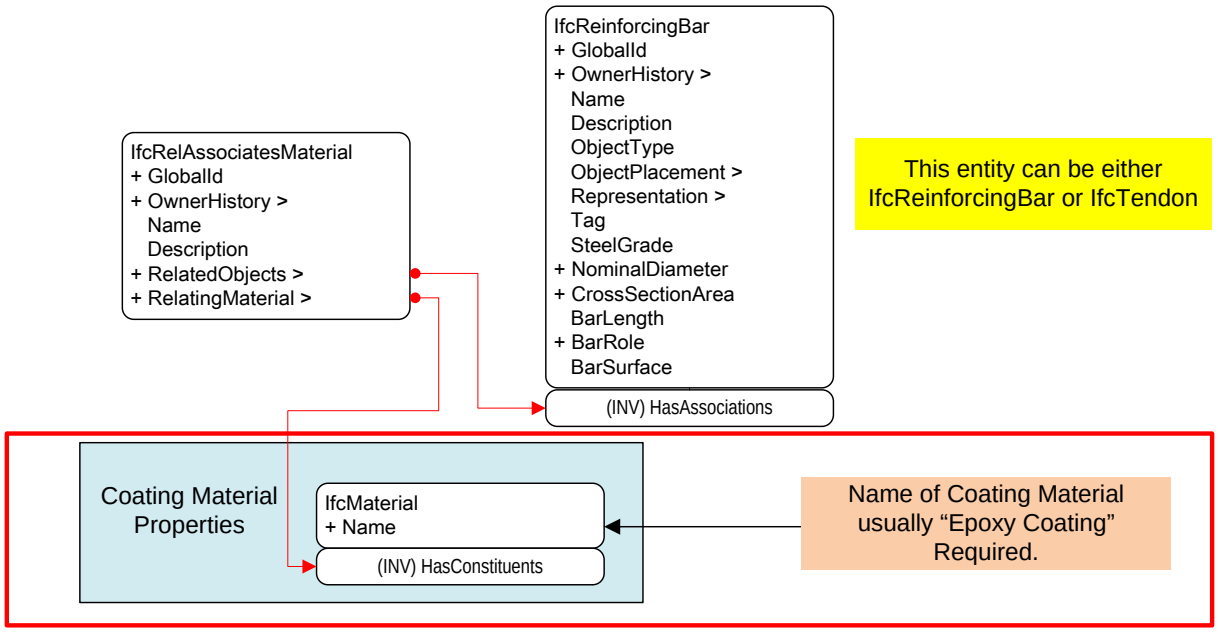
Coating Material Properties

Reference	PCI-110	**Version**	1.1	**Status**	Draft
Relationships	Provides the coating material properties for rebar and tendon				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelAssociatesMaterial

Attribute	Implementation agreements
Name	Must be provided and must contain the text "Rebar Coating Material"

IfcMaterial

Attribute	Implementation agreements
Name	Must be provided and must provide a precise definition of the name of the rebar coating material used, such as "Epoxy Coating"

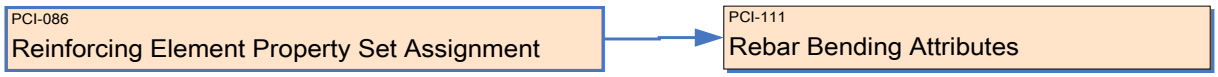
IFC Release Specific Concept Description (<IFC Release 2x3>)

Rebar Bending Attributes

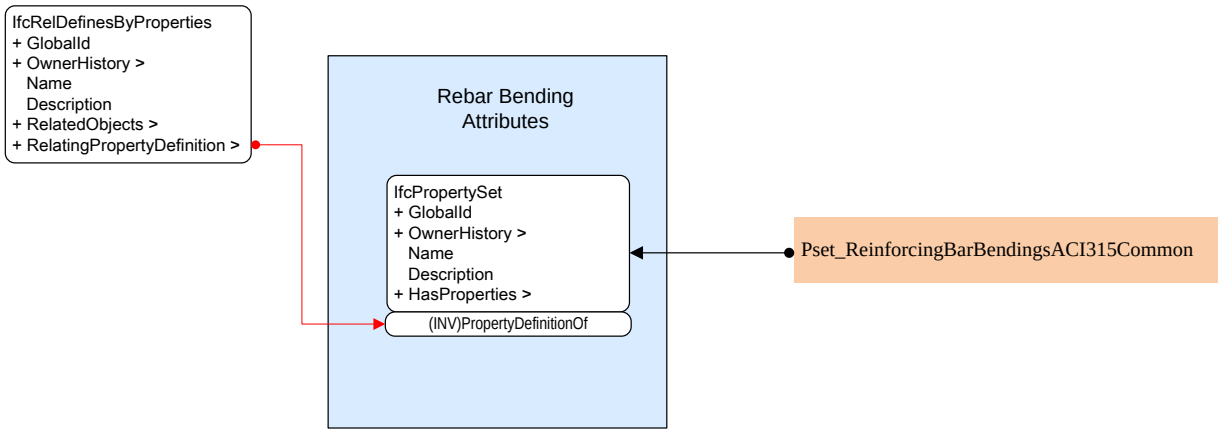
Reference	PCI-111	Version	1.1	Status	Draft

Relationships	Provides the property set with information for reinforcing bar bending. The property set is based on the ACI-315 standard (Details and Detailing of Concrete Reinforcement).
History	Revised Nov 18, 2012
Authors	Shiva Aram
Document Owner	Precast/Prestress Concrete Institute

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcPropertySet

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Must be provided
Description	<Open>
HasProperties	Must point to the a set of properties defined according to Pset_ReinforcingBarBendingsACI315Common

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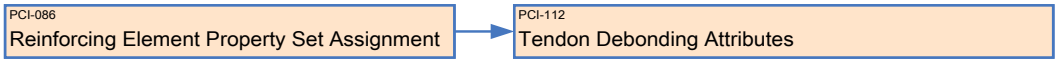
IFC Release Specific Concept Description (<IFC Release 2x3>)

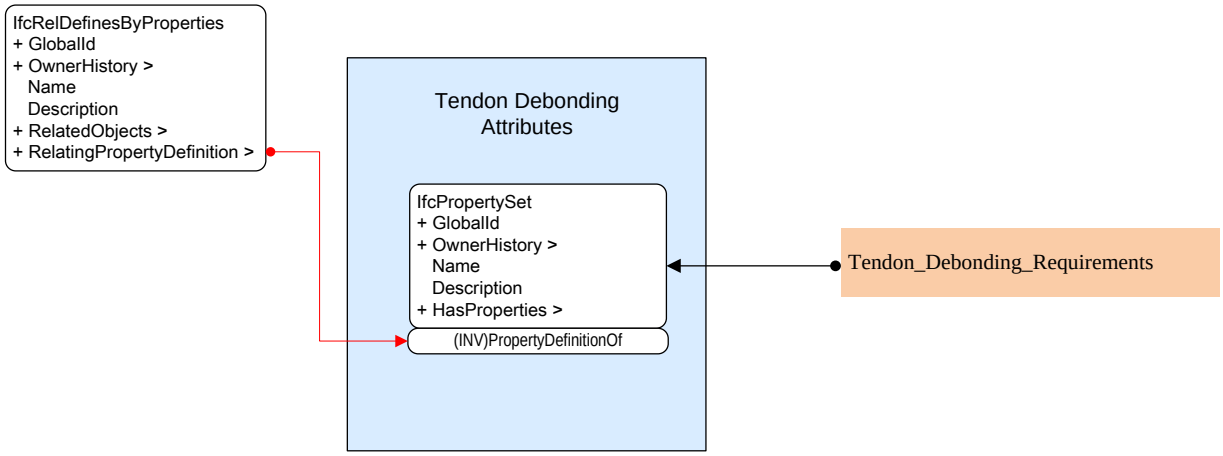
Tendon Debonding Attributes

Reference	PCI-112	**Version**	1.1	**Status**	Draft
Relationships	Links building elements to their shape representation				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcPropertySet

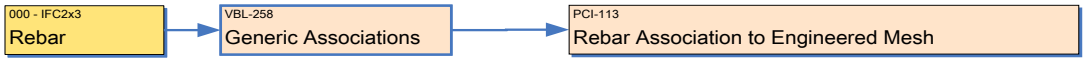
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	Must be provided. The properties used for tendon debonding.
Description	<Open>
HasProperties	Must point to a set of Ifcproperty entities that include the following data: - Tendon debonding relative placement (see PCI-127). - Tendon debonding length (see PCI-128). - Tendon debonding material (see PCI-129).

IFC Release Specific Concept Description (<IFC Release 2x3>)

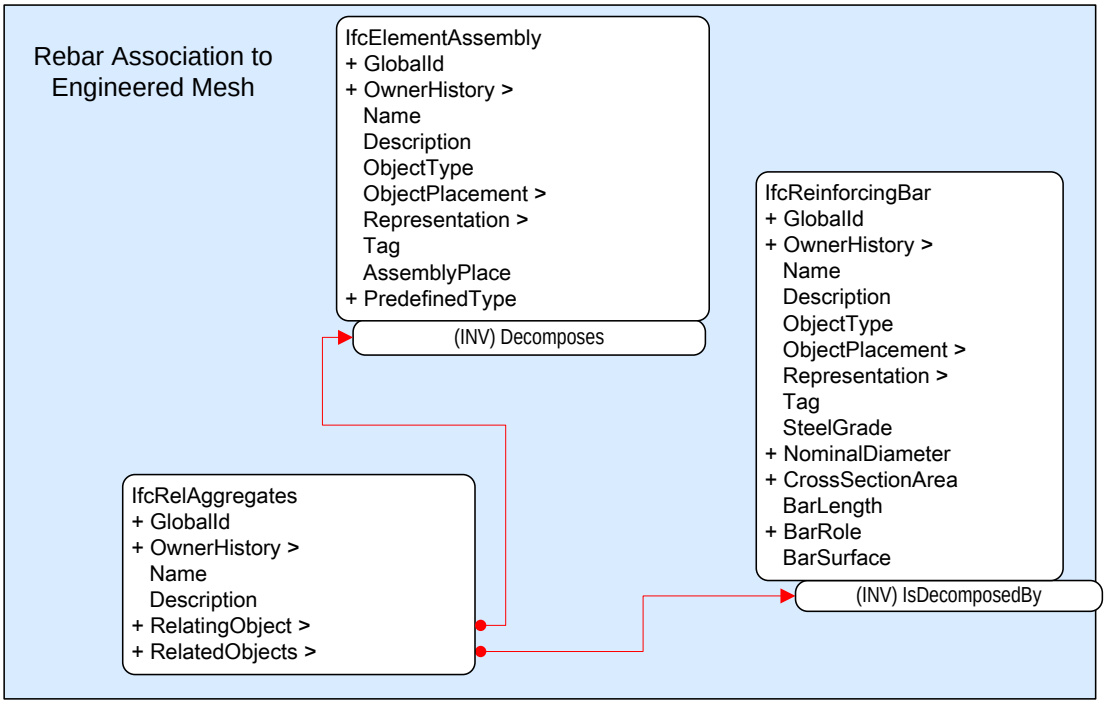
Rebar Association to Engineered Mesh

Reference	PCI-113	**Version**	1.1	**Status**	Draft
Relationships	. Assigns a reinforcing bar to customly fabricated meshes				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcElementAssembly:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data

Name	<Open>
Description	<Open>
Tag	If we have aggregation of IfcReinforcingBar it must be the label: “Rebar Assembly”. If we have aggregation of IfcTendon it must be the label: “Tendon Group”. If we have aggregation of IfcMesh it must be the label: “Mesh Group”.
(INV) Decomposes	Decomposes an assembly to its rebar, tendon or mesh constituents. It makes an inverse relationship with RelatingObject attribute of IfcRelAggregates

IfcRelAggregates:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	An assembly of rebars or a group of tendons or meshes.
RelatedObjects	Refers to rebars, tendons, or meshes that are aggregated into an reinforcing element assembly.

Example: Part21 file for Reinforcing Element Association to Reinforcing Element Aggregation:

```
#1= IFCPERSON('RDG-HOME/gk900591','Undefined',$,$,$,$,$,$);
#3= IFCORGANIZATION($,$,$,$,$);
#7= IFCPERSONANDORGANIZATION(#1,#3,$);
#8= IFCAPPLICATION(#3,'15.0',$,$);
#20= IFCOWNERHISTORY(#7,#8,$,.ADDED.,$,$,$,1241690761);
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
#79= IFCLOCALPLACEMENT(#66,#37);
#82= IFCBUILDINGSTOREY('0eOYgfP7bBKuiN8xQ7ES6h',#20,'Undefined',$,$,#79,$,$,.ELEMENT.,$);
#96= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#99= IFCLOCALPLACEMENT(#79,#96);
#309= IFCPOLYLOOP((#268,#249,#230,#211,#192,#173,#154,#135,#112,#108));
#313= IFCFACEOUTERBOUND(#309,.T.);
#316= IFCFACE((#313));
#320= IFCCLOSEDSHELL((#131,#150,#169,#188,#207,#226,#245,#264,#283,#294,#305,#316));
#324= IFCFACETEDBREP(#320);
#327= IFCSTYLEDITEM(#324,(#106),'Name');
#331= IFCSHAPEREPRESENTATION(#40,'Body','Brep',(#324));
```

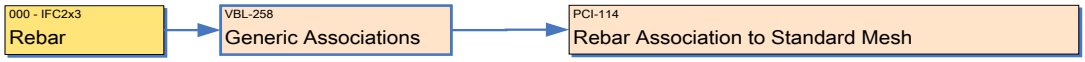
```
#337= IFCPRODUCTDEFINITIONSHAPE('','',(#331));
#341=IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_42
01');
#343= IFCELEMENTASSEMBLY('2JSdo2Lp9309Sv6zKzNTMZ',#20,'','',
'Reinforcing Array',#99,#337,'','FACTORY','REINFORCEMENT_UNIT');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#403= IFCCARTESIANPOINT((220.,1807.5,2300.));
#407= IFCAXIS2PLACEMENT3D(#403,#33,#25);
#408= IFCLOCALPLACEMENT(#99,#407);
#409= IFCAXIS2PLACEMENT2D(#104,#108);
#410= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#409,10.,160.);
#411= IFCCARTESIANPOINT((0.,0.,780.));
#412= IFCAXIS2PLACEMENT3D(#411,#120,#25);
#413= IFCEXTRUDEDAREASOLID(#410,#412,#33,780.);
#414= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#413));
#419= IFCPRODUCTDEFINITIONSHAPE('','',(#414);
#421= IFCREINFORCINGBAR('1A0gmi1112rZ4oD34sE3au',#20,'REBAR',$,$,#99,#419,$,'6',
'0'  0 1/2"','0.45',$,'MAIN',$);
#422= IFCRELAGGREGATES('1IpcTrJ3X67Ph$9b4UuEL6',#20,$,$,#343,(#421));
```

IFC Release Specific Concept Description (<IFC Release 2x3>)

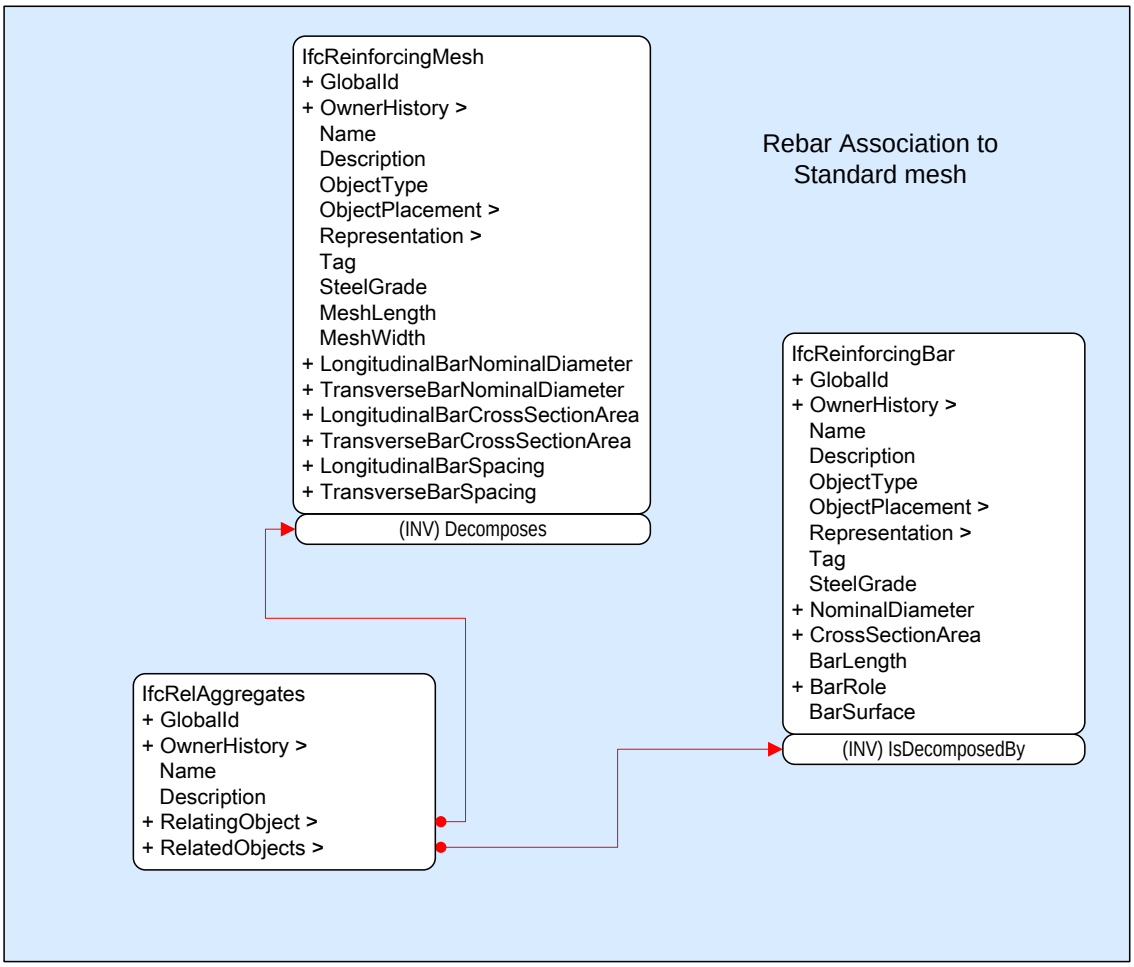
Rebar Association to Standard Mesh

Reference	PCI-114	**Version**	1.1	**Status**	Draft
Relationships	Assigns a reinforcing bar to a standard mesh				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelAggregates:

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	An assembly of rebars or a group of tendons or meshes.
RelatedObjects	Refers to rebars, tendons, or meshes that are aggregated into an reinforcing element assembly.

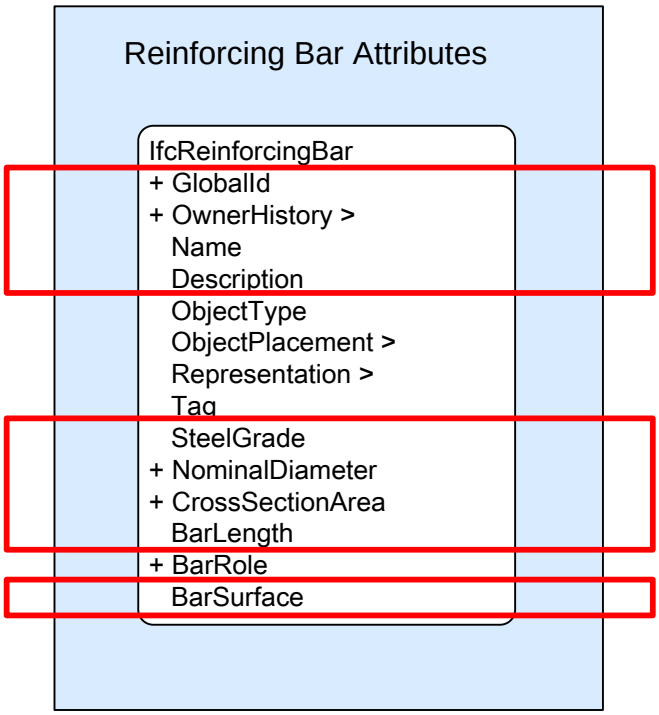
IFC Release Specific Concept Description (<IFC Release 2x3)

Reinforcing Bar Attributes

Reference	PCI-117	**Version**	1.1	**Status**	Draft
Relationships	. Different attributes of reinforcing bars needed to design and fabricate them like steel grade, nominal diameter and so on				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcReinforcingBar

Attribute	Implementation agreements
GUID	Must be provided.
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>

Description	<Open>
SteelGrade	Must be provided; The nominal steel grade defined according to local standards.
NominalDiameter	Must be provided, the cross-section size of the reinforcing bar.
CrossSectionArea	Must be provided.
Barlength	Must be provided. The total length of the reinforcing bar. The total length of bended bars are calculated according to local standards with corrections for the bends.
BarRole	<Optional>
BarSurface	<Open> Indicating whether the bar is plain or textured

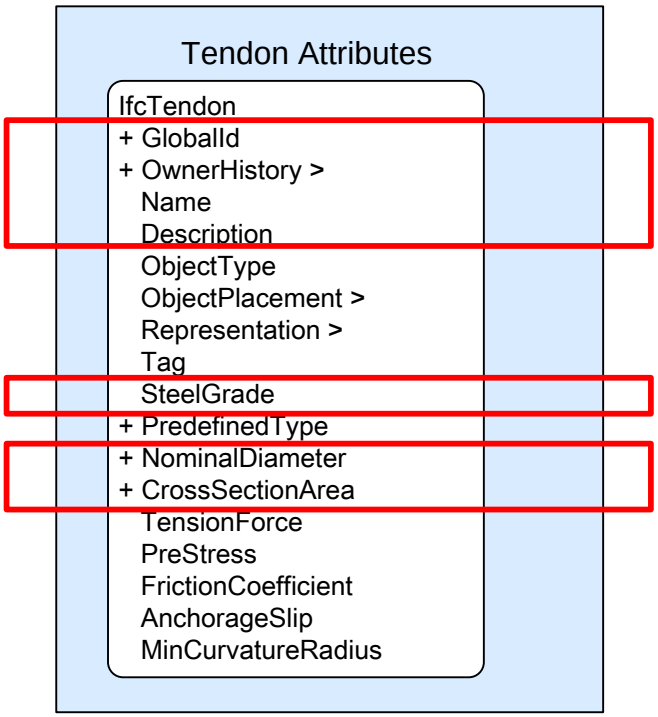
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Attributes

Reference	PCI-118	**Version**	1.1	**Status**	Draft
Relationships	Different attributes of tendons needed to design and fabricate them like steel grade, nominal diameter and so on.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcTendon

Attribute	Implementation agreements
GUID	Must be provided.
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>

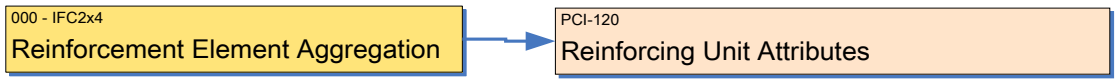
SteelGrade	Must be provided; Nominal steel grade defined by standards.
NominalDiameter	Must be provided, Defines the cross-section size of the tendon
CrossSectionArea	Must be provided
TensionForce	Must be provided for level of detail 300 and higher
PreStress	Must be provided for level of detail 300 and higher
FrictionCoefficient	Must be provided for level of detail 300 and higher
AnchorageSlip	Must be provided for level of detail 300 and higher
MinCurvatureRadius	Must be provided for level of detail 300 and higher

IFC Release Specific Concept Description (<IFC Release 2x3>)

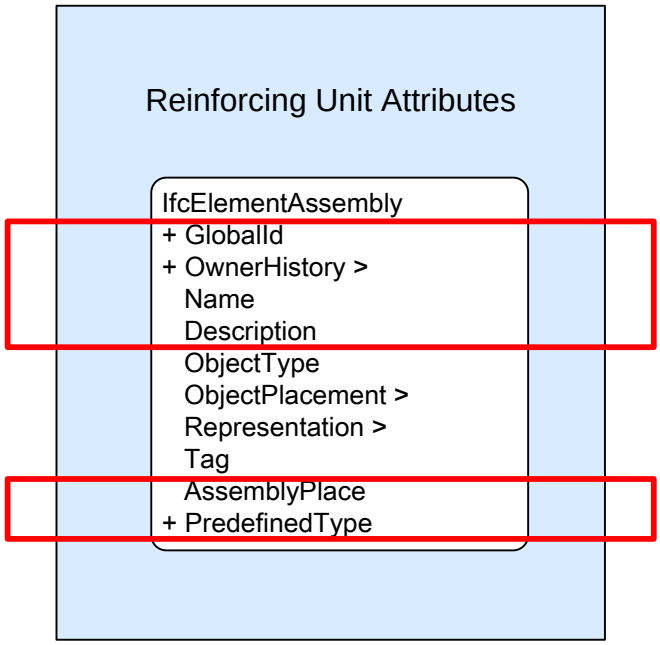
Reinforcing Unit Attributes

Reference	PCI-120	**Version**	1.1	**Status**	Draft
Relationships	Provides different attributes required to design and fabricate reinforcing units like arrays of tendons or cages of rebar.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcElementAssembly

Attribute	Implementation agreements
GlobalID	Must be provided.
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
AssemblyPlace	<Open>

PredefinedType	Must be 'REINFORCEMENT_UNIT'.

Example:

#3063= IFCLOCALPLACEMENT(#79,#3060);

#3202= IFCPRODUCTDEFINITIONSHAPE('','',(#3200));

#3210= IFCELEMENTASSEMBLY('21cnI70007J34oCpGvC3Kt',#20,'Tendon assembly1', '','',#3063,#3202,'TS_21776395',$,.REINFORCEMENT_UNIT.);

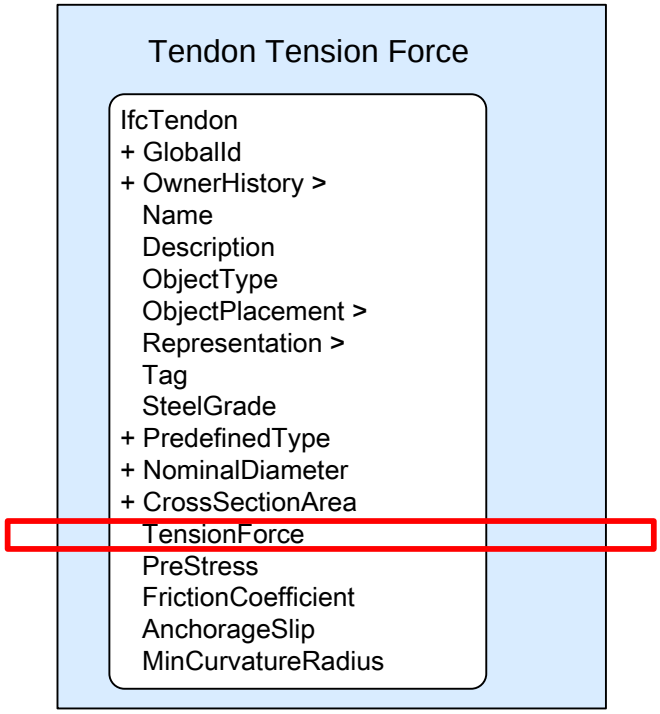
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Tension Force

Reference	PCI-122	**Version**	1.1	**Status**	Draft
Relationships	Provides the maximum allowed tension force for tendon				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcTendon

Attribute	Implementation agreements
TensionForce	Must be provided. Maximum allowed tension force

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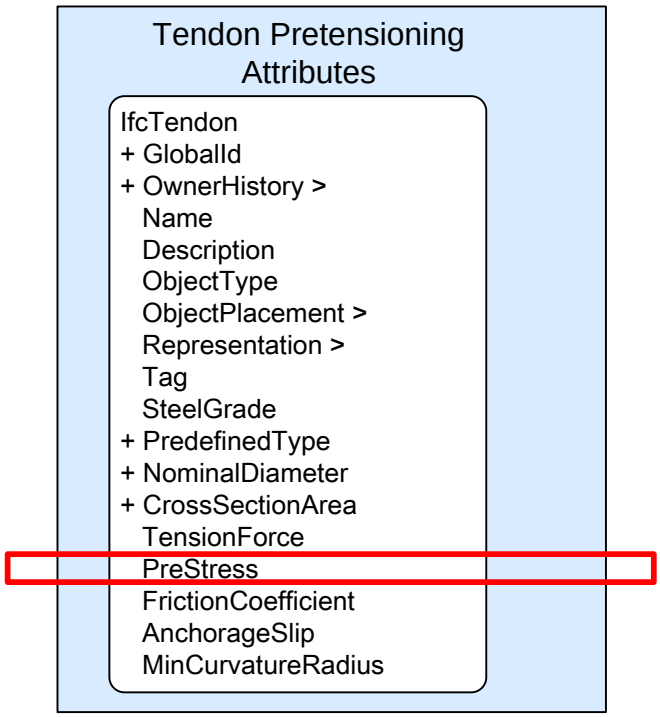
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Pretensioning

Reference	PCI-123	**Version**	1.1	**Status**	Draft
Relationships	Provides information about prestressing for tendon.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcTendon:

Attribute	Implementation agreements
PreStress	Must be provided.

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The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

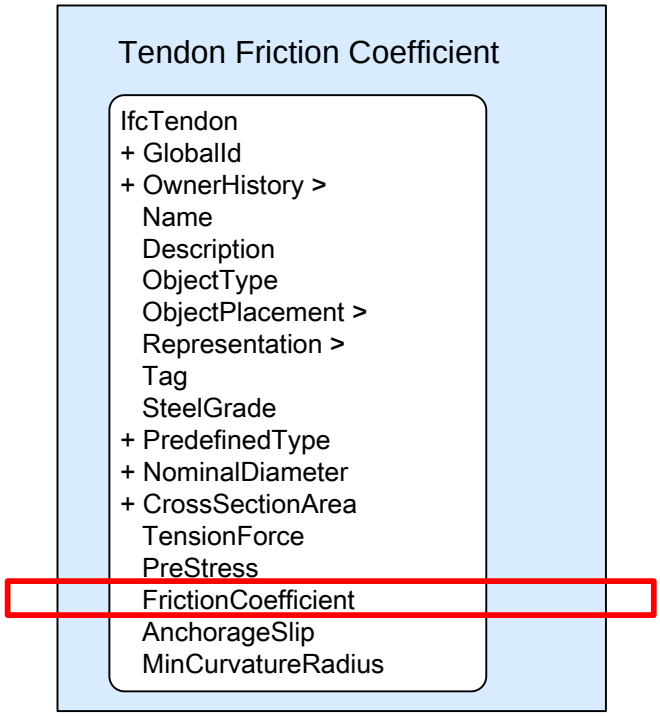
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Friction Coefficient

Reference	PCI-124	**Version**	1.1	**Status**	Draft
Relationships	Defined friction coefficient for prestressing /pretensioning elements.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcTendon

Attribute	Implementation agreements
FrictionCoefficient	<Open>

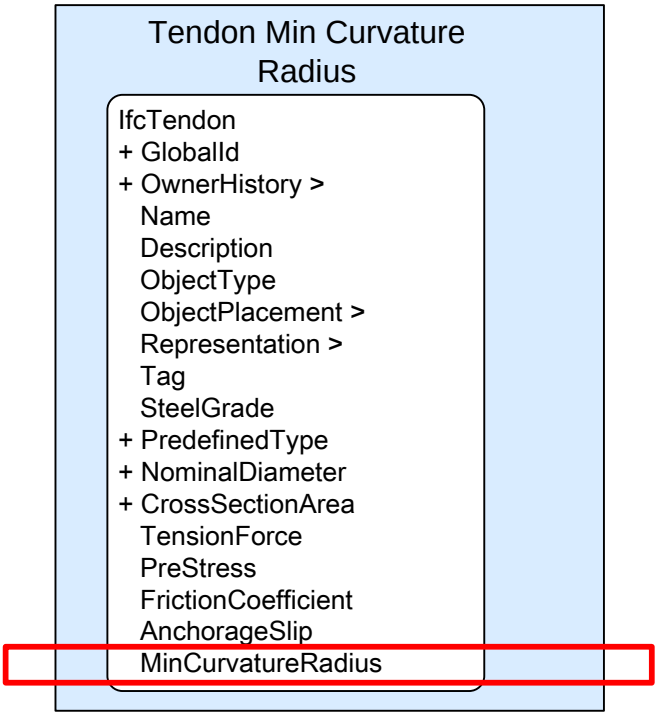
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Min Curvature Radius

Reference	PCI-125	**Version**	1.1	**Status**	Draft
Relationships	Defines the smallest curvature radius calculated on the whole effective length of the tendon where the tension properties are still valid.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcTendon

Attribute	Implementation agreements
MinCurvatureRadius	Must be provided.

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The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

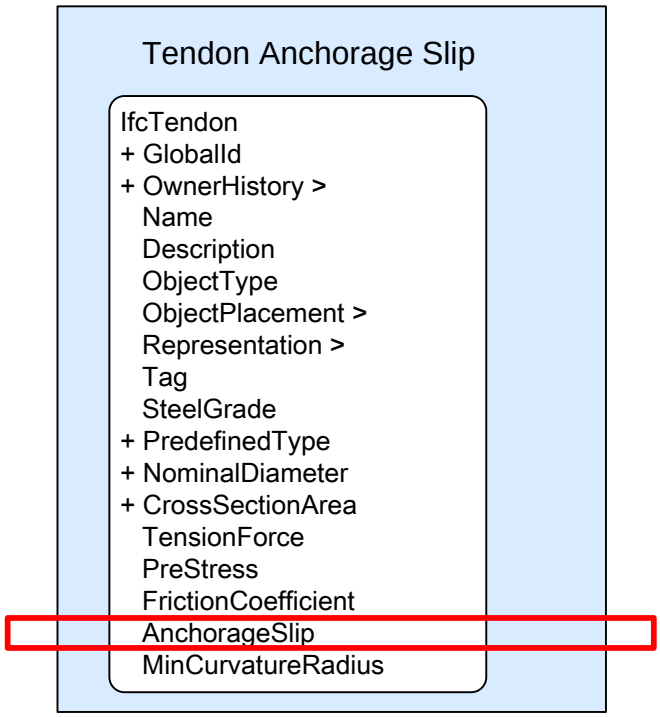
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Anchorage Slip

Reference	PCI-126	**Version**	1.1	**Status**	Draft
Relationships	Defines the slippage of tendons when the prestressing device is released.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcTendon

Attribute	Implementation agreements
AnchorageSlip	Must be provided. The slippage of tendons when the prestressing device is released.

This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

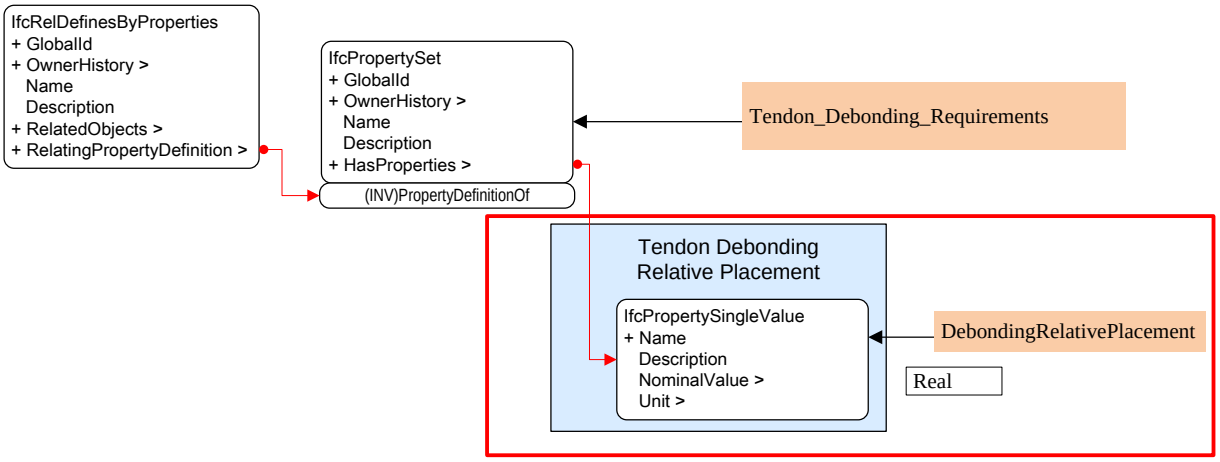
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Debonding Relative Placement

Reference	PCI-127	**Version**	1.1	**Status**	Draft
Relationships	Provides information about the tendon debonding relative placement.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcPropertySet

Attribute	Implementation agreements
Name	Must be provided.
Description	<Open>
NominalValue	Must be provided. It must be a real number.

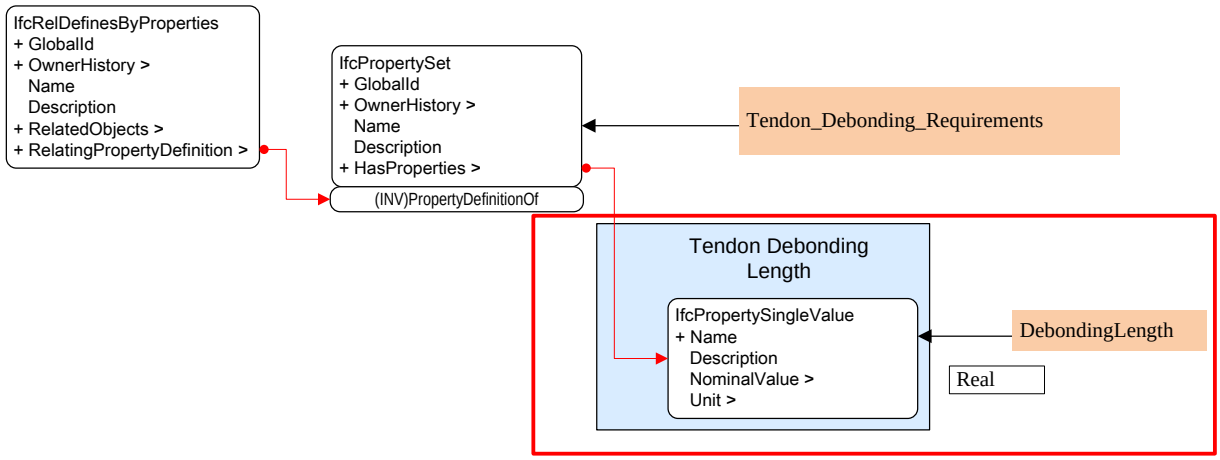
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Debonding Length

Reference	PCI-128	**Version**	1.1	**Status**	Draft
Relationships	Provides information about the tendon debonding length.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcPropertySet

Attribute	Implementation agreements
Name	Must be provided.
Description	<Open>
NominalValue	Must be provided. It must be a real number.

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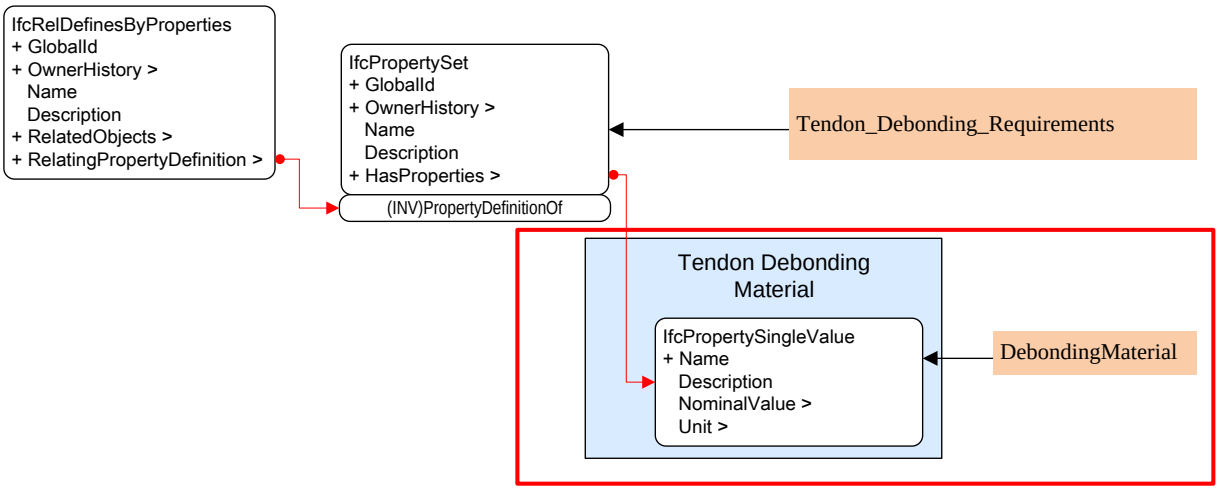
IFC Release Specific Concept Description (<IFC Release 2x3>)

Tendon Debonding Material

Reference	PCI-129	**Version**	1.1	**Status**	Draft
Relationships	Provides information about the tendon debonding material.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements

IfcPropertySet

Attribute	Implementation agreements
Name	Must be provided.
Description	<Open>
NominalValue	<Open>

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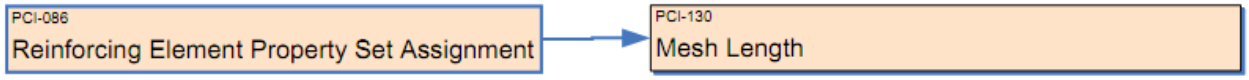
IFC Release Specific Concept Description (<IFC Release 2x3>)

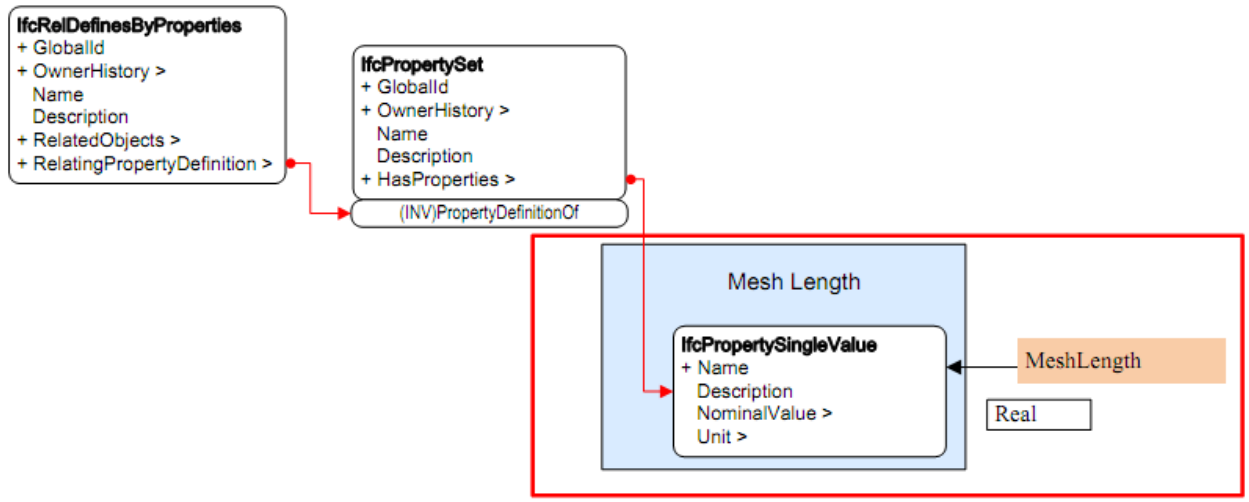
Mesh Length

Reference	PCI-130	**Version**	1.1	**Status**	Draft
Relationships	. Provides mesh length for engineered meshes.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcPropertySet

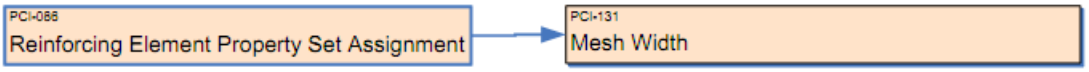
Attribute	Implementation agreements
Name	Must be provided.
Description	<Open>
NominalValue	Must be provided. It must be a real number

IFC Release Specific Concept Description (<IFC Release 2x3>)

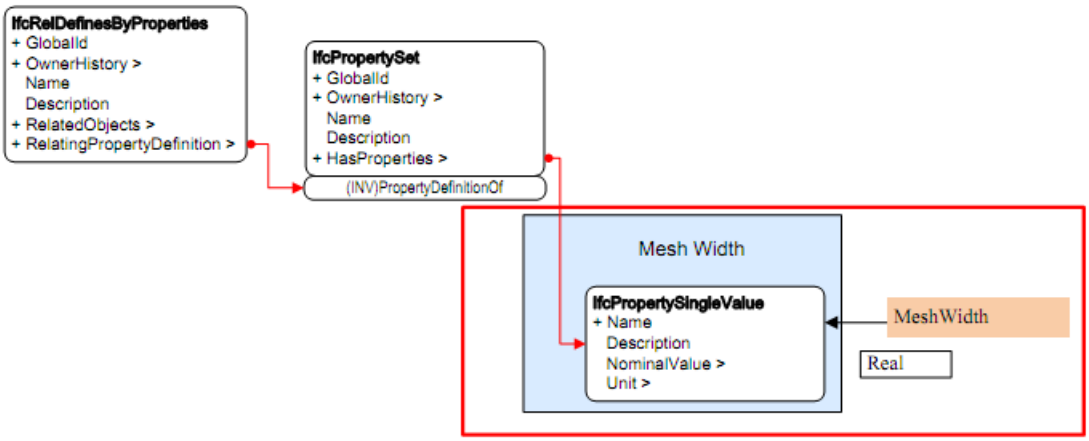
Mesh Width

Reference	PCI-131	**Version**	1.1	**Status**	Draft
Relationships	. Provides mesh length for engineered meshes.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcPropertySet

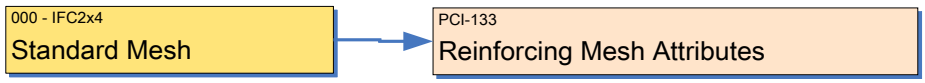
Attribute	Implementation agreements
Name	Must be provided.
Description	<Open>
NominalValue	Must be provided. It must be a real number

IFC Release Specific Concept Description (<IFC Release 2x3>)

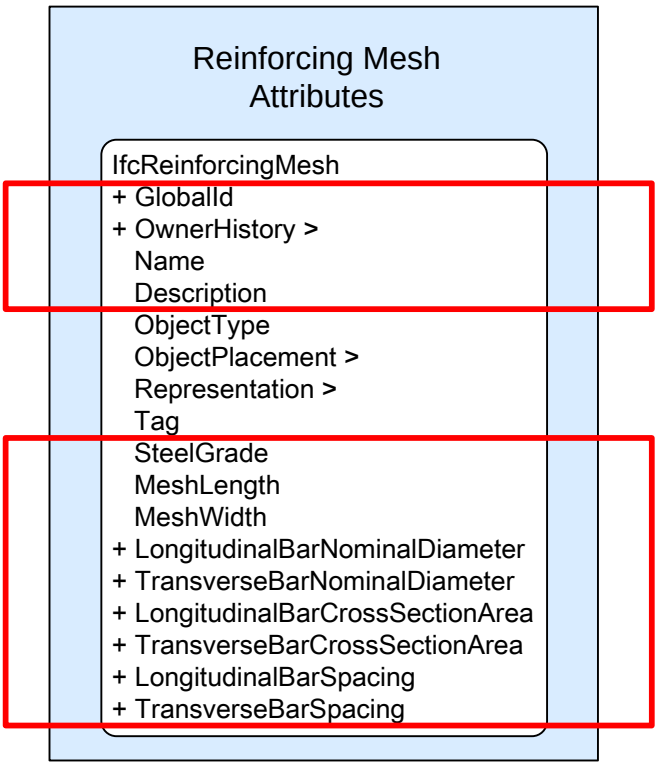
Reinforcing Mesh Attributes

Reference	PCI-133	**Version**	1.1	**Status**	Draft
Relationships	Different attributes required to design and fabricate standard mesh like steel grade, nominal diameter and cross section of longitudinal and transverse bars.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcReinforcingMesh

Attribute	Implementation agreements
GlobalID	Must be provided.
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
SteelGrade	Must be provided; Nominal steel grade defined by standards.
MeshLength	Must be provided, Defines the overall length of the mesh measured in its longitudinal direction.
MeshWidth	Must be provided. Defines the overall width of the mesh measured in its transversal direction.
LongitudinalBarNominalDiameter	Must be provided, Determines the nominal diameter denoting the cross-section size of the longitudinal bars.
TransverseBarNominalDiameter	Must be provided, Determines the nominal diameter denoting the cross-section size of the transverse bars.
LongitudinalBarCrossSectionArea	Must be provided, Determines the effective cross-section area of the longitudinal bars of the mesh.
TransverseBarCrossSectionArea	Must be provided, Determines the effective cross-section area of the transverse bars of the mesh.
LongitudinalBarSpacing	Must be provided, Determines the spacing between the longitudinal bars.
TransverseBarSpacing	Must be provided, Determines the spacing between the transverse bars.

Example:

#10357= IFCLOCALPLACEMENT(#79,#10354);

#10350= IFCPRODUCTDEFINITIONSHAPE('','',(#10344));

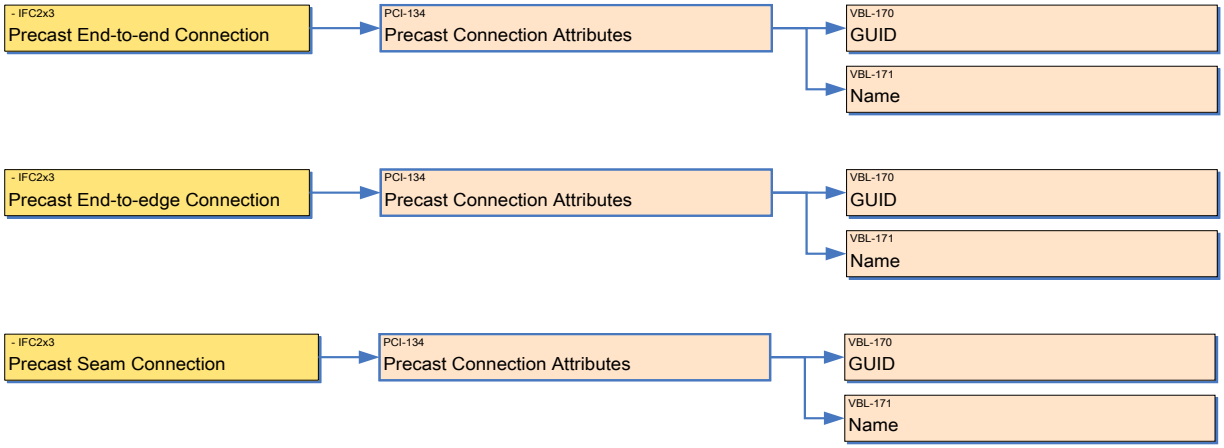
#10360= IFCREINFORCINGMESH('19fN_r0007EJ4oCpKrE3Sp',#20,'Standard Mesh', '','',#10357,#10350,'TS_22715175',$,$,$,14.288,14.288,123.87,123.87,150,150);

IFC Release Specific Concept Description (IFC 2x3**)**

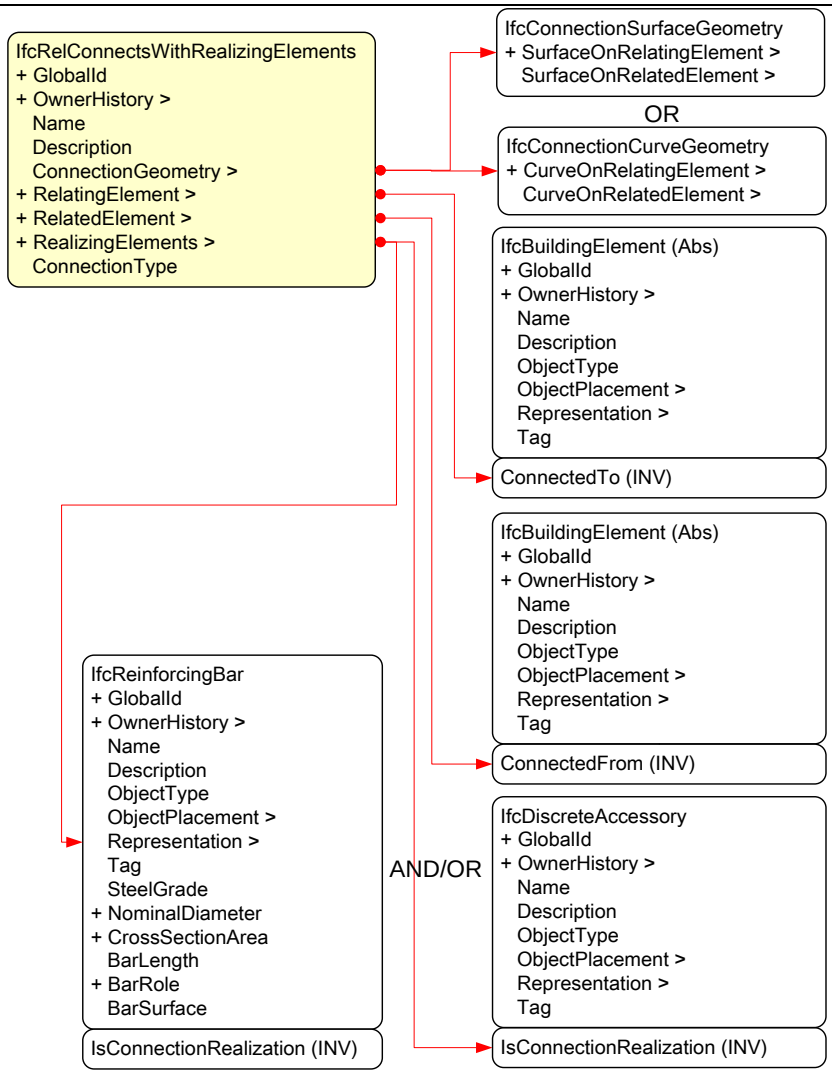
Precast Connection Attributes

Reference	PCI-134	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; Revised 22 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelConnectsWithRealizingElements

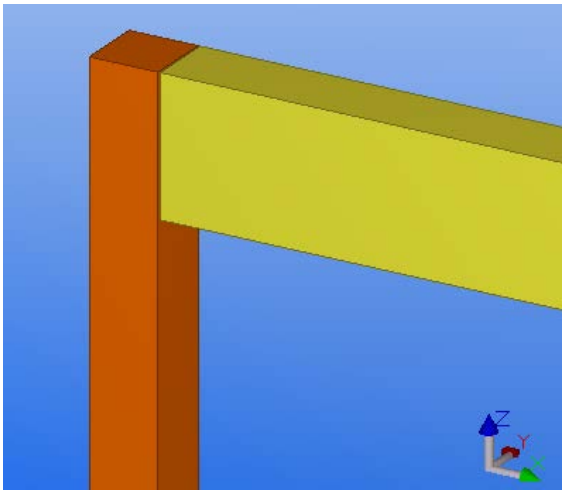
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ConnectionGeometry	This defines the geometry of the connection at design stage, before blockouts are defined in fabrication detailing. They must be either: a) an instance of IcfConnectionSurfaceGeometry, with two intersecting surfaces; b) an instance of IcfConnectionCurveGeometry, with two parallel curves. See *Precast Point Connection Geometry* concept or *Precast Seam Connection*

	Geometry concept pages for details.
RelatingElement	Must be a sub-type of IfcBuildingElement. See *Precast Connection Element Assignment* concept page for details.
RelatedElement	Must be a sub-type of IfcBuildingElement. See *Precast Connection Element Assignment* concept page for details.
RealizingElements	Must be IfcDiscreteAccessory or IfcReinforcingBar
ConnectionType	This must be a string from one of the following lists: For End-to-end connection: Column base-plate, Socket base, Grout-sleeve base, Bolted, Welded plate, Tube to tube, Grouted sleeve, Welded lap bar, Tube sleeve, Post-tensioned splice, Simple Welded, Doweled, Composite moment, Corbel, Pocket, Sleeve and dowel, Moment-resistant, Architectural bearing, Alignment, Seismic shear plates, Other precast end-to-end connection. For End-to-edge connection: Column base-plate, Socket base, Grout-sleeve base, Bolted, Welded plate, Tube to tube, Grouted sleeve, Welded lap bar, Tube sleeve, Post-tensioned splice, Simple Welded, Doweled, Hanger, Composite moment, Corbel, Pocket, Sleeve and dowel, Moment-resistant, Architectural bearing, Tie-back, Alignment, Soffit hanger, Masonry tie-back, Seismic shear plates, Other precast point connection. For Seam connection: Double-tee seam, Wall to Wall doweled, Other precast seam connection.

Example Part 21 File for End to End Connection

```
……..
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
……..
#115= IFCRECTANGLEPROFILEDEF(.AREA.,'400*400',#112,400.,400.);
#116= IFCDIRECTION((-1.,0.,0.));
#120= IFCDIRECTION((0.,0.,-1.));
#124= IFCCARTESIANPOINT((0.,0.,4000.));
#128= IFCAXIS2PLACEMENT3D(#124,#120,#116);
#131= IFCEXTRUDEDAREASOLID(#115,#128,#33,4000.);
……
#138= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#131));
#144= IFCPRODUCTDEFINITIONSHAPE('','',(#138));
#148= IFCCOLUMN('1AH7uO00004Z4oD3OmC38t',#20,'COLUMN','400*400','400*400',#95,#144,'TS_509');
……
#229= IFCRECTANGLEPROFILEDEF(.AREA.,'400*800',#226,400.,800.);
#230= IFCDIRECTION((0.,-1.,0.));
#234= IFCCARTESIANPOINT((6000.,0.,0.));
#238= IFCAXIS2PLACEMENT3D(#234,#116,#230);
#241= IFCEXTRUDEDAREASOLID(#229,#238,#33,5789.);
……
#248= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#241));
#254= IFCPRODUCTDEFINITIONSHAPE('','',(#248));
#258= IFCBEAM('1AH7uO00006Z4oD3OmC38v',#20,'BEAM','400*800','400*800',#217,#254,'TS_753');
…..
#328= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#325,10.,160.);
#329= IFCCARTESIANPOINT((0.,0.,780.));
```

#333= IFCAXIS2PLACEMENT3D(#329,#120,#25);
#336= IFCEXTRUDEDAREASOLID(#328,#333,#33,780.);
…..
#343= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#336));
#349= IFCPRODUCTDEFINITIONSHAPE('','',(#343));
#353= IFCDISCRETEACCESSORY ('1AH7uO0000834oD3OmC3Cn',#20,'PLATE','PLT10*160','PLT10*160',#316,#349,'TS_1443');
……
#207= IFCMATERIAL('CONCRETE');
#404= IFCMATERIAL('STEEL');
……
#433= IFCRELASSOCIATESMATERIAL('0k$iXhwlbEyRav8sn9hE$T',#20,$,$,(#258,#148),#207);
#435= IFCRELASSOCIATESMATERIAL('1t98EIvvjCSfoOA5jQczRu',#20,$,$,(#353),#404);
…...
Surface on Relating Element – side face of the column, offset 1cm for the plate, that shortens the beam:
#599= IFCCARTESIANPOINT((0.,410.,4000.));
#601= IFCAXIS2PLACEMENT3D(#599,#25,#29);
#603= IFCPLANE(#601);
…..
Surface on Related Element – top face of the beam that defines the top of the column:
#699= IFCCARTESIANPOINT((0.,400.,4000.));
#701= IFCAXIS2PLACEMENT3D(#599,#33,#25);
#703= IFCPLANE(#701);
…..
#801= IFCCONNECTIONSURFACEGEOMETRY(#603,#703);
#901= IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99EIvvjCSfoOA4jQczRu',#20,$,$,#801,#148,#258,(#353),'Welded plate');
…..



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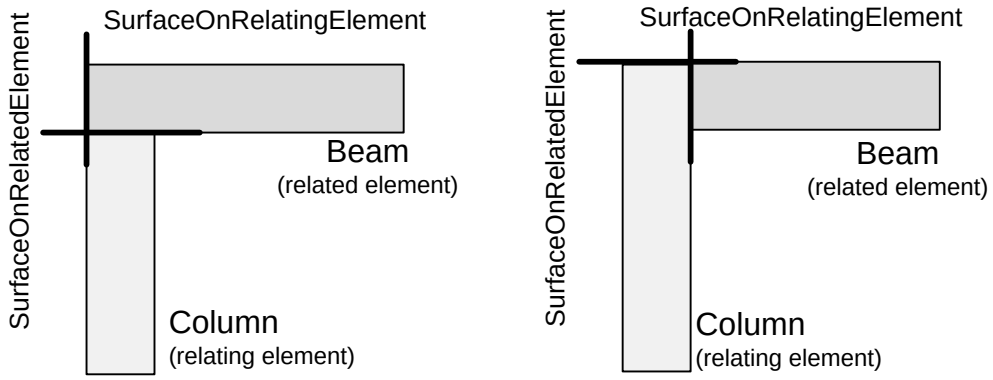
IFC Release Specific Concept Description (IFC 2x3**)**

Precast End-to-end Connection Geometry

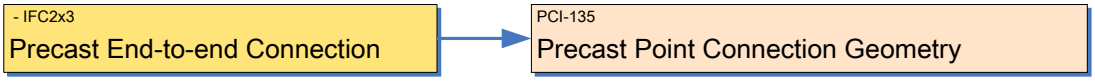
Reference	PCI-135	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; revised 22 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Description

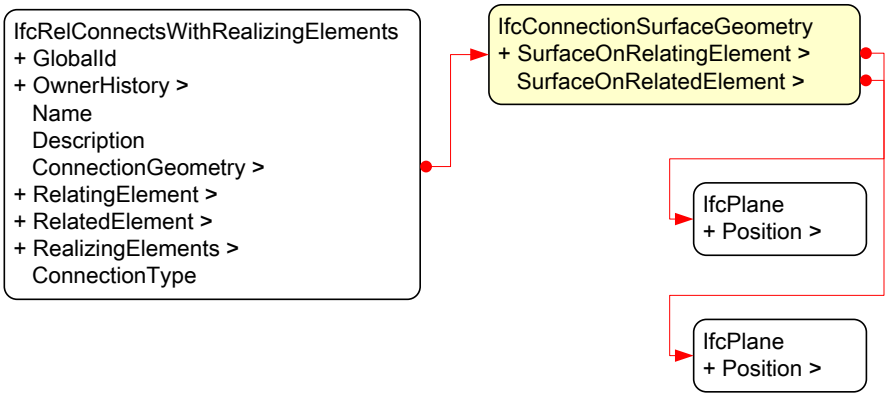
This concept defines the local geometry of the end conditions at a point connection of two connecting linear precast pieces or a linear precast piece and other linear structural member (steel or CIP concrete). The figure below describes the relating and related members and the surfaces defined for them. In the figure, the column is the relating element and the beam is the related element. The concept is used in all of the exchanges that occur before the fabrication detailing phase, in which the ends of the members would be defined with blockouts and would no longer need the fitting surfaces to define their end geometry.



Usage in view definition diagram



Instantiation diagram



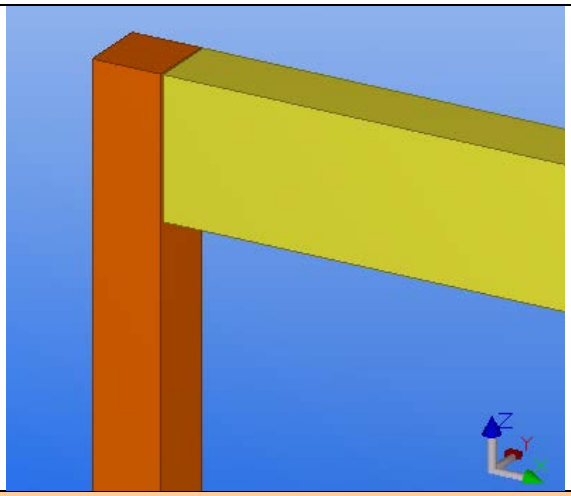
Implementation agreements

IfcConnectionSurfaceGeometry

Attribute	Implementation agreements
SurfaceOnRelatingElement	This plane must be provided. It must be an IfcPlane that cuts the related element (i.e. is not parallel to the axis of the related element)
SurfaceOnRelatedElement	Must be an IfcPlane that cuts the relating element (i.e. is not parallel to the axis of the relating element)

Example Part 21 File for End to End Connection

```
……..
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
……..
#115= IFCRECTANGLEPROFILEDEF(.AREA.,'400*400',#112,400.,400.);
#116= IFCDIRECTION((-1.,0.,0.));
#120= IFCDIRECTION((0.,0.,-1.));
#124= IFCCARTESIANPOINT((0.,0.,4000.));
#128= IFCAXIS2PLACEMENT3D(#124,#120,#116);
#131= IFCEXTRUDEDAREASOLID(#115,#128,#33,4000.);
……
#138= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#131));
#144= IFCPRODUCTDEFINITIONSHAPE('','',(#138));
#148= IFCCOLUMN('1AH7uO00004Z4oD3OmC38t',#20,'COLUMN','400*400','400*400',#95,#144,'TS_509');
……
#229= IFCRECTANGLEPROFILEDEF(.AREA.,'400*800',#226,400.,800.);
#230= IFCDIRECTION((0.,-1.,0.));
#234= IFCCARTESIANPOINT((6000.,0.,0.));
#238= IFCAXIS2PLACEMENT3D(#234,#116,#230);
#241= IFCEXTRUDEDAREASOLID(#229,#238,#33,5789.);
……
#248= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#241));
#254= IFCPRODUCTDEFINITIONSHAPE('','',(#248));
#258= IFCBEAM('1AH7uO00006Z4oD3OmC38v',#20,'BEAM','400*800','400*800',#217,#254,'TS_753');
……..
Surface on Relating Element – side face of the column, offset 1cm for the plate, that shortens the beam:
#599= IFCCARTESIANPOINT((0.,410.,4000.));
#601= IFCAXIS2PLACEMENT3D(#599,#25,#29);
#603= IFCPLANE(#601);
…..
Surface on Related Element – top face of the beam that defines the top of the column:
#699= IFCCARTESIANPOINT((0.,400.,4000.));
#701= IFCAXIS2PLACEMENT3D(#599,#33,#25);
#703= IFCPLANE(#701);
…..
#801= IFCCONNECTIONSURFACEGEOMETRY(#603,#703);
#901=
IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99ElvvjCSfoOA4jQczRu',#20,$,$,#801,#148,#258,(#353),'Welded plate');
…..
```



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IFC Release Specific Concept Description (IFC 2x3**)**

Precast Connection Component Assignment

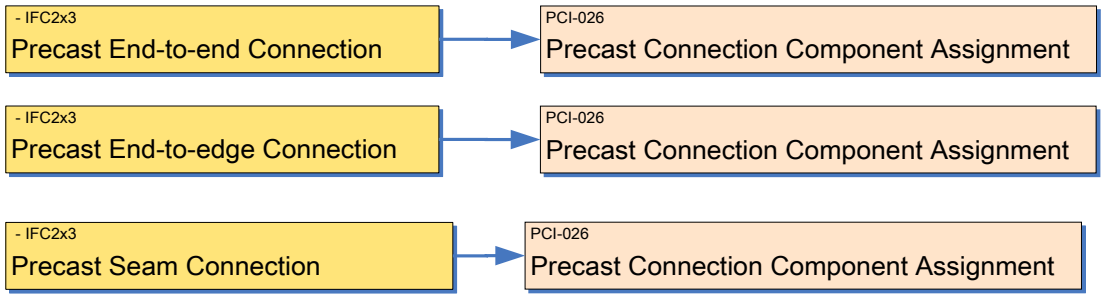
Reference	PCI-136	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 22 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Description

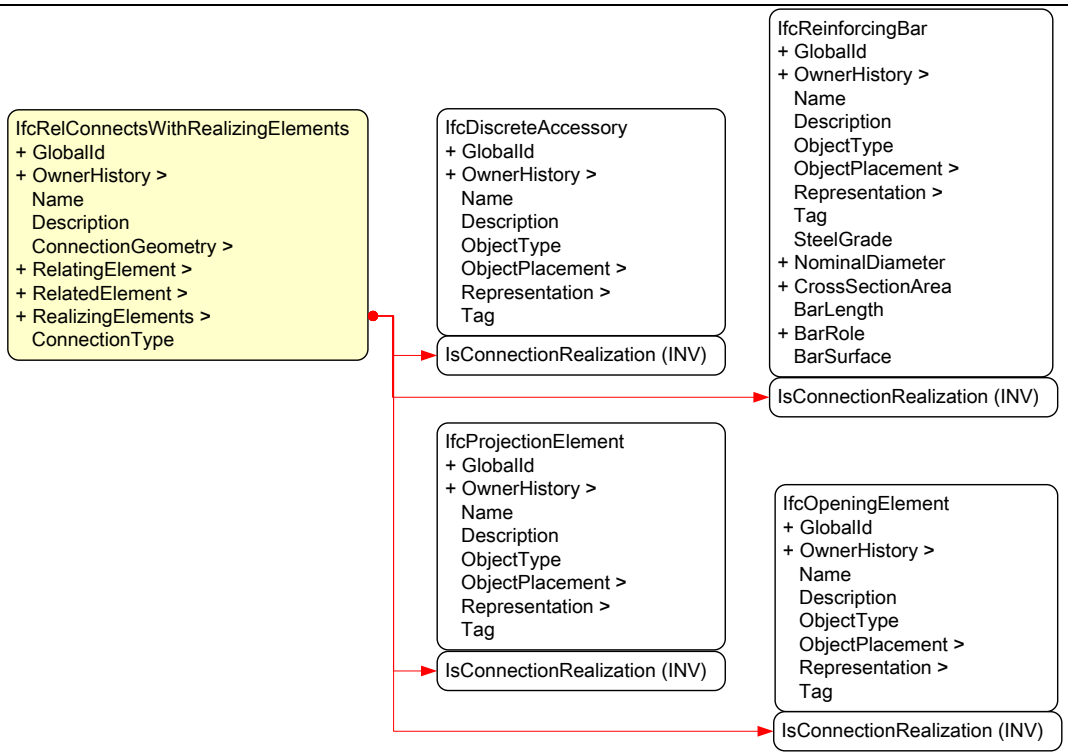
Defines the relationship between a precast connection and its component parts, which may be any of:

- Plant-applied connection components (discrete accessories - plates, anchors, etc.)
- Field-applied connection components (discrete accessories - plates, shims, bolts, etc.)
- Precast concrete projections, such as a corbel or shelf added to a column or a spandrel
- Reinforcement bars
- Blockouts

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelConnectsWithRealizingElements

Attribute	Implementation agreements
RealizingElements	Must be IfcDiscreteAccessory, IfcReinforcingBar, IfcProjectionElement (a projecting feature such as a corbel) or IfcOpeningElement (a blockout, such as a pocket).

Note: Realizing elements of type reinforcing bar or discrete accessory may be embedded in one of the precast pieces that is part of the connection, or they may be delivered to the site as field hardware. In the former case, the element must also be associated directly with the building element in which it is embedded using an aggregation relationship, in addition to its relationship to the connection as defined here. For details, see “Precast Embed Assignment” concept.

Example Part 21 File for End to End Connection

```
#21= IFCCARTESIANPOINT((0.,0.,0.));
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
#37= IFCAXIS2PLACEMENT3D(#21,#33,#25);
…..
#115= IFCRECTANGLEPROFILEDEF(.AREA.,'400*400',#112,400.,400.);
#116= IFCDIRECTION((-1.,0.,0.));
#120= IFCDIRECTION((0.,0.,-1.));
#124= IFCCARTESIANPOINT((0.,0.,4000.));
#128= IFCAXIS2PLACEMENT3D(#124,#120,#116);
#131= IFCEXTRUDEDAREASOLID(#115,#128,#33,4000.);
#134= IFCSTYLEDITEM(#131,(#102),'Name');
#138= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#131));
#144= IFCPRODUCTDEFINITIONSHAPE('','',(#138));
#148= IFCCOLUMN('1AH7uO00004Z4oD3OmC38t',#20,'COLUMN','400*400','400*400',#95,#144,'TS_509');
```

```
.....
#207= IFCMATERIAL('CONCRETE');
#210= IFCCARTESIANPOINT((-6.0632980E-14,6.8212103E-13,3600.));
#214= IFCAXIS2PLACEMENT3D(#210,#33,#25);
#217= IFCLOCALPLACEMENT(#79,#214);
#220= IFCCOLOURRGB('Light Yellow',0.89803922,0.89803922,0.2);
#221=
IFCSURFACESTYLERENDERING(#220,0.,$,$,$,$,IFCNORMALISEDRATIOMEASURE(0.00390625),IFCSPECULAREXPONENT(10.),.NO
TDEFINED.);
#222= IFCSURFACESTYLE('',.POSITIVE.,(#221));
#224= IFCPRESENTATIONSTYLEASSIGNMENT((#222));
#226= IFCAXIS2PLACEMENT2D(#104,#108);
#229= IFCRECTANGLEPROFILEDEF(.AREA.,'400*800',#226,400.,800.);
#230= IFCDIRECTION((0.,-1.,0.));
#234= IFCCARTESIANPOINT((6000.,0.,0.));
#238= IFCAXIS2PLACEMENT3D(#234,#116,#230);
#241= IFCEXTRUDEDAREASOLID(#229,#238,#33,5789.);
#244= IFCSTYLEDITEM(#241,(#224),'Name');
#248= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#241));
#254= IFCPRODUCTDEFINITIONSHAPE('','',(#248));
#258= IFCBEAM('1AH7uO00006Z4oD3OmC38v',#20,'BEAM','400*800','400*800',#217,#254,'TS_753');
.....
#309= IFCCARTESIANPOINT((206.,6.8212103E-13,3210.));
#313= IFCAXIS2PLACEMENT3D(#309,#33,#25);
#316= IFCLOCALPLACEMENT(#79,#313);
#319= IFCCOLOURRGB('Light Gray',0.60000002,0.60000002,0.60000002);
#320=
IFCSURFACESTYLERENDERING(#319,0.,$,$,$,$,IFCNORMALISEDRATIOMEASURE(0.00390625),IFCSPECULAREXPONENT(10.),.NO
TDEFINED.);
#321= IFCSURFACESTYLE('',.POSITIVE.,(#320));
#323= IFCPRESENTATIONSTYLEASSIGNMENT((#321));
#325= IFCAXIS2PLACEMENT2D(#104,#108);
#328= IFCRECTANGLEPROFILEDEF(.AREA.,'PLT10*160',#325,10.,160.);
#329= IFCCARTESIANPOINT((0.,0.,780.));
#333= IFCAXIS2PLACEMENT3D(#329,#120,#25);
#336= IFCEXTRUDEDAREASOLID(#328,#333,#33,780.);
#339= IFCSTYLEDITEM(#336,(#323),'Name');
#343= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#336));
#349= IFCPRODUCTDEFINITIONSHAPE('','',(#343));
#353= IFCDISCRETEACCESSORY ('1AH7uO0000834oD3OmC3Cn',#20,'PLATE','PLT10*160','PLT10*160',#316,#349,'TS_1443');
.....
#404= IFCMATERIAL('STEEL');
.....
#433= IFCRELASSOCIATESMATERIAL('0k$iXhwlbEyRav8sn9hE$T',#20,$,$,(#258,#148),#207);
#435= IFCRELASSOCIATESMATERIAL('1t98ElvvjCSfoOA5jQczRu',#20,$,$,(#353),#404);
#437= IFCPRESENTATIONLAYERASSIGNMENT('TS_1 Phase 1',$,(#343,#248,#138),$);

#485= IFCCARTESIANPOINT((0.,0.,0.));
#487= IFCCARTESIANPOINT((1000.,0.,0.));
#489= IFCPOLYLINE((#485,#487));
#491= IFCSWEPTDISKSOLID(#489,8.,$,$,$);
#493= IFCSHAPEREPRESENTATION(#40,'Body','SweptDiskSolid',(#491));
#495= IFCPRODUCTDEFINITIONSHAPE('','',(#493));
#497= IFCCARTESIANPOINT((0.,0.,3600.));
#499= IFCAXIS2PLACEMENT3D(#497,#33,#25);
#501= IFCLOCALPLACEMENT(#95,#499);
#503= IFCREINFORCINGBAR('5Bh4uO0000234oD3PmC3Cn',#20,'REBAR #12','Straight Rebar','Reinforcing
Bar',#501,#495,'TS_1443','Y-60',16.,200.,1000., 'ANCHORING', 'TEXTURED')

#599= IFCCARTESIANPOINT((0.,210.,4000.));
#601= IFCAXIS2PLACEMENT3D(#599,#25,#29);
#603= IFCPLANE(#601);
```

```
#699= IFCCARTESIANPOINT((0.,200.,4000.));
#701= IFCAXIS2PLACEMENT3D(#599,#33,#25);
#703= IFCPLANE(#701);

#801= IFCCONNECTIONSURFACEGEOMETRY(#603,#703);

#901= IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99ElvvjCSfoOA4jQczRu',#20,$,$,#801,#148,#258,(#353,#503),'Welded plate');
```

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IFC Release Specific Concept Description (IFC 2x3**)**

Precast Connection Element Assignment

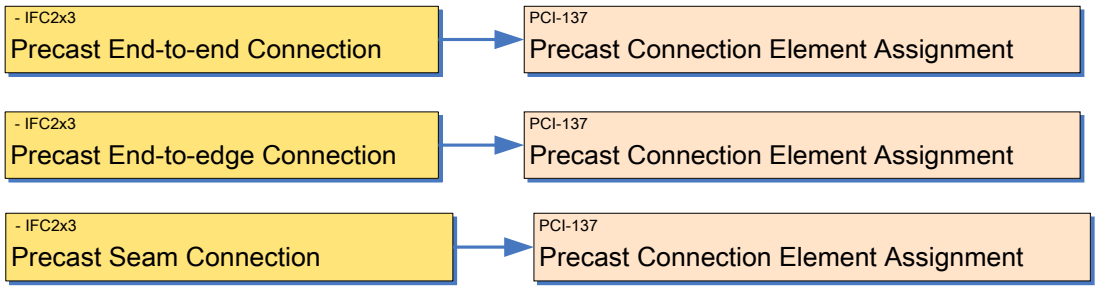
Reference	PCI -137	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 16 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Description

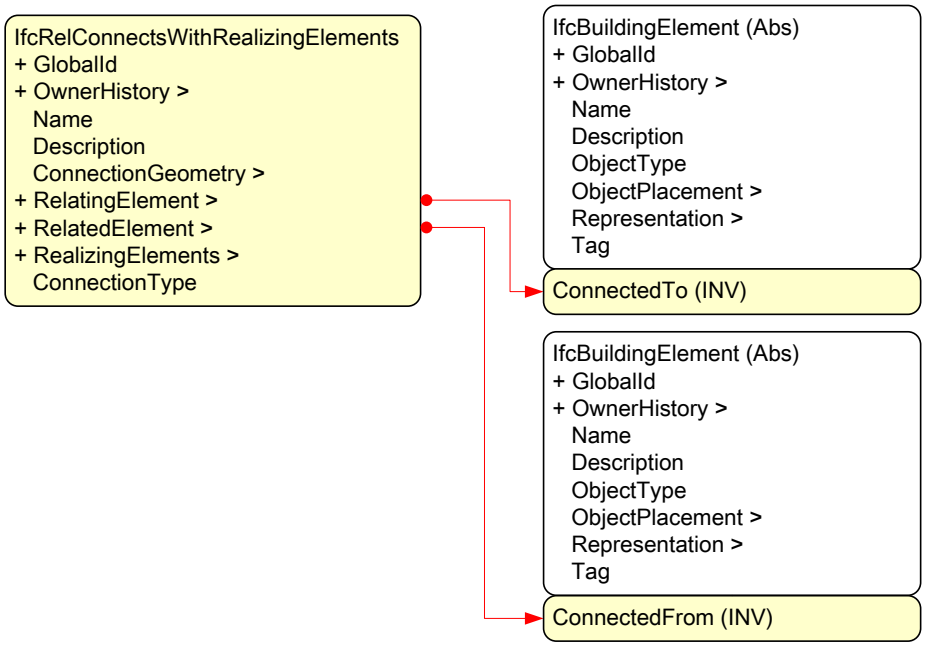
Defines the relationship between a precast connection and the two elements it connects, which must include either:

- Two precast pieces (not piece marks) or
- One precast piece and one structural element of another system (e.g. structural steel or CIP concrete)

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelConnectsWithRealizingElements

Attribute	Implementation agreements
RelatingElement	Must be an IfcBuildingElement that represents a **precast piece concept** (see the *Precast Piece* concept page for details). **It cannot be a precast piece type concept**, because connections are made between instances of pieces in their local positions.
RelatedElement	Must be an IfcBuildingElement that represents either one of: a) a **precast piece concept** (see the *Precast Piece* concept page for details). **It cannot be a precast piece type concept**, because connections are made between instances of pieces in their local positions. b) A member of another structural system, e.g. a structural steel member or a CIP concrete member.
RealizingElements	See rules for valid realizing elements on the “Precast Connection Component Assignment” binding page.
ConnectionType	Must be equal to “Precast Connection”. This value distinguishes it from a precast joint.

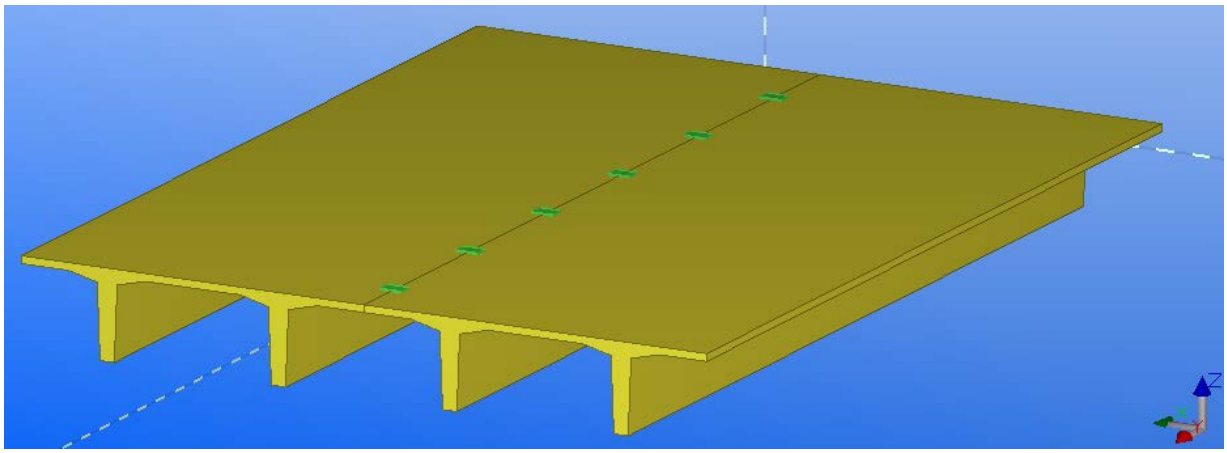
RelatingElement

R

elatingElement

Example Part 21 File for Seam Connection

```
…..
#152= IFCDISCRETEACCESSORY('1AH9bc0000Up4oD3OmCZGu',#20,'PLATE','100*10','100*10',#103,#148,'TS_3335');
……
#248= IFCDISCRETEACCESSORY('1AH9bc0000Tp4oD3OmCZGu',#20, 'PLATE','100*10','100*10',#221,#244,'TS_3299');
……
#301= IFCDISCRETEACCESSORY('1AH9bc0000Sp4oD3OmCZGu',#20, 'PLATE','100*10','100*10',#274,#297,'TS_3263');
……
#354= IFCDISCRETEACCESSORY('1AH9bc0000Rp4oD3OmCZGu',#20, 'PLATE','100*10','100*10',#327,#350,'TS_3227');
……
#407= IFCDISCRETEACCESSORY('1AH9bc0000Qp4oD3OmCZGu',#20, 'PLATE','100*10','100*10',#380,#403,'TS_3191');
……
#460= IFCDISCRETEACCESSORY('1AH9bc0000I34oD3OmCZGs',#20, 'PLATE','100*10','100*10',#433,#456,'TS_2766');
……
#588= IFCBEAM('1AH9bc0000GZ4oD3OmCZGq',#20,'BEAM','TT600*2400-100-50-1200-0.04-200-0.25','TT600*2400-100-50-1200-0.04-
200-0.25',#486,#584,'TS_2703');
……
#685= IFCBEAM('1AH9bc0000Fp4oD3OmCZGq',#20,'BEAM','TT600*2400-100-50-1200-0.04-200-0.25','TT600*2400-100-50-1200-0.04-
200-0.25',#657,#681,'TS_2653');
……
#901=
IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99EIvvjCSfoOA4jQczRu',#20,$,$,#801,#588,#685,(#152,#248,#301,#354,#407,#46
0),'Double Tee Seam Connection');
…..
```



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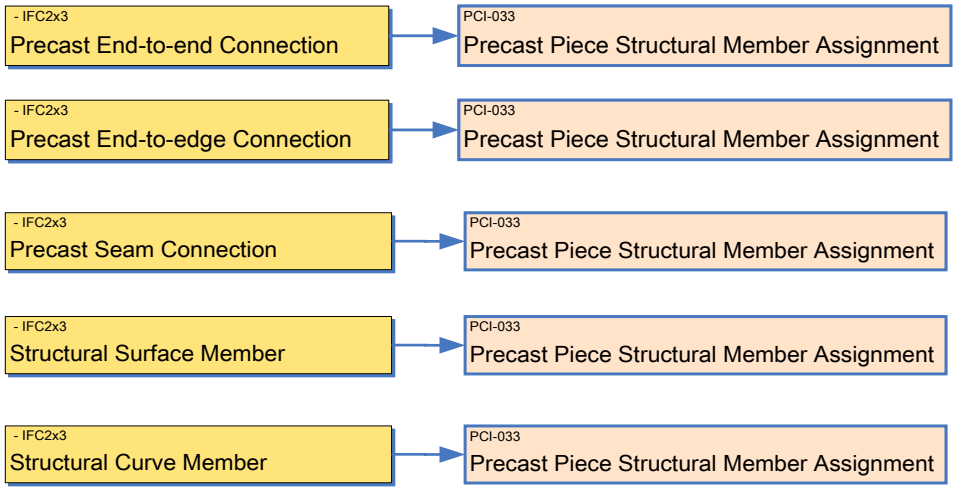
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (IFC 2x3**)**

Precast Piece Structural Member Assignment

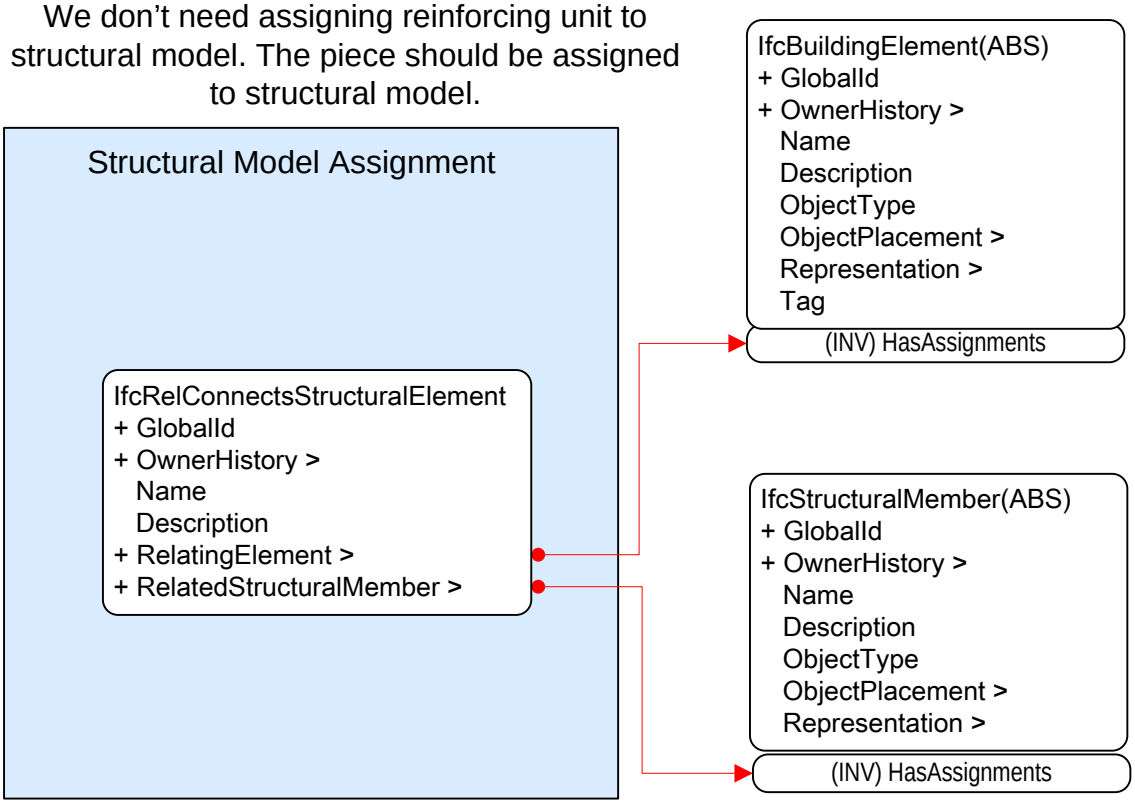
Reference	PCI-138	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; revised 22 November, 2012				
Authors	Rafael Sacks, Manu Venugopal, Chuck Eastman				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram

We don't need assigning reinforcing unit to structural model. The piece should be assigned to structural model.



Implementation agreements

IfcRelConnectStructuralElement

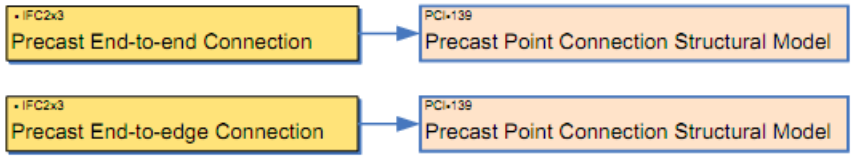
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedObjects	Must be one (and only one) subtype of IfcBuildingElement that defines a *Precast Piece* concept (not a precast piece mark). See PCI-053 for details of allowed subtypes of IfcBuildingElement for precast pieces.
RelatedObjectsType	Should be one of the precast member types (Beam, Wall, Spandrel, Column, Foundation, Slab)
RelatingProduct	May be one or multiple IfcStructuralMembers that represent a precast piece instance (for example, where a single precast column spans multiple floors, it may be represented by multiple structural members, one for each floor).

IFC Release Specific Concept Description (<IFC Release 2x3>)

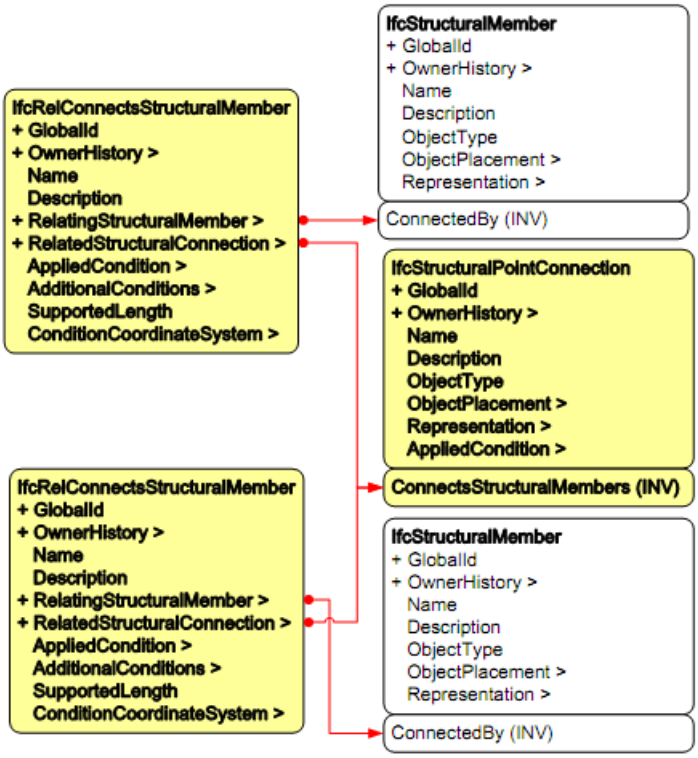
Precast Point Connection Structural Model

Reference	PCI-139	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; Revised Nov 18, 2012				
Authors	Rafael Sacks, Chuck Eastman				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelConnectsStructuralMember

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingStructural Member	Must be provided
RelatedStructuralConnection	Must be an IfcStructuralPointConnection
AppliedCondition	
AdditionalConditions	
SupportedLength	
ConditionCoordinateSystem	

IfcStructuralPointConnection

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	
ObjectPlacement	
Representation	Must be Null
AppliedCondition	

Example Part 21 Segment for Point Structural Connection ...

..

#46= IFCSTRUCTURALMEMBER('7J_3HbmQz7Zuggh7XqUO7q',#20,'Structural Column 1','400x400','Precast Concrete',$,$);

.....

#48= IFCSTRUCTURALMEMBER('5J_3HbmQz5Zuggh5XqUO5q',#20,'Structural Beam 1','400x400','Precast Concrete',$,$);

.....

#50= IFCSTRUCTURALPOINTCONNECTION('5J_1HbmQz5Zuggh3XqUO7q',#20,'Corbel Connection 1','Concrete Corbel','Precast Concrete Connection',$,$,$,$);

.....

#52= IFCRELCONNECTSSTRUCTURALMEMBER('9J_1HbmQz9Zuggh9XqUO9q',#20,'Structural Connection 1', 'Column to Corbel',#46,#50,$,$,$,$);

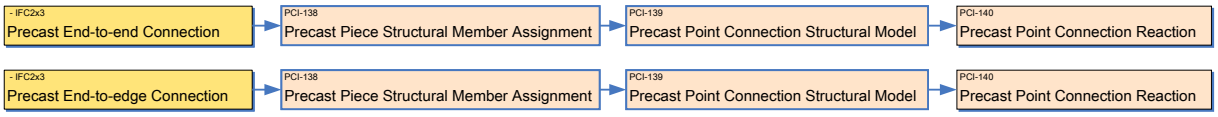
```
#54= IFCRELCONNECTSSTRUCTURALMEMBER('9L_1RbmLz9Zuggh9XqUL9q',#20,'Structural Connection 1', 'Beam to
Corbel',#48,#50,$,$,$,$); ....
```

IFC Release Specific Concept Description (IFC 2x3**)**

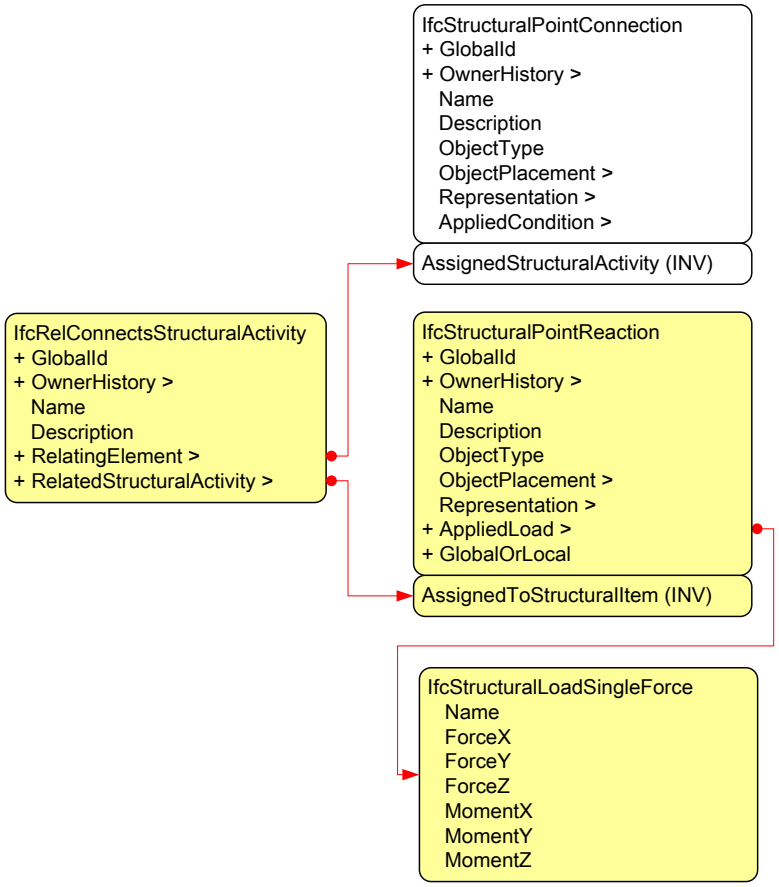
Precast Point Connection Reaction

Reference	PCI-140	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 22 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

Example Part 21 Segment for Point Connection Reaction

```
.....
#46= IFCSTRUCTURALMEMBER('7J_3HbmQz7Zuggh7XqUO7q',#20,'Structural Column 1','400x400','Precast Concrete',$,$);
.....
#48= IFCSTRUCTURALMEMBER('5J_3HbmQz5Zuggh5XqUO5q',#20,'Structural Beam 1','400x800','Precast Concrete',$,$);
```

```
.....
#50= IFCSTRUCTURALPOINTCONNECTION('5J_1HbmQz5Zuggh3XqUO7q',#20,'Corbel Connection 1','Concrete Corbel','Precast
Concrete Connection',$,$,$,$);
.....
#52= IFCSTRUCTURALLOADSINGLEFORCE ('Static Gravity Load',0.,0.,-100.,0.,0.,0.);
#54= IFCSTRUCTURALPOINTREACTION('1L_2QbmQz9Zuggh9XqUO9q',#20,'Structural Reaction 1', 'Beam to Column Transfer',
'Reaction',$,$,#52,GLOBAL_COORDS);
.....
#58= IFCRELCONNECTSSTRUCTURALACTIVITY('1E_2WbmEz9Zuggh9XqUO9q',#20,'ACT_1', 'Beam to Column Transfer',#50,#54);
.....
#62= IFCRELCONNECTSSTRUCTURALMEMBER('9J_1HbmQz9Zuggh9XqUO9q',#20,'Structural Connection 1', 'Column to
Corbel',#46,#50,$,$,$,$);
#64= IFCRELCONNECTSSTRUCTURALMEMBER('9L_1RbmLz9Zuggh9XqUL9q',#20,'Structural Connection 1', 'Beam to
Corbel',#48,#50,$,$,$,$);
....
```

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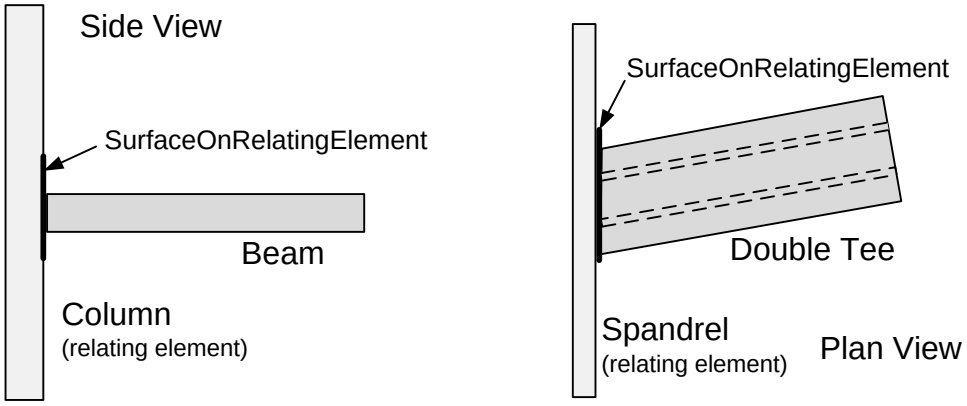
IFC Release Specific Concept Description (IFC 2x3**)**

Precast End-to-edge Connection Geometry

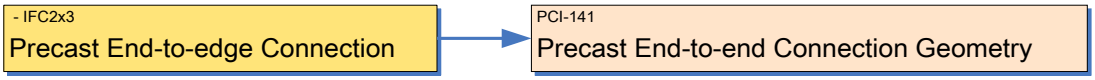
Reference	PCI-141	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 22 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Description

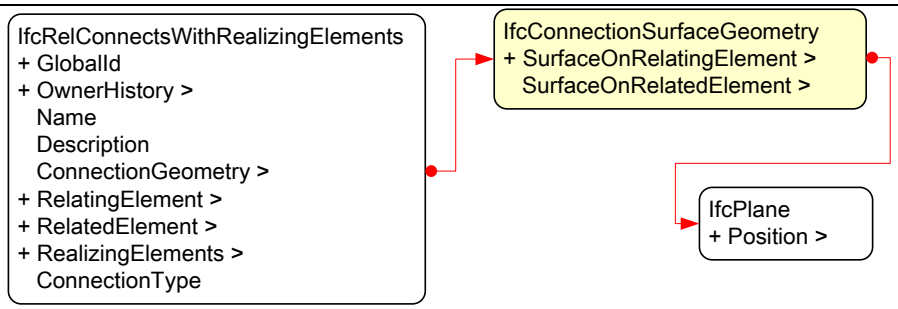
This concept defines the local geometry of the end conditions at a point connection of one linear precast piece to the edge of a linear or planar precast piece or to an edge of a linear or planar structural member of another system (steel or CIP concrete). The figure below describes two separate examples of the relating and related members and the surface defined to limit the extents of the related element. In the left-hand example figure, the column is the relating element and the beam is the related element; the beam is connected along the height of a multi-story column. In the right-hand example, a double tee is shown in plan view – it joins at an angle to a spandrel. The spandrel is the relating element and the double-tee is the related element. The concept is used in all of the exchanges that occur before the fabrication detailing phase, in which the ends of the members would be defined with blockouts and would no longer need the fitting surfaces to define their end geometry.



Usage in view definition diagram



Instantiation diagram



Implementation agreements

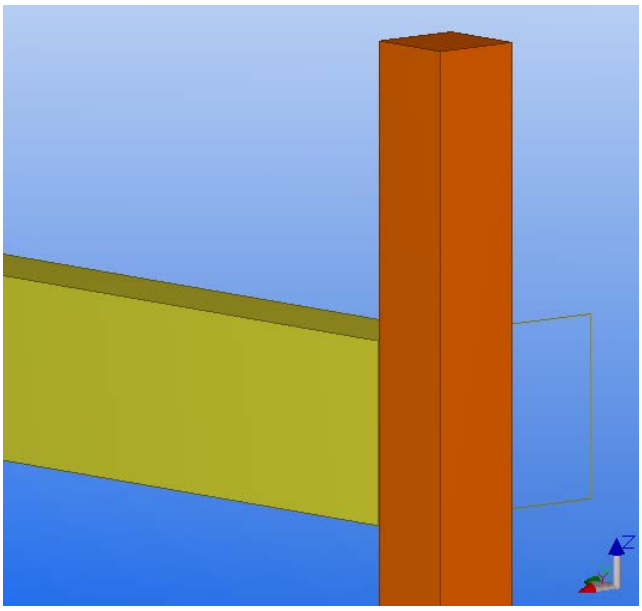
IfcConnectionSurfaceGeometry

Attribute	Implementation agreements
SurfaceOnRelatingElement	This plane must be provided if the end point of the Must be an IfcPlane that cuts the related element (i.e. is not parallel to the axis of the related element)
SurfaceOnRelatedElement	Must be Null

Example Part 21 File for End to Edge Connection

```
……..
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
……..
#115= IFCRECTANGLEPROFILEDEF(.AREA.,'400*400',#112,400.,400.);
#116= IFCDIRECTION((-1.,0.,0.));
#120= IFCDIRECTION((0.,0.,-1.));
#124= IFCCARTESIANPOINT((0.,0.,4000.));
#128= IFCAXIS2PLACEMENT3D(#124,#120,#116);
#131= IFCEXTRUDEDAREASOLID(#115,#128,#33,4000.);
……
#138= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#131));
#144= IFCPRODUCTDEFINITIONSHAPE('','',(#138));
#148= IFCCOLUMN('1AH7uO00004Z4oD3OmC38t',#20,'COLUMN','400*400','400*400',#95,#144,'TS_509');
……
#229= IFCRECTANGLEPROFILEDEF(.AREA.,'400*800',#226,400.,800.);
#230= IFCDIRECTION((0.,-1.,0.));
#234= IFCCARTESIANPOINT((6000.,0.,0.));
#238= IFCAXIS2PLACEMENT3D(#234,#116,#230);
#241= IFCEXTRUDEDAREASOLID(#229,#238,#33,5789.);
……
#248= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#241));
#254= IFCPRODUCTDEFINITIONSHAPE('','',(#248));
#258= IFCBEAM('1AH7uO00006Z4oD3OmC38v',#20,'BEAM','400*800','400*800',#217,#254,'TS_753');
……..
Surface on Relating Element – side face of the column, offset 1cm for the plate, that shortens the beam:
#599= IFCCARTESIANPOINT((0.,410.,4000.));
#601= IFCAXIS2PLACEMENT3D(#599,#25,#29);
#603= IFCPLANE(#601);
…..
```

#801= IFCCONNECTIONSURFACEGEOMETRY(#603,$);
#901=
IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99EIvvjCSfoOA4jQczRu',#20,$,$,#801,#148,#258,(#353),'Welded plate');
.....



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IFC Release Specific Concept Description (IFC 2x3**)**

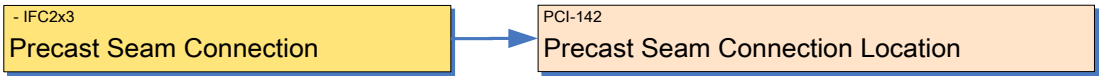
Precast Seam Connection Location

Reference	PCI-142	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 22 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

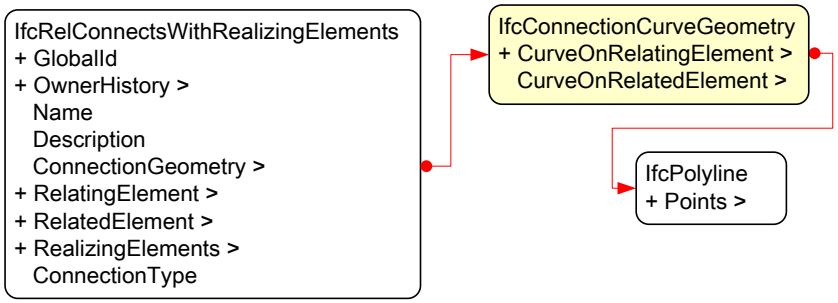
Description

This concept defines the extents of a seam connection between two precast pieces (such as two double tees or two wall sections), or a precast piece and another structural member (steel or CIP concrete). The curve defines line along which the connections are made. It is used in exchanges that take place before the actual connection hardware is defined, but may also be carried in subsequent exchanges. **It does not define any piece geometry for either the relating or related elements.**

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcConnectionCurveGeometry

Attribute	Implementation agreements
CurveOnRelatingElement	This is usually a line but may be a curve. It must be provided for all seam connections in exchanges where the connection hardware has not been defined, and is optional where the hardware is defined.
CurveOnRelatedElement	Must be null – assumed to be identical to the curve on the relating element.

IfcPolyline

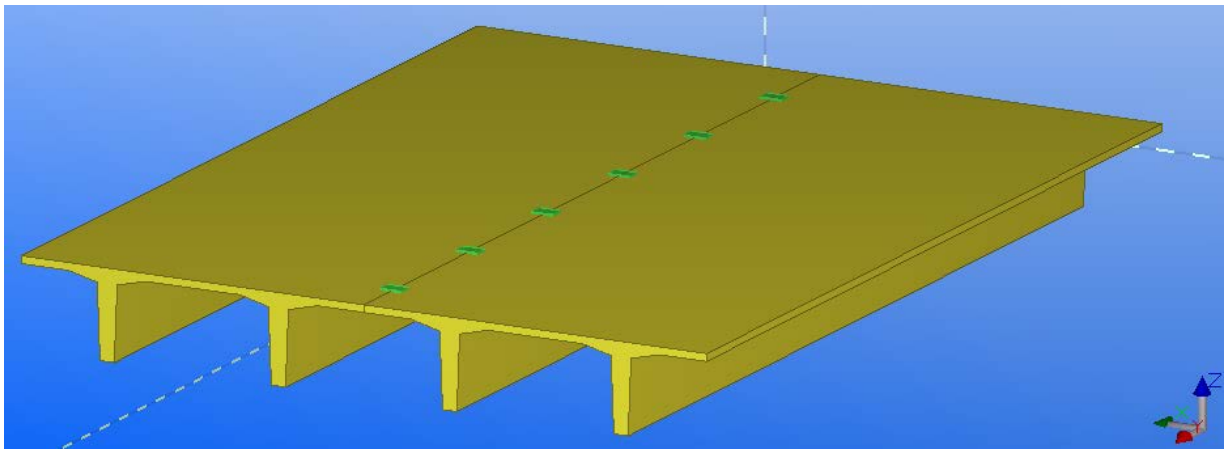
Attribute	Implementation agreements
Points	Must be at least two points in the local coordinate system of the relating element. A seam connection on a curve will be given by a faceted line; ideally, the points along the line will correspond to the exact locations of the actual connection hardware (which will likely

	not have been detailed yet).

Example Part 21 File for Seam Connection

```
……..
#25= IFCDIRECTION((1.,0.,0.));
#29= IFCDIRECTION((0.,1.,0.));
#33= IFCDIRECTION((0.,0.,1.));
……..
#123= IFCRECTANGLEPROFILEDEF(.AREA.,'100*10',#120,100.,10.);
#124= IFCDIRECTION((0.,-1.,0.));
#128= IFCCARTESIANPOINT((150.,0.,0.));
#132= IFCAXIS2PLACEMENT3D(#128,#96,#124);
#135= IFCEXTRUDEDAREASOLID(#123,#132,#33,150.);
…..
#142= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#135));
#148= IFCPRODUCTDEFINITIONSHAPE('','',(#142));
#152= IFCBEAM('1AH9bc0000Up4oD3OmCZGu',#20,'BEAM','100*10','100*10',#103,#148,'TS_3335');
……
#211= IFCMATERIAL('STEEL');
……
#248= IFCBEAM('1AH9bc0000Tp4oD3OmCZGu',#20,'BEAM','100*10','100*10',#221,#244,'TS_3299');
……
#301= IFCBEAM('1AH9bc0000Sp4oD3OmCZGu',#20,'BEAM','100*10','100*10',#274,#297,'TS_3263');
……
#354= IFCBEAM('1AH9bc0000Rp4oD3OmCZGu',#20,'BEAM','100*10','100*10',#327,#350,'TS_3227');
……
#407= IFCBEAM('1AH9bc0000Qp4oD3OmCZGu',#20,'BEAM','100*10','100*10',#380,#403,'TS_3191');
……
#460= IFCBEAM('1AH9bc0000I34oD3OmCZGs',#20,'BEAM','100*10','100*10',#433,#456,'TS_2766');
……
#495= IFCCARTESIANPOINT((1200.,300.));
#499= IFCCARTESIANPOINT((-1200.,300.));
#503= IFCCARTESIANPOINT((-1200.,250.));
#507= IFCCARTESIANPOINT((-870.,250.));
#511= IFCCARTESIANPOINT((-670.,200.));
#515= IFCCARTESIANPOINT((-650.,-300.));
#519= IFCCARTESIANPOINT((-550.,-300.));
#523= IFCCARTESIANPOINT((-530.,200.));
#527= IFCCARTESIANPOINT((-330.,250.));
#531= IFCCARTESIANPOINT((330.,250.));
#535= IFCCARTESIANPOINT((530.,200.));
#539= IFCCARTESIANPOINT((550.,-300.));
#543= IFCCARTESIANPOINT((650.,-300.));
#547= IFCCARTESIANPOINT((670.,200.));
#551= IFCCARTESIANPOINT((870.,250.));
#555= IFCCARTESIANPOINT((1200.,250.));
#559= IFCPOLYLINE((#495,#499,#503,#507,#511,#515,#519,#523,#527,#531,#535,#539,#543,#547,#551,#555,#495));
#563= IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,'TT600*2400-100-50-1200-0.04-200-0.25',#559);
#564= IFCCARTESIANPOINT((6000.,0.,0.));
#568= IFCAXIS2PLACEMENT3D(#564,#96,#124);
#571= IFCEXTRUDEDAREASOLID(#563,#568,#33,6000.);
#574= IFCSTYLEDITEM(#571,(#493),'Name');
#578= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#571));
#584= IFCPRODUCTDEFINITIONSHAPE('','',(#578));
#588= IFCBEAM('1AH9bc0000GZ4oD3OmCZGq',#20,'BEAM','TT600*2400-100-50-1200-0.04-200-0.25','TT600*2400-100-50-1200-0.04-
200-0.25',#486,#584,'TS_2703');
……
#647= IFCMATERIAL('CONCRETE');
……
#660= IFCPOLYLINE((#495,#499,#503,#507,#511,#515,#519,#523,#527,#531,#535,#539,#543,#547,#551,#555,#495));
```

#664= IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,'TT600*2400-100-50-1200-0.04-200-0.25',#660);
#665= IFCAXIS2PLACEMENT3D(#564,#96,#124);
#668= IFCEXTRUDEDAREASOLID(#664,#665,#33,6000.);
#671= IFCSTYLEDITEM(#668,(#493),'Name');
#675= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#668));
#681= IFCPRODUCTDEFINITIONSHAPE('','',(#675));
#685= IFCBEAM('1AH9bc0000Fp4oD3OmCZGq',#20,'BEAM','TT600*2400-100-50-1200-0.04-200-0.25','TT600*2400-100-50-1200-0.04-200-0.25',#657,#681,'TS_2653');
……
#724= IFCRELASSOCIATESMATERIAL('1RQI95UQv8dwNLyfKzPK6Z',#20,$,$,(#460,#407,#354,#301,#248,#152),#211);
#726= IFCRELASSOCIATESMATERIAL('0YPeRPZwP15v5Gi0G$B5h6',#20,$,$,(#685,#588),#647);
……
Polyline to define seam location
#485= IFCCARTESIANPOINT((12800.,6000.,0.));
#487= IFCCARTESIANPOINT((12800.,12000.,0.));
#489= IFCPOLYLINE((#485,#487));
…..
#801= IFCCONNECTIONCURVEGEOMETRY(#489,#489);
#901= IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99ElvvjCSfoOA4jQczRu',#20,$,$,#801,#588,#685,(#152,#248,#301,#354,#407,#460),'Double Tee Seam Connection');
…..



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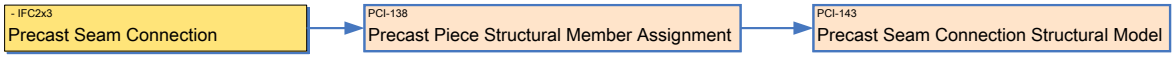
IFC Release Specific Concept Description (IFC 2x3**)**

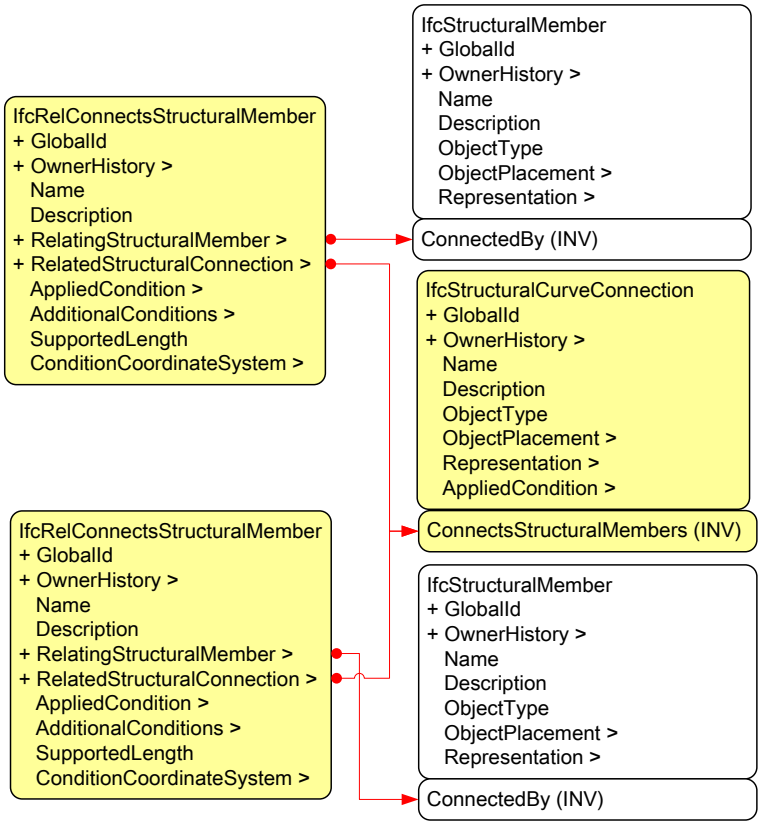
Precast Seam Connection Structural Model

Reference	PCI-143	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 22 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelConnectsStructuralMember

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>

Description	<Open>
RelatingStructural Member	Must be provided
RelatedStructuralConnection	Must be an IfcStructuralCurveConnection
AppliedCondition	
AdditionalConditions	
SupportedLength	
ConditionCoordinateSystem	

IfcStructuralCurveConnection

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	
ObjectPlacement	
Representation	Must be Null
AppliedCondition	

Example Part 21 Segment for Seam Structural Connection

```
.....
#746= IFCSTRUCTURALMEMBER('7J_3HbmQz7Zuggh7XqUO7q',#20,'Double Tee 1', 'TT600*2400-100-50-1200-0.04-200-0.25','Precast Concrete',$,$);
.....
#748= IFCSTRUCTURALMEMBER('5J_3HbmQz5Zuggh5XqUO5q',#20, 'Double Tee 2', 'TT600*2400-100-50-1200-0.04-200-0.25','Precast Concrete',$,$);
.....
#750= IFCSTRUCTURALCURVECONNECTION('5J_1HbmQz5Zuggh3XqUO7q',#20,'Seam Connection 1','Double Tee Seam','Precast Concrete Connection',$,$,$,$);
.....
#752= IFCRELCONNECTSSTRUCTURALMEMBER('9J_1HbmQz9Zuggh9XqUO9q',#20, 'Seam Connection 1','Double Tee Seam',#746,#750,$,$,$,$);
#754= IFCRELCONNECTSSTRUCTURALMEMBER('9L_1RbmLz9Zuggh9XqUL9q',#20, 'Seam Connection 1','Double Tee Seam',#748,#750,$,$,$,$);
....
```

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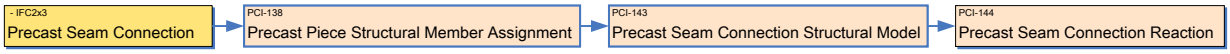
IFC Release Specific Concept Description (IFC 2x3**)**

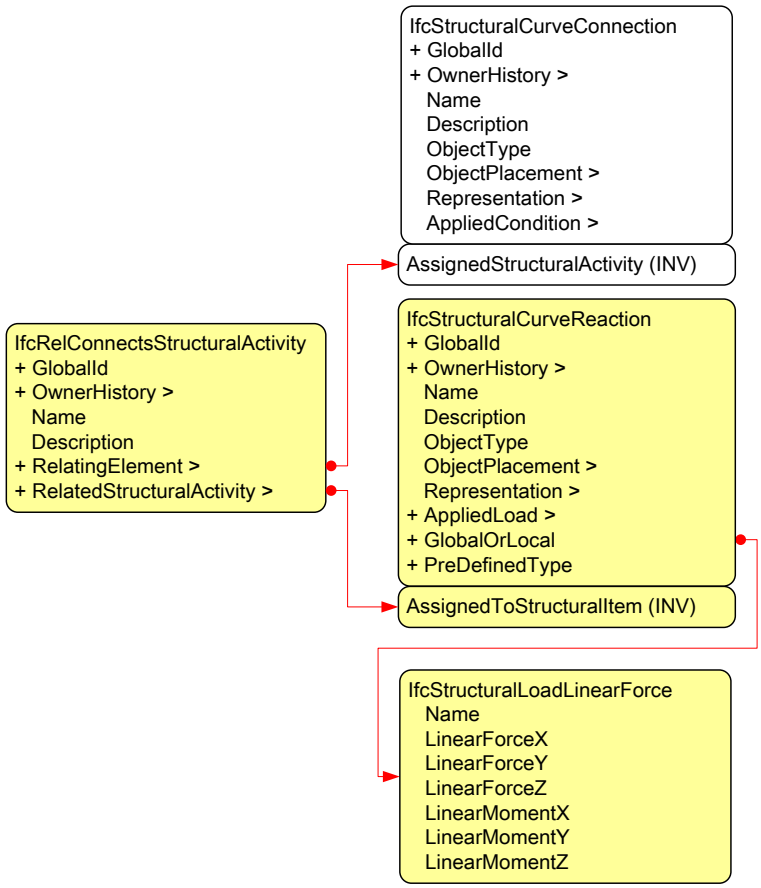
Precast Seam Connection Reaction

Reference	PCI-144	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 22 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

This concept is required for the following exchange models:

S_EM.2, A_EM.5, A_EM.6, S_EM.3, P_EM.7, P_EM.8, S_EM.6, P_EM.3, P_EM.11, A_EM.9, A_EM.10, A_EM.7, S_EM.7, S_EM.8, EM.52, EM.53, EM.59, EM.60, EM.61

Example Part 21 Segment for Seam Structural Reaction

```
.....
#746= IFCSTRUCTURALMEMBER('7J_3HbmQz7Zuggh7XqUO7q',#20,'Double Tee 1', 'TT600*2400-100-50-1200-0.04-200-0.25','Precast Concrete',$,$);
.....
#748= IFCSTRUCTURALMEMBER('5J_3HbmQz5Zuggh5XqUO5q',#20, 'Double Tee 2', 'TT600*2400-100-50-1200-0.04-200-0.25','Precast Concrete',$,$);
.....
#750= IFCSTRUCTURALCURVECONNECTION('5J_1HbmQz5Zuggh3XqUO7q',#20,'Seam Connection 1','Double Tee Seam','Precast Concrete Connection',$,$,$,$);
.....
#752= IFCSTRUCTURALLOADLINEARFORCE 'Diaphragm Maximum Load Transfer',100.,100.,-100.,0.,0.,0.);
#754= IFCSTRUCTURALCURVEREACTION('1L_2QbmQz9Zuggh9XqUO9q',#20,'Structural Reaction 2', 'Diaphragm Maximum Load Transfer', 'Reaction',$,$,#752,GLOBAL_COORDS,LINEAR);
.....
#58= IFCRELCONNECTSSTRUCTURALACTIVITY('1E_2WbmEz9Zuggh9XqUO9q',#20,'ACT_2', 'Diaphragm Maximum Load Transfer',#750,#754);
.....
#752= IFCRELCONNECTSSTRUCTURALMEMBER('9J_1HbmQz9Zuggh9XqUO9q',#20, 'Seam Connection 1','Double Tee Seam',#746,#750,$,$,$,$);
#754= IFCRELCONNECTSSTRUCTURALMEMBER('9L_1RbmLz9Zuggh9XqUL9q',#20, 'Seam Connection 1','Double Tee Seam',#748,#750,$,$,$,$);
....
```

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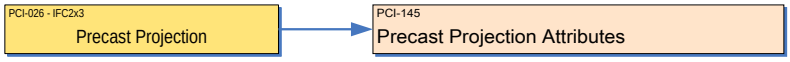
IFC Release Specific Concept Description (IFC 2x3**)**

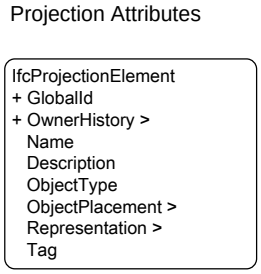
Precast Projection Attributes

Reference	PCI-145	**Version**	1.1	**Status**	Draft
Relationships	Provides a Boolean addition to a precast piece, such as a corbel or any other projection from the normal bounds of the piece. If the projection is also a part of a connection, as well as a feature of the a building element, then it will also be related to the precast piece element of which it is a part using IfcRelConnectsWithRealizingElements.				
History	v.1.0 8-Aug-09; reiviewed 13 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreement

IfcProjectionElement

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Should be 'Precast Projection'
ObjectPlacement	Local placement
Representation	Geometric representation, Brep or Swept Solid
Tag	.CORBEL. or similar

Example: Part21 file

Precast Beam, 40x80 cm

#108= IFCCARTESIANPOINT((0.,0.));
#112= IFCDIRECTION((1.,0.));

```
#116= IFCAXIS2PLACEMENT2D(#108,#112);
#119= IFCRECTANGLEPROFILEDEF(.AREA.,'400*800',#116,400.,800.);
#120= IFCDIRECTION((0.,-1.,0.));
#124= IFCDIRECTION((-1.,0.,0.));
#128= IFCCARTESIANPOINT((6000.,0.,0.));
#132= IFCAXIS2PLACEMENT3D(#128,#124,#120);
#135= IFCEXTRUDEDAREASOLID(#119,#132,#33,5780.);
#138= IFCSTYLEDITEM(#135,(#106),'Name');
#142= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#135));
#148= IFCPRODUCTDEFINITIONSHAPE('','',(#142));
#152= IFCBEAM('1AH9bc00001p4oD3OmC3at',#20,'BEAM','400*800','400*800',#99,#148,'TS_1667');
```

Precast Blockout – to accommodate the corbel in the Beam

```
#214= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#217= IFCLOCALPLACEMENT(#79,#214);
#220= IFCAXIS2PLACEMENT2D(#108,#112);
#223= IFCRECTANGLEPROFILEDEF(.AREA.,'',#220,300.,420.);
#224= IFCDIRECTION((0.,0.,-1.));
#228= IFCCARTESIANPOINT((520.,0.,-250.));
#232= IFCAXIS2PLACEMENT3D(#228,#124,#224);
#235= IFCEXTRUDEDAREASOLID(#223,#232,#33,320.);
#238= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#235));
#244= IFCPRODUCTDEFINITIONSHAPE('','',(#238));
#248= IFCOPENINGELEMENT('1AH9bc00008Z4oD3OmC3at',#20,'','','Recess',#217,#244,'');
#269= IFCRELVOIDSELEMENT('14s_88t61DDAWL8IgoQ$vK',#20,'','',#152,#248);
```

Precast Blockout – 6x8cm to accommodate shear pin

```
#270= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#273= IFCLOCALPLACEMENT(#79,#270);
#276= IFCAXIS2PLACEMENT2D(#108,#112);
#279= IFCRECTANGLEPROFILEDEF(.AREA.,'',#276,60.,80.);
#280= IFCCARTESIANPOINT((330.,0.,-105.));
#284= IFCAXIS2PLACEMENT3D(#280,#33,#120);
#287= IFCEXTRUDEDAREASOLID(#279,#284,#33,510.);
#290= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#287));
#296= IFCPRODUCTDEFINITIONSHAPE('','',(#290));
#300= IFCOPENINGELEMENT('1AH9bc0000AZ4oD3OmC3at',#20,'','','Recess',#273,#296,'');
#321= IFCRELVOIDSELEMENT('0aj1PHxYbCRg0czFQ$vO6H',#20,'','',#152,#300);
```

Precast Column 40x40 cm

```
#338= IFCAXIS2PLACEMENT2D(#108,#112);
#341= IFCRECTANGLEPROFILEDEF(.AREA.,'400*400',#338,400.,400.);
#342= IFCCARTESIANPOINT((0.,0.,4000.));
#346= IFCAXIS2PLACEMENT3D(#342,#224,#124);
#349= IFCEXTRUDEDAREASOLID(#341,#346,#33,4000.);
#352= IFCSTYLEDITEM(#349,(#336),'Name');
#356= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#349));
#362= IFCPRODUCTDEFINITIONSHAPE('','',(#356));
#366= IFCCOLUMN('1AH9bc00000p4oD3OmC3at',#20,'COLUMN','400*400','400*400',#329,#362,'TS_1635');
#385= IFCCOLUMNTYPE('2JpEbDHDD3URR4xlAGV2A9',#20,'400*400',$,$,$,$,$,.NOTDEFINED.);
```

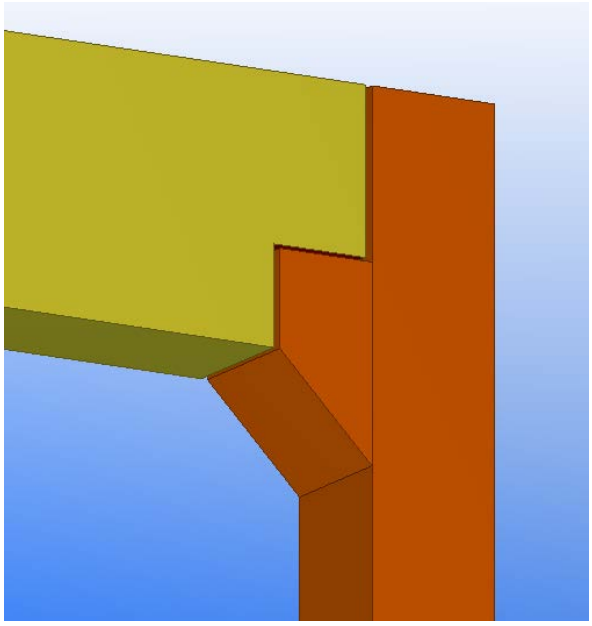
Precast Projection – Corbel

```
#508= IFCCARTESIANPOINT((0.,590.));
#512= IFCCARTESIANPOINT((300.,290.));
#516= IFCCARTESIANPOINT((300.,0.));
#520= IFCCARTESIANPOINT((0.,0.));
#524= IFCPOLYLINE((#508,#512,#516,#520,#508));
#528= IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,'PLT400*300',#524);
```

```
#529= IFCCARTESIANPOINT((0.,0.,-200.));
#533= IFCAXIS2PLACEMENT3D(#529,#33,#25);
#536= IFCEXTRUDEDAREASOLID(#528,#533,#33,400.);

#543= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#536));
#549= IFCPRODUCTDEFINITIONSHAPE('','',(#543));
#553= IFCPROJECTIONELEMENT('1AH9bc00005p4oD3OmC3at',#20,'Corbel','Corbel cast with column','Precast
Projection',#99,#549,'TS_2331',.CORBEL.);
#555= IFCRELPROJECTSELEMENT('2D89NMFVzDoeR6bcf1DEQ9',#20,'Projection 1', 'Precast Projection Relationship',#366,#553);
```

Connection Geometry and Relationship

```
#699= IFCCARTESIANPOINT((0.,210.,4000.));
#701= IFCAXIS2PLACEMENT3D(#699,#25,#29);
#703= IFCPLANE(#701);
#799= IFCCARTESIANPOINT((0.,200.,4000.));
#801= IFCAXIS2PLACEMENT3D(#799,#33,#25);
#803= IFCPLANE(#701);
#901= IFCCONNECTIONSURFACEGEOMETRY(#703,#803);
#903= IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99ElvvjCSfoOA4jQczRu',#20,$,$,#901,#152,#366,(#553),'Corbel');
```



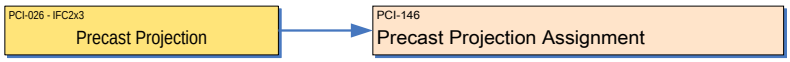
Precast Projection Example - Corbel on Column

IFC Release Specific Concept Description (<IFC Release 2x3>)

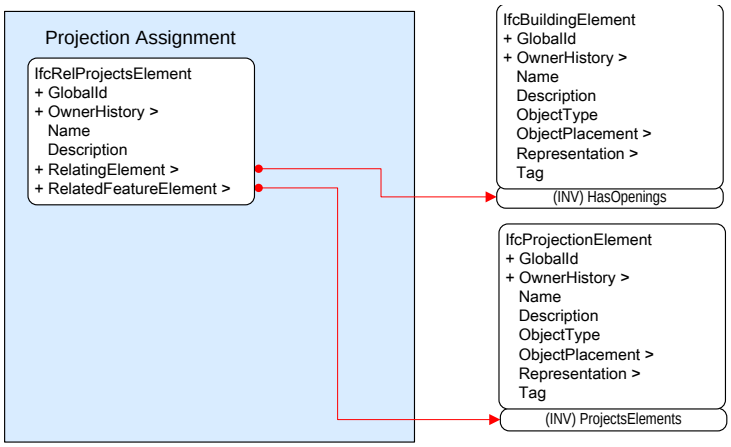
Generic

Reference	PCI-146	**Version**	1.1	**Status**	Draft
Relationships	Provides a Boolean addition to a precast piece, such as a corbel or any other projection from the normal bounds of the piece. If the projection is also a part of a connection, as well as a feature of the a building element, then it will also be related to the precast piece element of which it is a part using IfcRelConnectsWithRealizingElements.				
History	Revised Nov 18, 2012				
Authors	Rafael Sacks (cvsacks@technion.ac.il)				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram

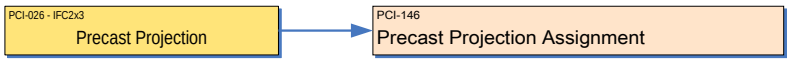


Instantiation diagram

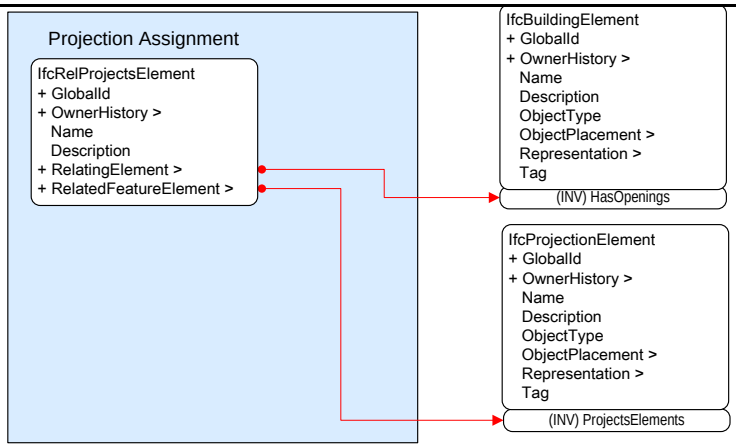


Implementation agreements

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelProjectsElement

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingElement	The hosting precast piece (subtype of precast IfcBuildingElement).
RelatedFeatureElement	The projecting element (IfcProjectionElement) (corbels, shelves, etc.)

Example: Part21 file

Precast Beam, 40x80 cm

```
#108= IFCCARTESIANPOINT((0.,0.));
#112= IFCDIRECTION((1.,0.));
#116= IFCAXIS2PLACEMENT2D(#108,#112);
#119= IFCRECTANGLEPROFILEDEF(.AREA.,'400*800',#116,400.,800.);
#120= IFCDIRECTION((0.,-1.,0.));
#124= IFCDIRECTION((-1.,0.,0.));
#128= IFCCARTESIANPOINT((6000.,0.,0.));
#132= IFCAXIS2PLACEMENT3D(#128,#124,#120);
#135= IFCEXTRUDEDAREASOLID(#119,#132,#33,5780.);
#138= IFCSTYLEDITEM(#135,(#106),'Name');
#142= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#135));
#148= IFCPRODUCTDEFINITIONSHAPE('','',(#142));
#152= IFCBEAM('1AH9bc00001p4oD3OmC3at',#20,'BEAM','400*800','400*800',#99,#148,'TS_1667');
```

Precast Blockout in the Beam to accommodate the corbel

```
#214= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#217= IFCLOCALPLACEMENT(#79,#214);
#220= IFCAXIS2PLACEMENT2D(#108,#112);
#223= IFCRECTANGLEPROFILEDEF(.AREA.,'',#220,300.,420.);
#224= IFCDIRECTION((0.,0.,-1.));
#228= IFCCARTESIANPOINT((520.,0.,-250.));
#232= IFCAXIS2PLACEMENT3D(#228,#124,#224);
#235= IFCEXTRUDEDAREASOLID(#223,#232,#33,320.);
```

#238= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#235));
#244= IFCPRODUCTDEFINITIONSHAPE('','',(#238));
#248= IFCOPENINGELEMENT('1AH9bc00008Z4oD3OmC3at',#20,'','','Recess',#217,#244,'');
#269= IFCRELVOIDSELEMENT('14s_88t61DDAWL8IgoQ$vK',#20,'','',#152,#248);

Precast Blockout – 6x8cm to accommodate shear pin

#270= IFCAXIS2PLACEMENT3D(#92,#33,#25);
#273= IFCLOCALPLACEMENT(#79,#270);
#276= IFCAXIS2PLACEMENT2D(#108,#112);
#279= IFCRECTANGLEPROFILEDEF(.AREA.,'',#276,60.,80.);
#280= IFCCARTESIANPOINT((330.,0.,-105.));
#284= IFCAXIS2PLACEMENT3D(#280,#33,#120);
#287= IFCEXTRUDEDAREASOLID(#279,#284,#33,510.);
#290= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#287));
#296= IFCPRODUCTDEFINITIONSHAPE('','',(#290));
#300= IFCOPENINGELEMENT('1AH9bc0000AZ4oD3OmC3at',#20,'','','Recess',#273,#296,'');
#321= IFCRELVOIDSELEMENT('0aj1PHxYbCRg0czFQ$vO6H',#20,'','',#152,#300);

Precast Column 40x40 cm

#338= IFCAXIS2PLACEMENT2D(#108,#112);
#341= IFCRECTANGLEPROFILEDEF(.AREA.,'400*400',#338,400.,400.);
#342= IFCCARTESIANPOINT((0.,0.,4000.));
#346= IFCAXIS2PLACEMENT3D(#342,#224,#124);
#349= IFCEXTRUDEDAREASOLID(#341,#346,#33,4000.);
#352= IFCSTYLEDITEM(#349,(#336),'Name');
#356= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#349));
#362= IFCPRODUCTDEFINITIONSHAPE('','',(#356));
#366= IFCCOLUMN('1AH9bc00000p4oD3OmC3at',#20,'COLUMN','400*400','400*400',#329,#362,'TS_1635');
#385= IFCCOLUMNTYPE('2JpEbDHDD3URR4xlAGV2A9',#20,'400*400',$,$,$,$,$,$,.NOTDEFINED.);

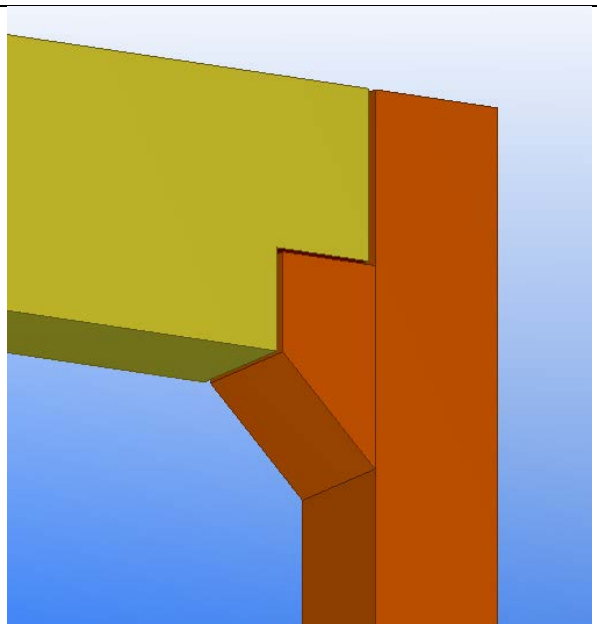
Precast Projection – Corbel

#508= IFCCARTESIANPOINT((0.,590.));
#512= IFCCARTESIANPOINT((300.,290.));
#516= IFCCARTESIANPOINT((300.,0.));
#520= IFCCARTESIANPOINT((0.,0.));
#524= IFCPOLYLINE((#508,#512,#516,#520,#508));
#528= IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,'PLT400*300',#524);
#529= IFCCARTESIANPOINT((0.,0.,-200.));
#533= IFCAXIS2PLACEMENT3D(#529,#33,#25);
#536= IFCEXTRUDEDAREASOLID(#528,#533,#33,400.);

#543= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#536));
#549= IFCPRODUCTDEFINITIONSHAPE('','',(#543));
#553= IFCPROJECTIONELEMENT('1AH9bc00005p4oD3OmC3at',#20,'Corbel','Corbel cast with column','Precast Projection',#99,#549,'TS_2331',.CORBEL.);
#555= IFCRELPROJECTSELEMENT('2D89NMFVzDoeR6bcf1DEQ9',#20, 'Projection 1', 'Precast Projection Relationship',#366,#553);

Connection Geometry and Relationship

#699= IFCCARTESIANPOINT((0.,210.,4000.));
#701= IFCAXIS2PLACEMENT3D(#699,#25,#29);
#703= IFCPLANE(#701);
#799= IFCCARTESIANPOINT((0.,200.,4000.));
#801= IFCAXIS2PLACEMENT3D(#799,#33,#25);
#803= IFCPLANE(#701);
#901= IFCCONNECTIONSURFACEGEOMETRY(#703,#803);
#903= IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99ElvvjCSfoOA4jQczRu',#20,$,$,#901,#152,#366,(#553),'Corbel');



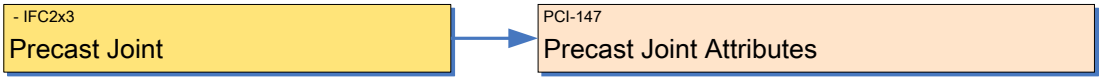
Precast Projection Example - Corbel on Column

IFC Release Specific Concept Description (IFC 2x3**)**

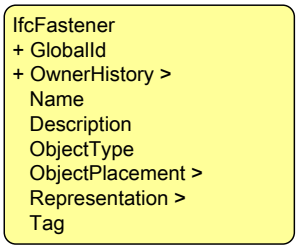
Precast Joint Attributes

Reference	PCI-147	**Version**	1.1	**Status**	Draft
Relationships	PCI-148, PCi-147				
History	V.1.0 8-Aug-09, revioewed 16 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be 'Precast Joint'. The specific joint type is defined through relationship to the IfcFastenerType.
ObjectPlacement	This is the placement of the physical joint material, such as mortar or insulation strip. Where thre is more than one, there will be multiple instances of IfcFastener. The extents of the joint are defined by the ConnectionGeometry property of the IfcConnectsWithRealizingElements entity. For details see the *Precast Joint Location* and the *Precast Joint Element Assignment* concept pages.
Representation	This is the geometry of the physical joint material, as defined above. Wherever the joint applies a specific required geometry profile to the edges of the pieces that participate in the joint, the details are provided through relationship to the IfcFastenerType.
Tag	<Open>

Example Part 21 Excerpt for Joint

Joint Material – Strip 8mmx110mm

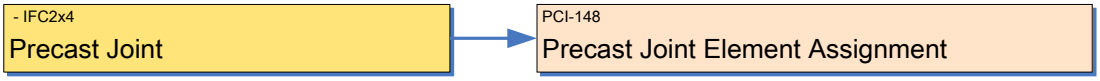
```
#108= IFCCARTESIANPOINT((0.,0.));
#112= IFCDIRECTION((1.,0.));
#116= IFCAXIS2PLACEMENT2D(#108,#112);
#119= IFCRECTANGLEPROFILEDEF(.AREA.,'FLT8*110',#116,8.,110.);
#120= IFCDIRECTION((0.,-1.,0.));
#124= IFCDIRECTION((0.,0.,-1.));
#128= IFCCARTESIANPOINT((0.,0.,3300.));
#132= IFCAXIS2PLACEMENT3D(#128,#124,#120);
#135= IFCEXTRUDEDAREASOLID(#119,#132,#33,3300.);
#138= IFCSTYLEDITEM(#135,(#106),'Name');
#142= IFCSHAPEREPRESENTATION(#40,'Body','SweptSolid',(#135));
#148= IFCPRODUCTDEFINITIONSHAPE('','',(#142));

#152= IFCFASTENER('1AInrC0000UZ4oD3OqCpWt',#20, 'J-1', 'Vertical Precast Wall Panel to Wall Panel Joint Type 1', 'Precast
Joint',#99,#148,'TS_5017');

#171= IFCFASTENERTYPE ('1IWNApSzLApxnxVkw8XGZz',#20,'W2W JOINT T1', 'Vertical Precast Wall Panel to Wall Panel Joint Type
1','BOTH',$,(#700,#800 ),$,'Compression Seal with gasket');
#177= IFCPROPERTYSINGLEVALUE('Class','Class',IFCIDENTIFIER('14'),$);
#181= IFCPROPERTYSINGLEVALUE('Finish','Finish',IFCIDENTIFIER(''),$);
#185= IFCPROPERTYSINGLEVALUE('AssemblyId','AssemblyId',IFCIDENTIFIER('C0(?)'),$);
#189= IFCPROPERTYSINGLEVALUE('Part_Position','Part_Position',IFCIDENTIFIER('M0(?)'),$);
#193= IFCPROPERTYSET('3AuGznPDP1Iw2Q$9J9FIDn',#20,'Pset_Tekla_General','Pset_Tekla_General',(#177,#181,#185,#189));
#198= IFCQUANTITYLENGTH('Length',$,$,3300.);
#200= IFCQUANTITYAREA('OuterSurfaceArea',$,$,0.78056);
#202= IFCQUANTITYVOLUME('NetVolume',$,$,0.002904);
#204= IFCQUANTITYWEIGHT('NetWeight',$,$,22.7964);
#206= IFCELEMENTQUANTITY('2VZjjFNSf7p9QyLLCtUCpJ',#20,'BaseQuantities',$,$,(#198,#200,#202,#204));
#211= IFCMATERIAL('BITUMINOUS RUBBER');

#580=
IFCRELDEFINESBYPROPERTIES('1MZU9G$zPCN9iGAOwfWExJ',#20,'NameRelDefByProperties','DescriptionRelDefByProperties',(#152)
,#193);
#582=
IFCRELDEFINESBYPROPERTIES('2NVSUL$Of8KxQRvX0h_Fd_',#20,'NameRelDefByProperties','DescriptionRelDefByProperties',(#152),
#206);

#588= IFCRELDEFINESBYTYPE('0crXzXHVH4junajEt29zHs',#20,$,$,(#152),#171);

#592= IFCRELASSOCIATESMATERIAL('26QI_vQuL7lQnhaJs2Ze5p',#20,$,$,(#152),#211);
```

IFC Release Specific Concept Description (IFC 2x3**)**

Precast Joint Element Assignment

Reference	PCI-148	**Version**	1.1	**Status**	Draft
Relationships	PCI-147				
History	V.1.0 8-Aug-09; reviewed 16 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram

Implementation agreements

IfcRelConnectsWithRealizingElements

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data

Name	<Open>
Description	<Open>
ConnectionGeometry	Defines the line along which the joint is applied. See the *Precast Joint Location* concept page for details
RelatingElement	Must be an IfcBuildingElement that represents a **precast piece concept** (see the *Precast Piece* concept page for details). **It cannot be a precast piece mark concept**, because joints are made between instances of pieces in their local positions.
RelatedElement	Must be an IfcBuildingElement that represents either one of: c) a **precast piece concept** (see the *Precast Piece* concept page for details). **It cannot be a precast piece mark concept**, because joints are made between instances of pieces in their local positions. d) A member of another structural system, e.g. a structural steel member or a CIP concrete member.
ConnectionType	Must be equal to “Precast Joint”. The specific type is determined by the type property of the IfcFastenerType related to this joint. This value also distinguishes the joint from precast connections.

RelatingElement

RelatingElement

Example Part 21 Excerpt for Joint Location

Joint Material – Neoprene Strip 8mmx110mm

#152= IFCFASTENER('1AInrC0000UZ4oD3OqCpWt',#20, 'J-1', 'Vertical Precast Wall Panel to Wall Panel Joint Type 1', 'Precast Joint',#99,#148,'TS_5017');

First Wall Panel 20cm thick, 3.3m high

#268= IFCWALLSTANDARDCASE('1AInrC0000A34oD3OqCpSo',#20,'PANEL','200*3300','200*3300',#217,#264,'TS_3954');

Second Wall Panel 20cm thick, 3.3m high

#468= IFCWALLSTANDARDCASE('1AInrC0000934oD3OqCpSo',#20,'PANEL','200*3300','200*3300',#431,#464,'TS_3919');

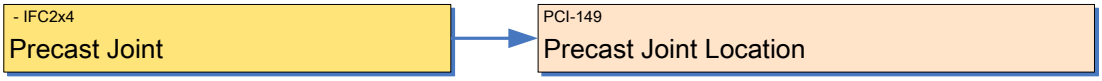
Logical Joint Representation and Element Assignment
#650= IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99ElvvjCSfoOA4jQczRu',#20,'J-1','Logical Joint',#630,#268,#468,(#152),'Precast Joint');

IFC Release Specific Concept Description (IFC 2x3**)**

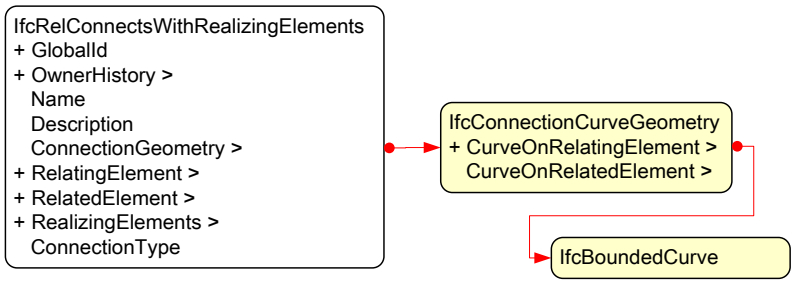
Precast Joint Location

Reference	PCI-149	**Version**	1.1	**Status**	Draft
Relationships	PCI-147, Pci-148				
History	V.1.0 8-Aug-09; reviewed 16 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcConnectionCurveGeometry

Attribute	Implementation agreements
CurveOnRelatingElement	Must be provided to delimit the location and extents of the joint.
CurveOnRelatedElement	Must be Null – the joint line is identical for both elements.

IfcBoundedCurve

This will most commonly be an IfcLine that extends through the full length of contact of the two pieces, but it may be an IfcPolyline, or, in special cases, it can be an IfcCompositeCurve.

This line determines the 'axis' of the joint. If there are profiles that cut the pieces on either side of the joint (see the *Precast Joint Type Profiling Geometry* concept page for details) then this axis defines their location and their extrusion direction.

Example Part 21 Excerpt for Joint Location

Joint Material – Neoprene Strip 8mmx110mm

#152= IFCFASTENER('1AInrC0000UZ4oD3OqCpWt',#20, 'J-1', 'Vertical Precast Wall Panel to Wall Panel Joint Type 1', 'Precast Joint',#99,#148,'TS_5017');

First Wall Panel 20cm thick, 3.3m high

#268= IFCWALLSTANDARDCASE('1AInrC0000A34oD3OqCpSo',#20,'PANEL','200*3300','200*3300',#217,#264,'TS_3954');

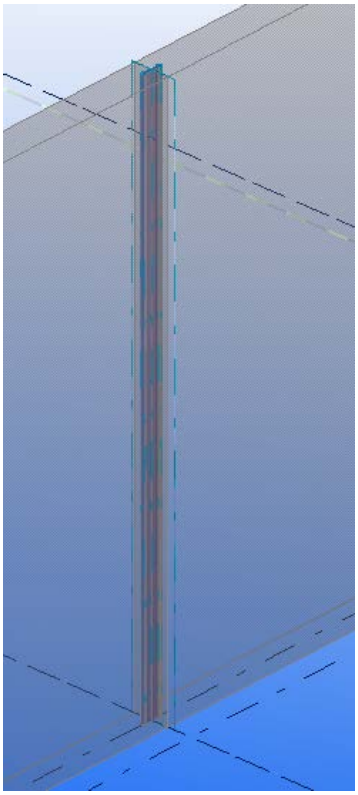
Second Wall Panel 20cm thick, 3.3m high

#468= IFCWALLSTANDARDCASE('1AInrC0000934oD3OqCpSo',#20,'PANEL','200*3300','200*3300',#431,#464,'TS_3919');

Joint geometry (curve along which the joint is applied)

#620= IFCCARTESIANPOINT((6000.,0.,0.));
#622= IFCCARTESIANPOINT((6000.,0.,3300.));
#624= IFCPOLYLINE((#620,#622));
#630= IFCCONNECTIONCURVEGEOMETRY(#624,$);

Logical Joint Representation and Element Assignment
#650= IFCRELCONNECTSWITHREALIZINGELEMENTS('2t99ElvvjCSfoOA4jQczRu',#20,'J-1','Logical Joint',#630,#268,#468,(#152),'Precast Joint');



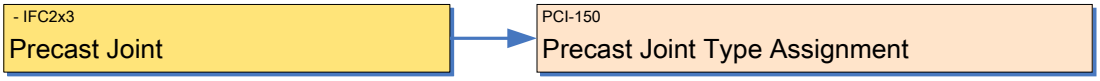
Joint location along vertical axis between wall panels

IFC Release Specific Concept Description (IFC 2x3)

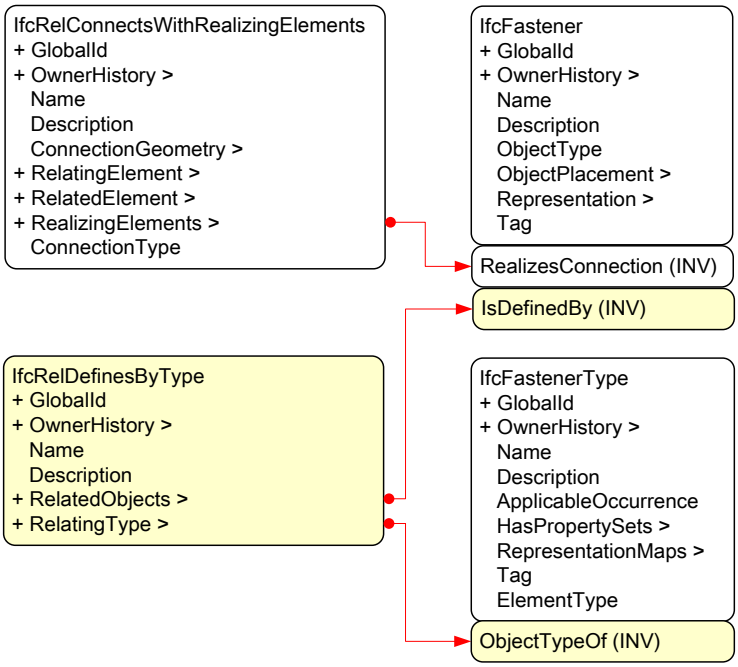
Precast Joint Type Assignment

Reference	PCI-150	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 13 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelDefinesByType

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedObjects	Must be only instances of IfcFastener
RelatingType	Must be one instance of IfcFastenerType

Example Part 21 Excerpt for Joint Type Assignment

```
#152= IFCFASTENER('1AInrC0000UZ4oD3OqCpWt',#20, 'J-1', 'Vertical Precast Wall Panel to Wall Panel Joint Type 1', 'Precast Joint',#99,#148,'TS_5017');

#171= IFCFASTENERTYPE ('1IWNApSzLApxnxVkw8XGZz',#20,'W2W JOINT T1', 'Vertical Precast Wall Panel to Wall Panel Joint Type 1','BOTH',$,(#700,#800 ),$,'Compression Seal with gasket');

#588= IFCRELDEFINESBYTYPE('0crXzXHVH4junajEt29zHs',#20,$,$,(#152),#171);
```

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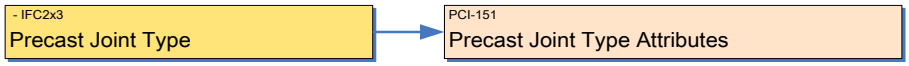
IFC Release Specific Concept Description (IFC 2x3**)**

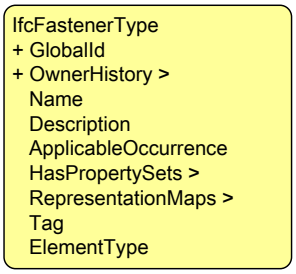
Precast Joint Type Attributes

Reference	PCI-151	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 8-Aug-09; reviewed 13 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcFastenerType

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
AppicableOccurrence	This is used to denote the applicability of the profile maps to the jointed elements (relating and related precast piece elements). It must have one of four values: ***None, RelatingOnly, RelatedOnly, Both*** These correspond to the cases where a) None - neither element is profiled, b) RelatingOnly - where only the element first is profiled by the single representation map provided, c) RelatedOnly - where only the second element is profiled by the single representation map provided, d) Both – where the first element is profiled by the first representation map and the second element is profiled by the second representation map.
HasPropertySets	
RepresentationMaps	Can be null, but should be provided wherever the joint applies a specific required geometry profile to the edges of the pieces that participate in the joint. When provided, it must map to a geometric set of 2D curves that define the cross-section profiling of the pieces on either side of the joint.

Tag	
ElementType	This defines the physical application of the joint. Possible values include: Vertical open-drained: Slotted neoprene baffle plus vertical air-seal Horizontal open-drained: profiled with flashing and horizontal air-seal Face Sealed Compression Seal with gasket Compression Seal with flexible material Other joint type ***Note - this list must be checked with PCI BIM Advisory Committee***

This concept is required for the following exchange models:

Example Part 21 Excerpt for Joint Attributes

#171= IFCFASTENERTYPE ('1IWNApSzLApxnxVkw8XGZz',#20,'W2W JOINT T1', 'Vertical Precast Wall Panel to Wall Panel Joint Type 1','BOTH',$,(#700,#800),$,'Compression Seal with gasket');

First profile definition for joint type

#700= IFCREPRESENTATIONMAP(#660,#690);

Second profile definition for joint type

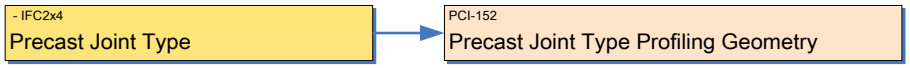
#800= IFCREPRESENTATIONMAP(#660,#790);

IFC Release Specific Concept Description (IFC 2x3**)**

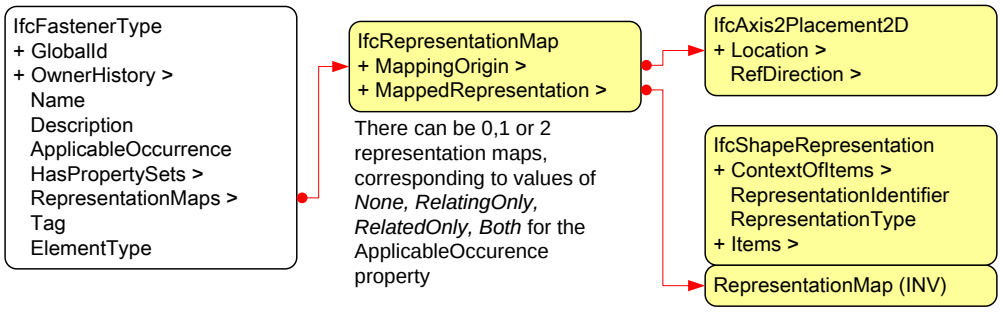
Precast Joint Type Profiling Geometry

Reference	PC-152	**Version**	1.1	**Status**	Draft
Relationships	PCI-147, Pci-148, Pci-149				
History	V.1.0 8-Aug-09, reviewed 17 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcAxisPlacement2D

Attribute	Implementation agreements
Location	Defines the relative location of the profile to the central axis of the joint (which is defined for each occurrence of the joint).
RefDirection	Must be provided, but may contain dummy data

IfcShapeRepresentation

Attribute	Implementation agreements
ContextOfItems	
RepresentationIdentifier	Must be provided, but may contain dummy data
RepresentationType	Curve2D
Items	Must be provided and define a profile that can void the piece.

This concept is required for the following exchange models:

Example Part 21 Excerpt for Joint Type

Fastener Type

#171= IFCFASTENERTYPE ('1IWNApSzLApxnxVkw8XGZz',#20,'W2W JOINT T1', 'Vertical Precast Wall Panel to Wall Panel Joint Type 1','BOTH',$,(#700,#800),$,'Compression Seal with gasket');

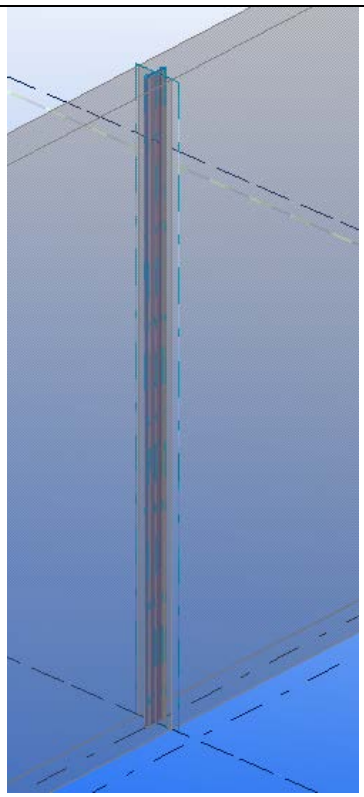
First profile definition for joint type

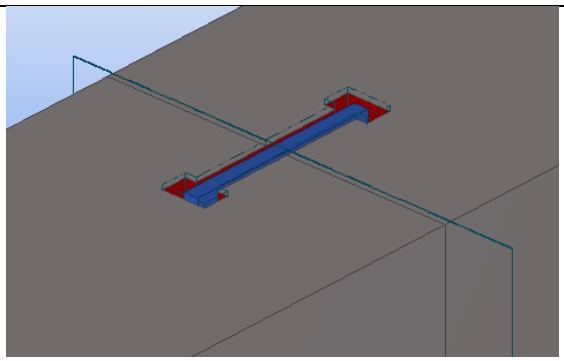
#650= IFCCARTESIANPOINT((0.,0.));
#652= IFCDIRECTION((1.,0.));
#660= IFCAXIS2PLACEMENT2D(#650,#652);

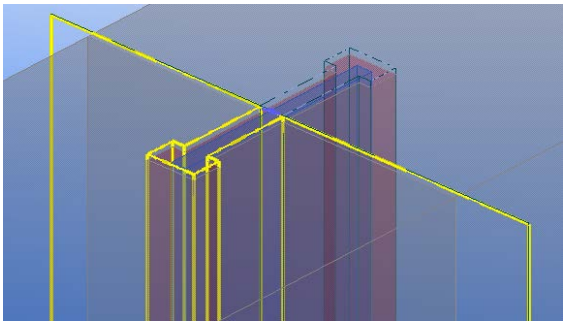
#664= IFCCARTESIANPOINT((-6.25,0.));
#666= IFCCARTESIANPOINT((-6.25,-45.));
#668= IFCCARTESIANPOINT((-12.5,-45.));
#670= IFCCARTESIANPOINT((-12.5,-60.));
#672= IFCCARTESIANPOINT((12.5,-60.));
#674= IFCCARTESIANPOINT((12.5,-45.));
#676= IFCCARTESIANPOINT((6.25,-45.));
#678= IFCCARTESIANPOINT((6.25,0.));
#680= IFCPOLYLINE(#664,#666,#668,#670,#672,#674,#676,#678,#664);
#690= IFCSHAPEREPRESENTATION(#40,'Profile','Curve2D',(#680));
#700= IFCREPRESENTATIONMAP(#660,#690);

Second profile definition for joint type

#764= IFCCARTESIANPOINT((-6.25,0.));
#766= IFCCARTESIANPOINT((-6.25,45.));
#768= IFCCARTESIANPOINT((-12.5,45.));
#770= IFCCARTESIANPOINT((-12.5,60.));
#772= IFCCARTESIANPOINT((12.5,60.));
#774= IFCCARTESIANPOINT((12.5,45.));
#776= IFCCARTESIANPOINT((6.25,45.));
#778= IFCCARTESIANPOINT((6.25,0.));
#780= IFCPOLYLINE(#764,#766,#768,#770,#772,#774,#776,#778,#764);
#790= IFCSHAPEREPRESENTATION(#40,'Profile','Curve2D',(#780));
#800= IFCREPRESENTATIONMAP(#660,#790);







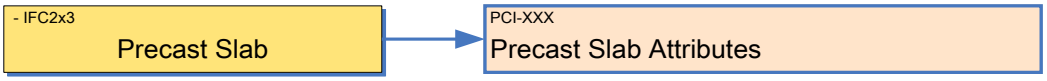
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (IFC Release 2x3)

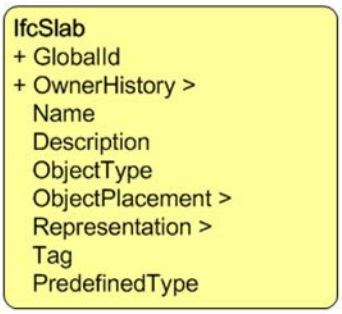
Precast Slab Aggregation

Reference	PCI-153	**Version**	1.1	**Status**	Draft
Relationships	Slab is considered here an aggregation of multiple parts. These may be doubletees, hollowcore or precast slabs				
History	Created October 5, 2009, reviewed 15 November, 2012				
Authors	Rafael Sacks				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



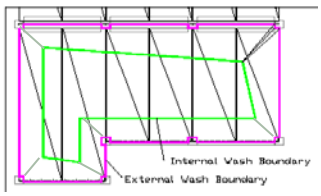
Instantiation diagram



Implementation agreements

IfcSlab

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be 'Precast Slab'
ObjectPlacement	May be absolute, relative or relative to grid.
Representation	Must have its own brep geometry.
Tag	<Open>
PredefinedType	Must be 'USERDEFINED'.



Slabs are a composition of individual precast pieces, such as hollow core, doubletees or solid slabs. The cut shapes of these components fit inside the slab shape. The shape of a slab is defined as a general purpose shape, boundary representation because its top may not be planar because of toppings. Care should be taken to ensure that the slab shape and its components, when unioned together, has no spaces between. Thus specific recommendations of shape are defined for each type of embedded beam.

Example: Part21 file for IcfBeam type assignments

Component hollow-core parts

#341= IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#423= IFCBEAM('1A0gmi0000yZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#410,#419,'TS_2628');
#462= IFCBEAM('1A0gmi0000xZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#449,#458,'TS_2624');
#501= IFCBEAM('1A0gmi0000wZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#488,#497,'TS_2620');
#540= IFCBEAM('1A0gmi0000vZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#527,#536,'TS_2616');
#579= IFCBEAM('1A0gmi0000uZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#566,#575,'TS_2612');
#1454= IFCBEAM('1A0gmi0000A34oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1441,#1450,'TS_2122');
#1493= IFCBEAM('1A0gmi0000934oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1480,#1489,'TS_2118');
#1532= IFCBEAM('1A0gmi0000834oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1519,#1528,'TS_2114');
#1571= IFCBEAM('1A0gmi0000734oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1558,#1567,'TS_2108');

Precast slab

#3406=IFCSLABELEMENTEDCASE('34sdfsdfDVSASDF4545',#20,'SLAB 5','Fifth Floor Slab','Precast Slab',
#2050,#2560,$,'USERDEFINED')

Relationship

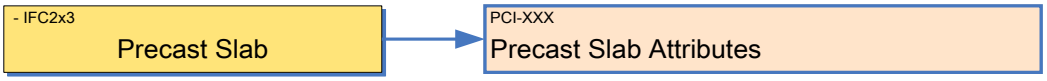
#3500=
IFCRELAGGREGATES('3QM6ooNoz02vFwZd5JedV9',#20,$,$,#2069,(#1571,#1532,#1493,#1454,#579,#540,#501,#462,#423,#341));

IFC Release Specific Concept Description (IFC Release 2x3)

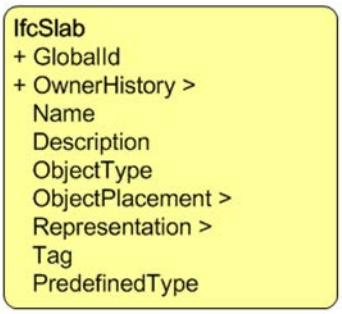
Precast Slab Aggregation

Reference	PCI-153	**Version**	1.1	**Status**	Draft
Relationships	Slab is considered here an aggregation of multiple parts. These may be doubletees, hollowcore or precast slabs				
History	Created October 5, 2009, reviewed 15 November, 2012				
Authors	Rafael Sacks				
Document Owner	Precast/Prestress Concrete Institute				

Usage in view definition diagram



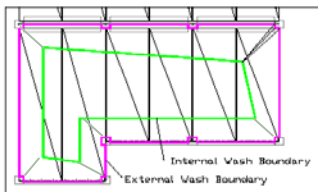
Instantiation diagram



Implementation agreements

IfcSlab

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be 'Precast Slab'
ObjectPlacement	May be absolute, relative or relative to grid.
Representation	Must have its own brep geometry.
Tag	<Open>
PredefinedType	Must be 'USERDEFINED'.



Slabs are a composition of individual precast pieces, such as hollow core, doubletees or solid slabs. The cut shapes of these components fit inside the slab shape. The shape of a slab is defined as a general purpose shape, boundary representation because its top may not be planar because of toppings. Care should be taken to ensure that the slab shape and its components, when unioned together, has no spaces between. Thus specific recommendations of shape are defined for each type of embedded beam.

Example: Part21 file for IcfBeam type assignments

Component hollow-core parts

#341= IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,$,.NOTDEFINED.);
#423= IFCBEAM('1A0gmi0000yZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#410,#419,'TS_2628');
#462= IFCBEAM('1A0gmi0000xZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#449,#458,'TS_2624');
#501= IFCBEAM('1A0gmi0000wZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#488,#497,'TS_2620');
#540= IFCBEAM('1A0gmi0000vZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#527,#536,'TS_2616');
#579= IFCBEAM('1A0gmi0000uZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#566,#575,'TS_2612');
#1454= IFCBEAM('1A0gmi0000A34oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1441,#1450,'TS_2122');
#1493= IFCBEAM('1A0gmi0000934oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1480,#1489,'TS_2118');
#1532= IFCBEAM('1A0gmi0000834oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1519,#1528,'TS_2114');
#1571= IFCBEAM('1A0gmi0000734oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1558,#1567,'TS_2108');

Precast slab

#3406=IFCSLABELEMENTEDCASE('34sdfsdfDVSASDF4545',#20,'SLAB 5','Fifth Floor Slab','Precast Slab',
#2050,#2560,$,'USERDEFINED')

Relationship

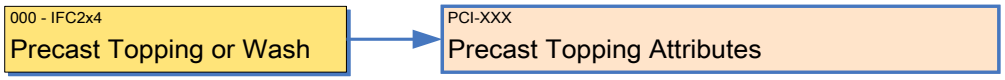
#3500=
IFCRELAGGREGATES('3QM6ooNoz02vFwZd5JedV9',#20,$,$,#2069,(#1571,#1532,#1493,#1454,#579,#540,#501,#462,#423,#341));

IFC Release Specific Concept Description (IFC 2x3**)**

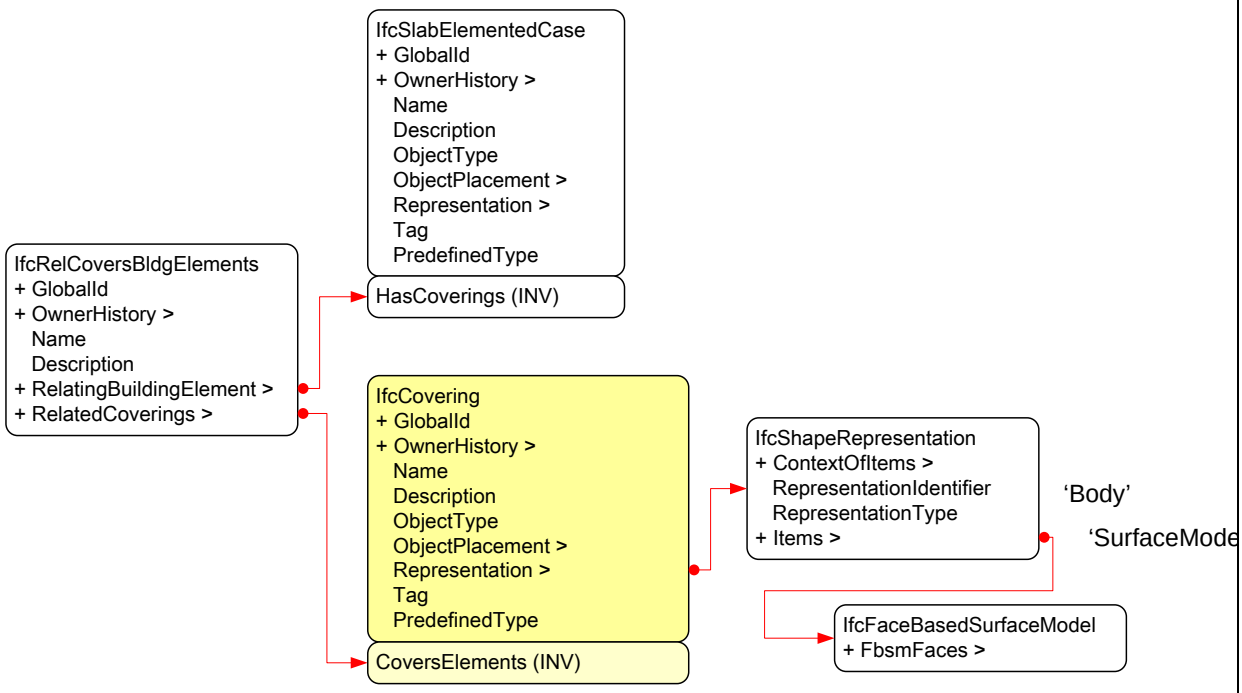
Precast Topping Attributes

Reference	PCI-154	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 4-Oct-09; reviewed 15 November, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Definitions

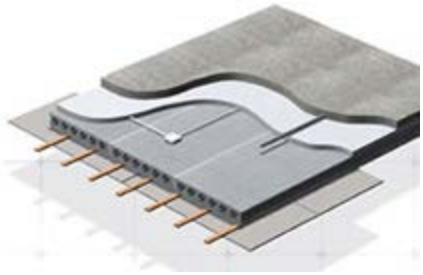
A **topping** is a cast-in-place concrete addition to a precast floor deck. It may be of uniform depth throughout, but may also be sloped to accommodate drainage requirements. It is typically from 1" and 2" deep, although it may be thicker than 2" at some points, and is most often reinforced with welded wire mesh. Precast components over which a topping is to be poured will usually have a rough finish on their top surfaces to enhance bonding with the fresh concrete when it is poured on site.

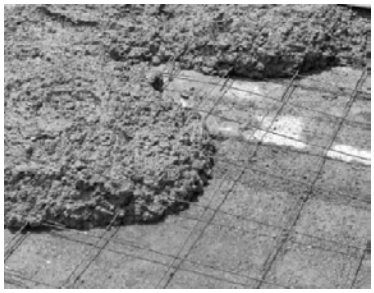
A **wash** (or **swale**) is an addition to a precast concrete floor deck. It may be poured

- integrally with each piece comprising the deck,
- on site.

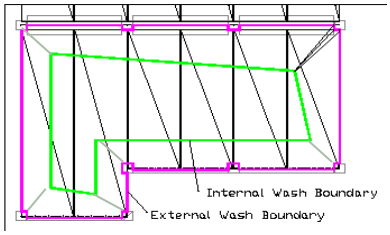
Whereas a topping will only have an external perimeter, a wash will commonly be a strip along the

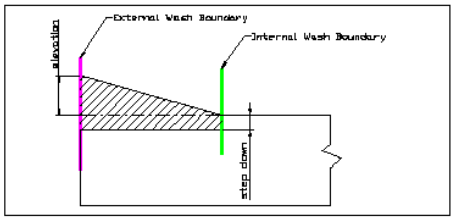
perimeter of a floor deck field.



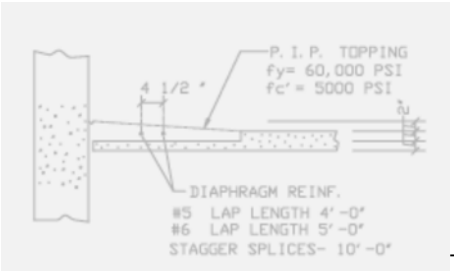


Pouring a concrete topping on a precast slab





Wash perimeter and cross section definitions



Typical wash detail with reinforcing information

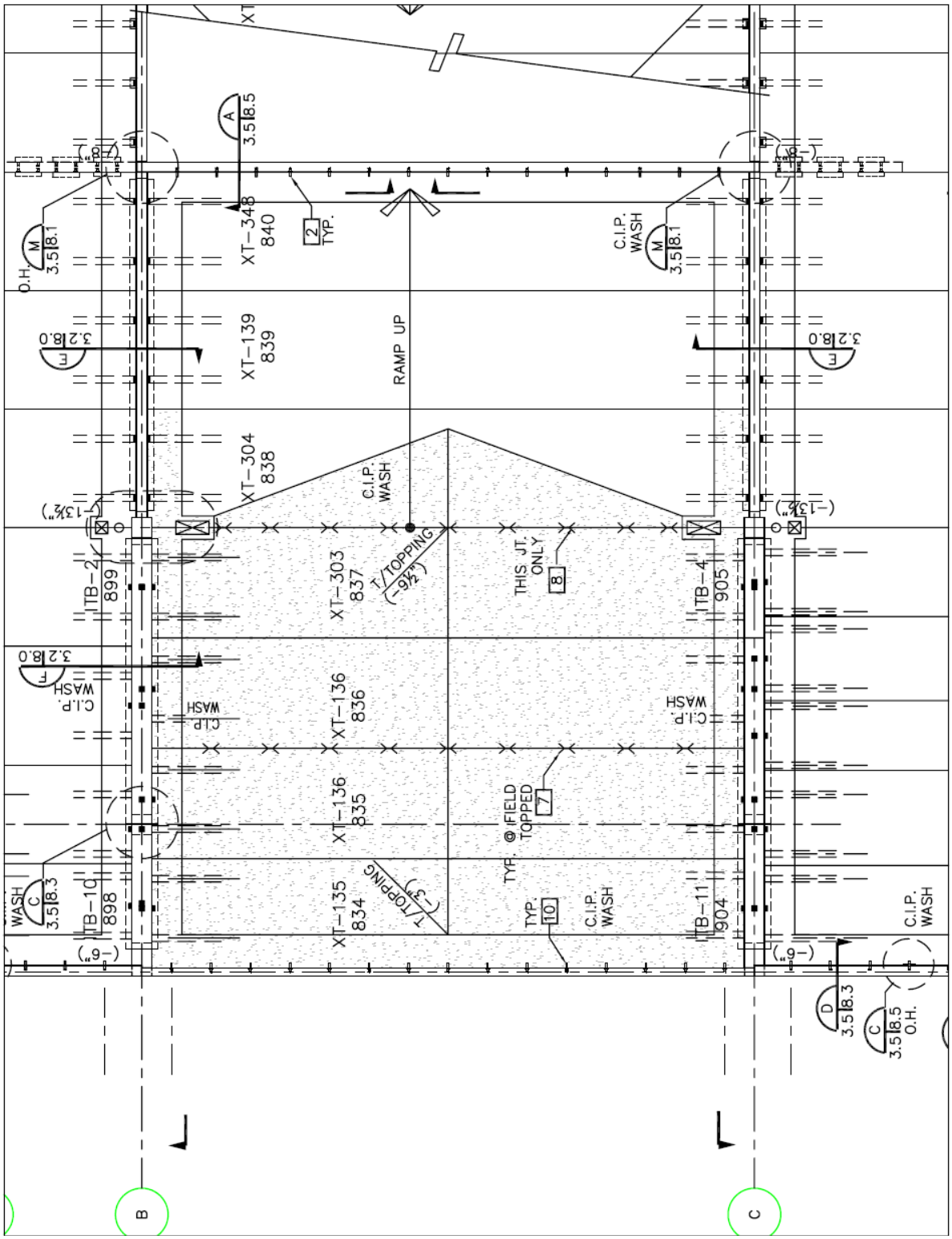
See next page for example topping and wash drawing

Implementation agreements

IfcCovering

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be 'CIP Topping' or 'CIP Wash'
ObjectPlacement	Object placement may be absolute or relative, as defined in the appropriate concepts.

Representation	This is the geometry of the topping or wash, defined explicitly (not parametrically). The representation must be a face based surface model.
Tag	<Open>
Predefined Type	Must be 'USERDEFINED'.



Example Topping Drawing. This example shows a cast-in-place concrete topping at the bottom of a parking deck ramp. A wash is also shown, on either side of the ramp (left of axis B and right of axis C). The wash extends 3' from the axis (drawing reproduced from PCSC Technical Spec, 2003. Original provided by Shockey Precast Inc.)

Example Part 21 Excerpt for Topping

Component hollow-core parts

```
#341= IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,.NOTDEFINED.);
#423= IFCBEAM('1A0gmi0000yZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#410,#419,'TS_2628');
#462= IFCBEAM('1A0gmi0000xZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#449,#458,'TS_2624');
#501= IFCBEAM('1A0gmi0000wZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#488,#497,'TS_2620');
#540= IFCBEAM('1A0gmi0000vZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#527,#536,'TS_2616');
#579= IFCBEAM('1A0gmi0000uZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#566,#575,'TS_2612');
#1454= IFCBEAM('1A0gmi0000A34oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1441,#1450,'TS_2122');
#1493= IFCBEAM('1A0gmi0000934oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1480,#1489,'TS_2118');
#1532= IFCBEAM('1A0gmi0000834oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1519,#1528,'TS_2114');
#1571= IFCBEAM('1A0gmi0000734oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1558,#1567,'TS_2108');
```

Precast slab

```
#3406=IFCSLABELEMENTEDCASE('34sdfsdfDVSASDF4545',#20,'SLAB 5','Fifth Floor Slab','Precast
        Slab',#2050,#2560,$,'USERDEFINED')
```

Relationship

```
#3500=
IFCRELAGGREGATES('3QM6ooNoz02vFwZd5JedV9',#20,$,$,#2069,(#1571,#1532,#1493,#1454,#579,#540,#501,#462,#423,#341));
```

Topping

```
#4000=IFCCOVERING('45sdfsdfDVSASDF4545',#20,'SLAB 5 Topping','Fifth floor slab topping','CIP
        Topping',#2050,#2560,$,'USERDEFINED');
```

Covering Relationship

```
#4500=
IFCRELCOVERSBLDGELEMENTS('4QM6ooNoz02vFwZd5JedV9',#20,$,$,#3406,(#4000));
```

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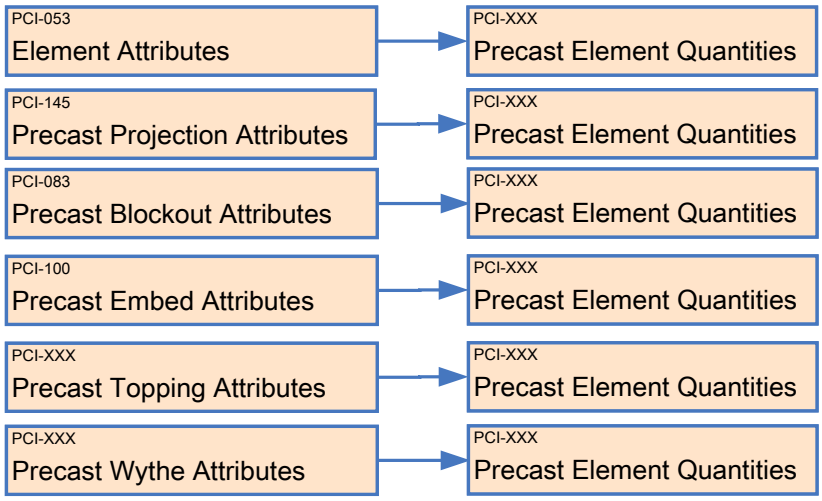
IFC Release Specific Concept Description (IFC 2x4**)**

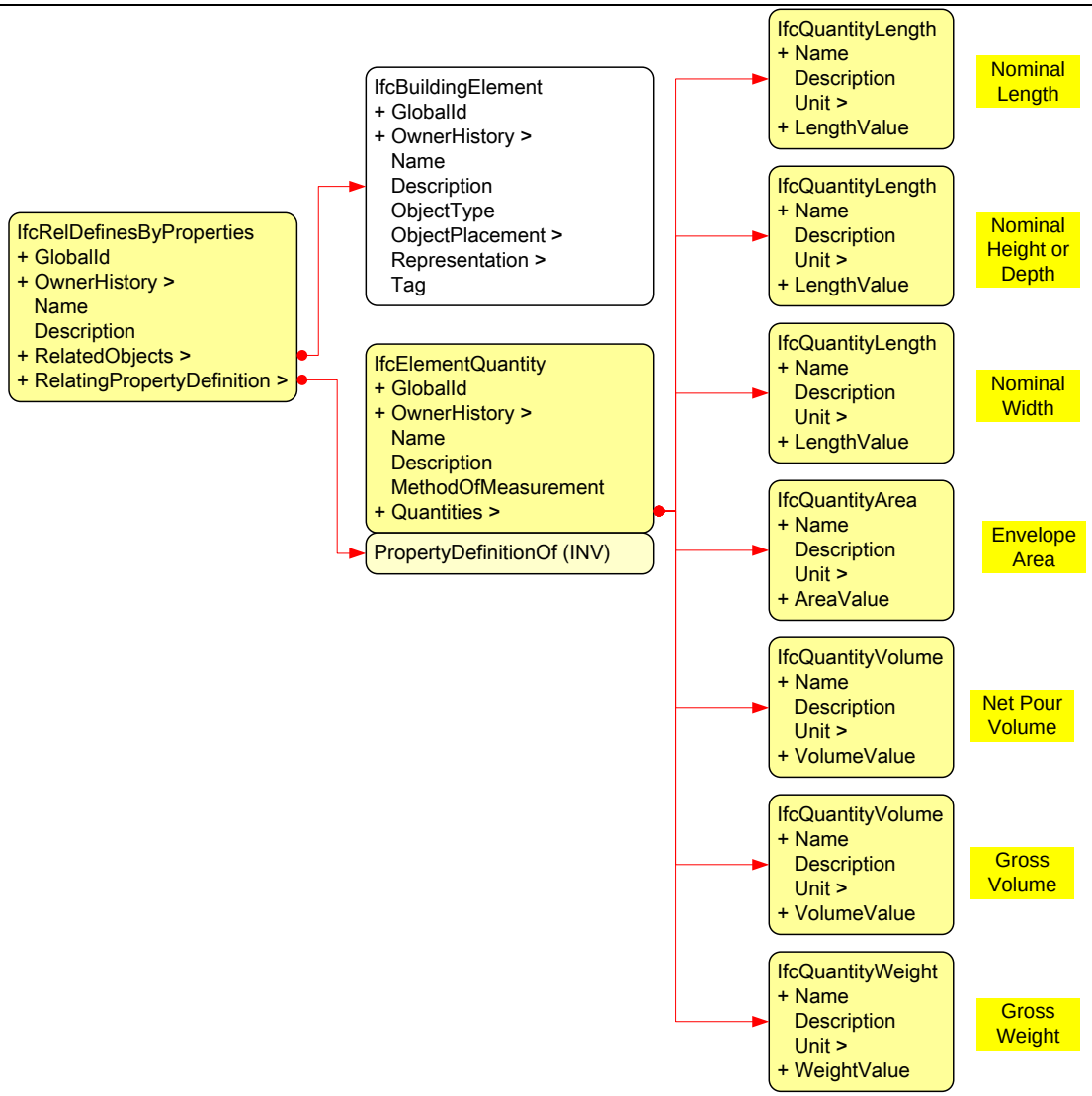
Precast Element Quantities

Reference	PCI-155	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 4-Oct-09; reviewed November 21, 2012				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelDefinesByProperties

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	'Precast Element Quantities'
Description	<Open>
RelatedObjects	A precast building element (or multiple elements if they are identical) (see Element Attributes concept, PCI-053). Can also refer to a blockout(s) (see PCI-083), a projection(s) (see PCI-145), an embed(s) (see PCI-100), a topping(s) (see PCI-154) or a wythe(s) (see PCI-164).

Relating PropertyDefinition	One instance of an IfcElementQuantity

IfcElementQuantity

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	'Precast Element Quantities'
Description	<Open>
MethodOfMeasurement	<Open>
Quantities	Must be a set of quantities as defined in the table below

Ifc Object	Name	Description	Value type
IfcQuantityLength	Nominal Length	Overall bounding box length	IfcLengthMeasure
IfcQuantityLength	Nominal Height or Depth	Overall bounding box height or depth	IfcLengthMeasure
IfcQuantityLength	Nominal Width	Overall bounding box width	IfcLengthMeasure
IfcQuantityArea	Envelope Area	Total area of all surfaces	IfcAreaMeasure
IfcQuantityVolume	Net Pour Volume (for concrete pieces) or Net Volume for embeds or blockouts	Concrete volume or Net Volume	IfcVolumeMeasure
IfcQuantityVolume	Gross Volume	Total volume including voids	IfcVolumeMeasure
IfcQuantityWeight	Gross Weight	Gross shipping weight	IfcMassMeasure

Example Part 21 Excerpt for Beam Element Quantities

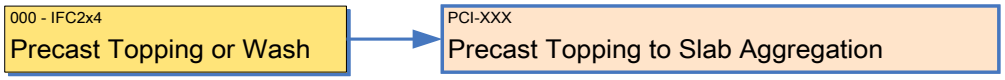
```
#301= IFCQUANTITYLENGTH('Nominal Length','Hollow-core cut length','MM',6000.0);
#302= IFCQUANTITYLENGTH ('Nominal Height or Depth'.'Hollow-core depth','MM',200.0);
#303= IFCQUANTITYLENGTH ('Nominal Width','Hollow-core nominal width','MM',1200.0);
#304= IFCQUANTITYAREA('Envelope Area','Total outside area','M2',16.6);
#305= IFCQUANTITYVOLUME('Net Pour Volume','Hollow-core concrete volume','M3',0.76);
#306= IFCQUANTITYVOLUME('Gross Volume','Hollow-core nominal volume','M3',1.44);
#307= IFCQUANTITYWEIGHT('Gross Weight','Hollow-core weight','T',1.56);

#310=IFCELEMENTQUANTITY(''1A0gmi0000vZ4oD34sE3ao',#20, 'Precast Element
Quantities',$,$,(#301,#302,#303,#304,#305,#306,#307));

#341= IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'SLAB_PART','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');

#360=IFCRELDEFINESBYPROPERTIES('1A0gmi0000vZ4oD34sE3ae',#20, 'Precast Element Quantities',$,(#341),#310);
```

IFC Release Specific Concept Description (IFC 2x4**)**

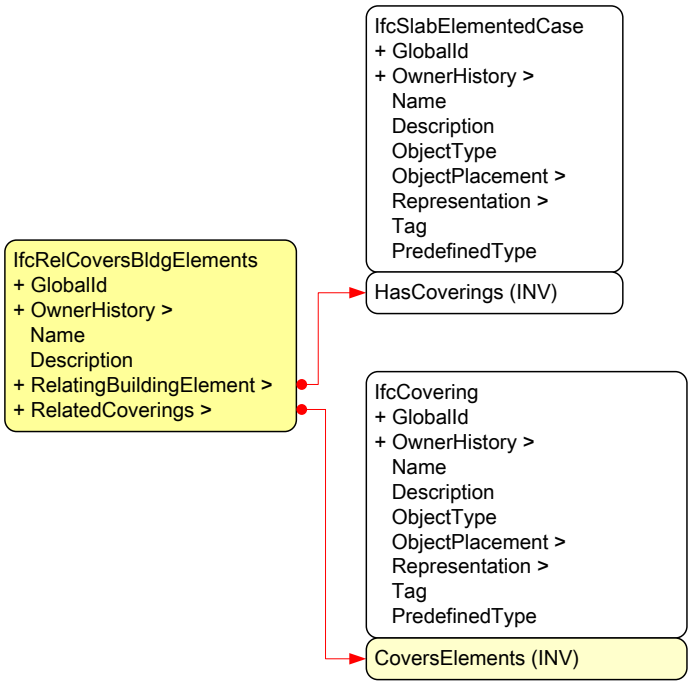
Precast Topping to Slab Aggregation

Reference	PCI-156	**Version**	1.1	**Status**	Draft
Relationships					
History	v.1.0 4-Oct-09				
Authors	Rafael Sacks				
Document Owner	GA Tech and Technion Precast NBIMS team				

Usage in view definition diagram



Instantiation diagram



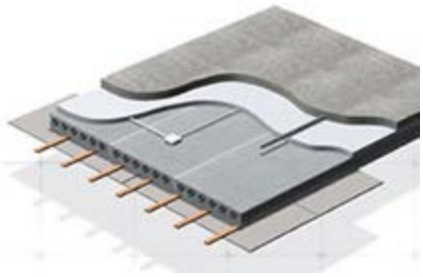
Definitions

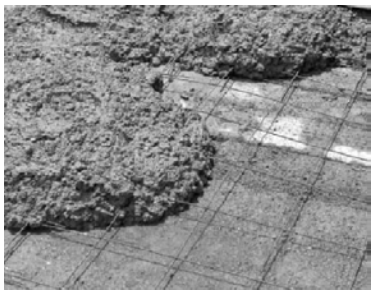
A **topping** is a cast-in-place concrete addition to a precast floor deck. It may be of uniform depth throughout, but may also be sloped to accommodate drainage requirements. It is typically from 1" and 2" deep, although it may be thicker than 2" at some points, and is most often reinforced with welded wire mesh. Precast components over which a topping is to be poured will usually have a rough finish on their top surfaces to enhance bonding with the fresh concrete when it is poured on site.

A **wash** (or **swale**) is an addition to a precast concrete floor deck. It may be poured

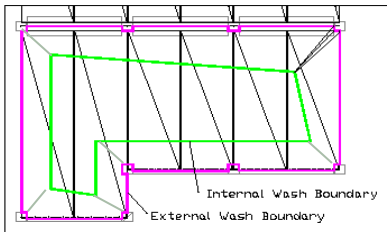
- integrally with each piece comprising the deck,
- on site.

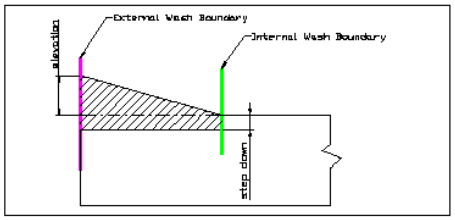
Whereas a topping will only have an external perimeter, a wash will commonly be a strip along the perimeter of a floor deck field.



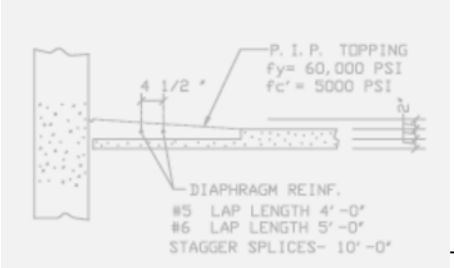


Pouring a concrete topping on a precast slab





Wash perimeter and cross section definitions



Typical wash detail with reinforcing information

See next page for example topping and wash drawing

Implementation agreements

IfcRelCoversBldgElements

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingBuildingElement	Must be an instance of IfcSlabElementedCase
RelatedCoverings	Must be an instance(s) of IfcCovering

Example Part 21 Excerpt for Topping

Component hollow-core parts

```
#341= IFCBEAM('1A0gmi0002rZ4oD34sE3au',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#99,#337,'TS_4201');
#360= IFCBEAMTYPE('1DdPlCcG176gSKQFDke08o',#20,'P32K(200X1200)',$,$,$,$,$,.NOTDEFINED.);
#423= IFCBEAM('1A0gmi0000yZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#410,#419,'TS_2628');
#462= IFCBEAM('1A0gmi0000xZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#449,#458,'TS_2624');
#501= IFCBEAM('1A0gmi0000wZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#488,#497,'TS_2620');
#540= IFCBEAM('1A0gmi0000vZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#527,#536,'TS_2616');
#579= IFCBEAM('1A0gmi0000uZ4oD34sE3ao',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#566,#575,'TS_2612');
#1454= IFCBEAM('1A0gmi0000A34oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1441,#1450,'TS_2122');
#1493= IFCBEAM('1A0gmi0000934oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1480,#1489,'TS_2118');
#1532= IFCBEAM('1A0gmi0000834oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1519,#1528,'TS_2114');
#1571= IFCBEAM('1A0gmi0000734oD34sE3an',#20,'PRECAST_SLAB','P32K(200X1200)','P32K(200X1200)',#1558,#1567,'TS_2108');
```

Precast slab

```
#3406=IFCSLABELEMENTEDCASE('34sdfsdfDVSASDF4545',#20,'SLAB 5','Fifth Floor Slab','Precast
        Slab',#2050,#2560,$,'USERDEFINED')
```

Relationship

```
#3500=
IFCRELAGGREGATES('3QM6ooNoz02vFwZd5JedV9',#20,$,$,#2069,(#1571,#1532,#1493,#1454,#579,#540,#501,#462,#423,#341));
```

Topping

```
#4000=IFCCOVERING('45sdfsdfDVSASDF4545',#20,'SLAB 5 Topping','Fifth floor slab topping','CIP
        Topping',#2050,#2560,$,'USERDEFINED');
```

Covering Relationship

```
#4500=
IFCRELCOVERSBLDGELEMENTS('4QM6ooNoz02vFwZd5JedV9',#20,$,$,#3406,(#4000));
```

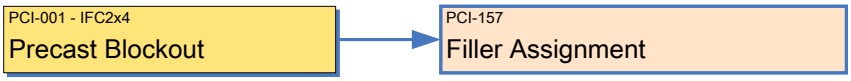
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)

IFC Release Specific Concept Description (IFC 2x3**)**

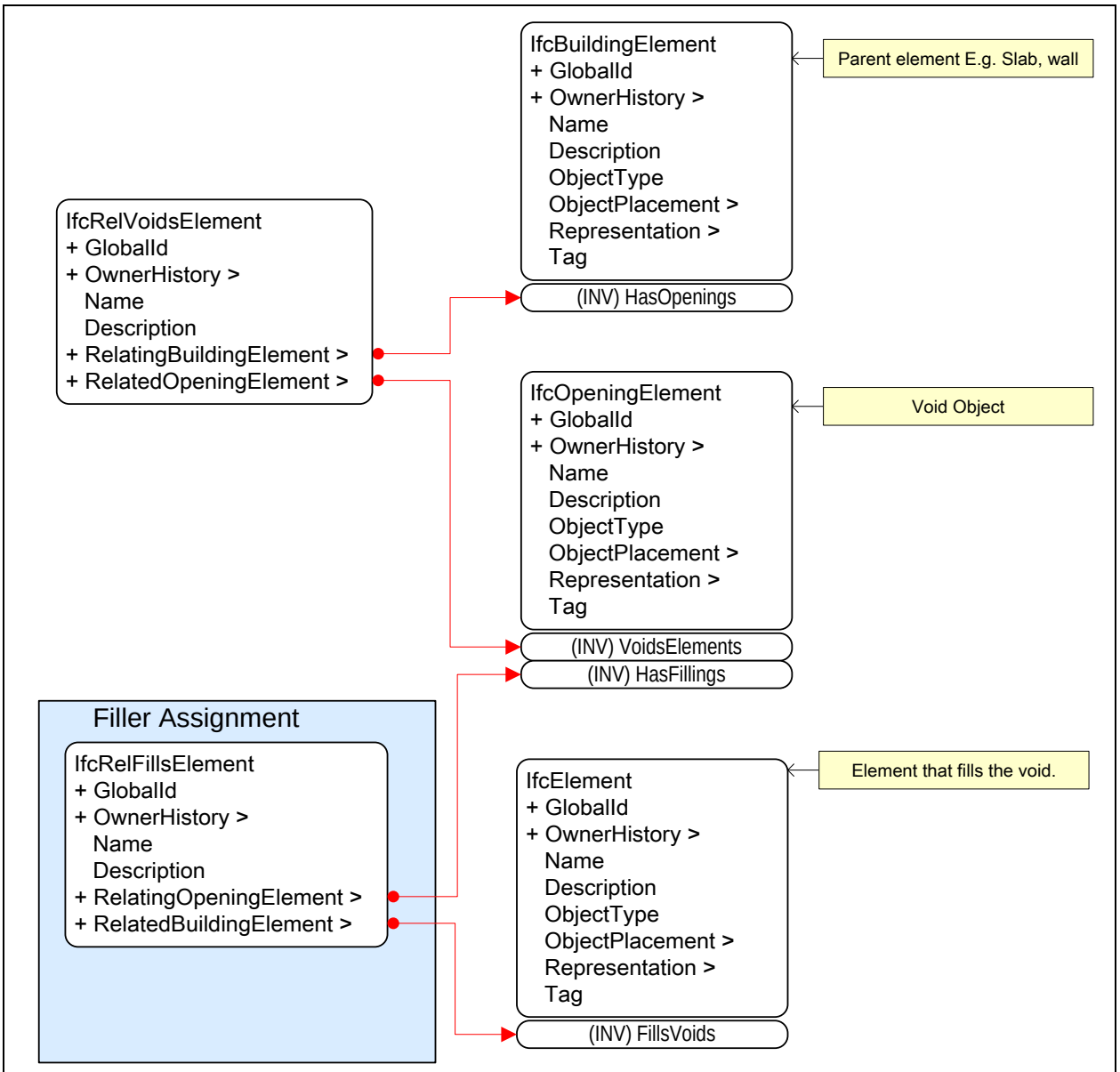
Filler Assignment

Reference	PCI-157	**Version**	1.1	**Status**	Draft
Relationships	Assigns the element to an opening and to the parent building element.				
History	Created 28-Oct-09				
Authors	Manu Venugopal				
Document Owner	Precast/Prestressed Concrete Institute (manu.menon@gatech.edu)				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcRelFillsElement

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingOpeningElement	Inversely related to the Void Object (IfcOpeningElement) through HasFillings.

RelatedBuildingElement	Inversely related to the filling element (IfcElement) through FillsVoids.

IfcElement

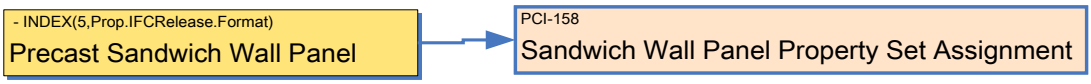
Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Must be provided.
ObjectPlacement	Inversely related to the concept Relative Placement through PlacesObject.
Representation	Inversely related to IfcProductDefinitionShape through ShapeOfProduct.
Tag	<Open>

IFC Release Specific Concept Description (<IFC Release 2x3>)

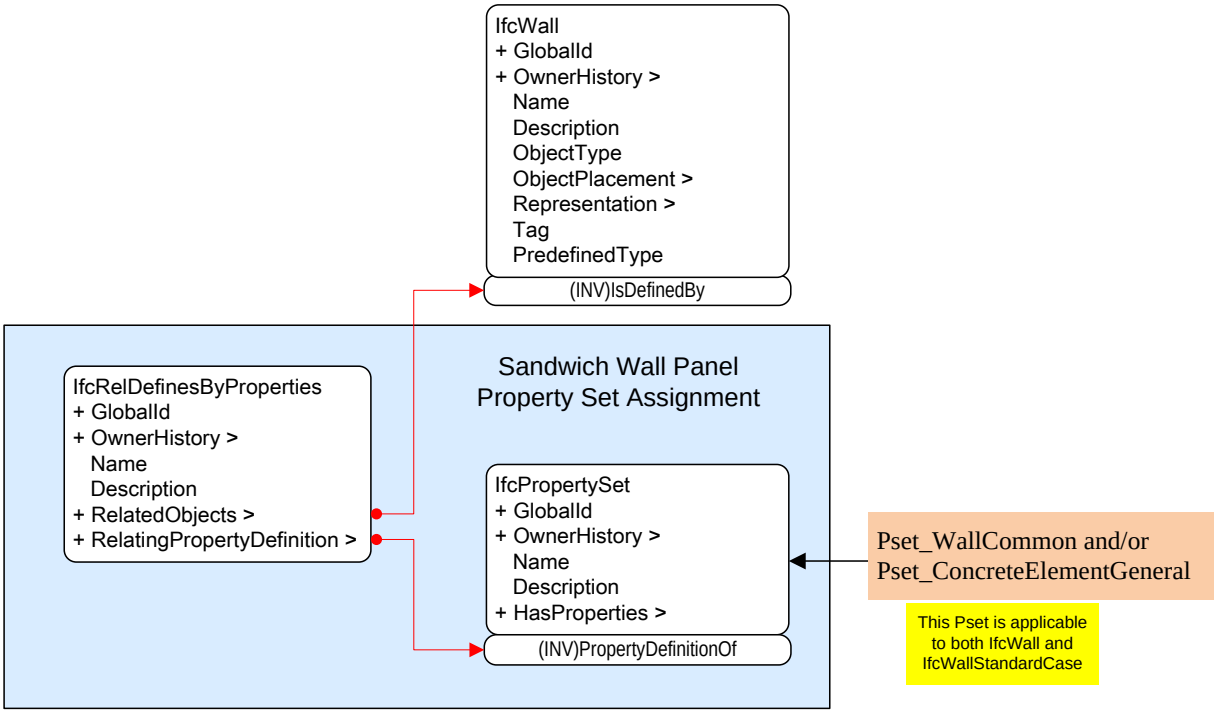
Precast Sandwich Wall Property Set Assignment

Reference	PCI-158	Version	1.1	Status	Draft
Relationships	Defines different properties of precast concrete sandwich wall panels like fire rating, thermal transmittance, acoustic rating, being used as internal or external wall and so on.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram:



Implementation agreements:

IfcRelDefinesByProperties

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data

Name	<Open>
Description	<Open>
RelatedObjects	Must be a subtype of IfcWall.
RelatingPropertyDefinition	A property set which is assigned to the sandwich wall panel.

IfcPropertySet

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	String " Pset_WallCommon" or Pset_ConcreteElementGeneral.
Description	<Open>
HasProperties	Contained set of properties including Pset_WallCommon and Pset_ConcreteElementGeneral.

URL Link for Pset_WallCommon:

http://www.iai-tech.org/ifc/IFC2x4/alpha/html/psd/IfcSharedBldgElements/Pset_WallCommon.xml

URL Link for Pset_ConcreteElementGeneral:

http://www.iai-tech.org/ifc/IFC2x4/alpha/html/psd/IfcStructuralElementsDomain/Pset_ConcreteElementGeneral.xml

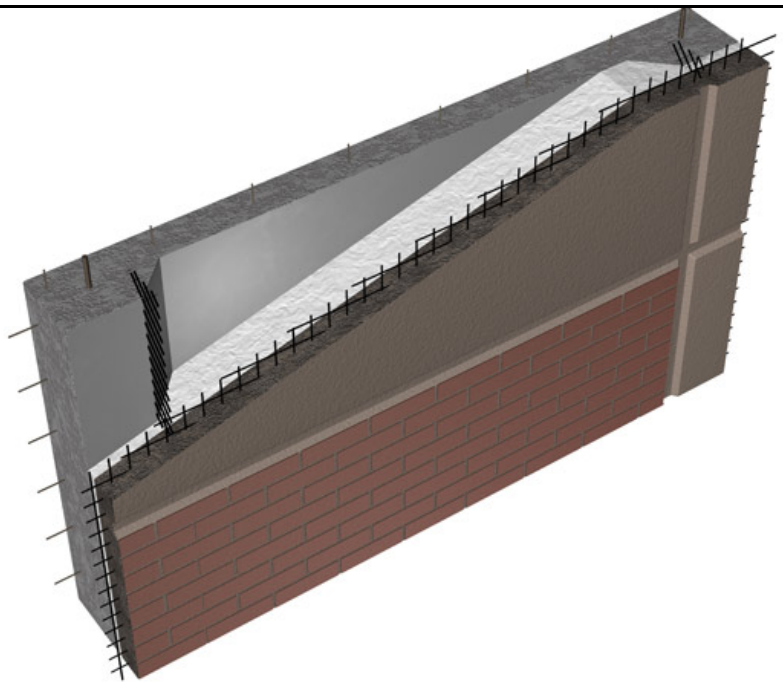
The following properties from **Pset_WallCommon** are mandatory:

- IsExt: Two possible values of "TRUE" for exterior walls and "FALSE" for interior walls.
- LoadBearing: Two possible values of "TRUE" when it is load bearing and "FALSE" when it is non-load bearing.

The following property from **Pset_ConcreteElementGeneral** is mandatory:

- ConstructionType: Must have the value "Precast".

.



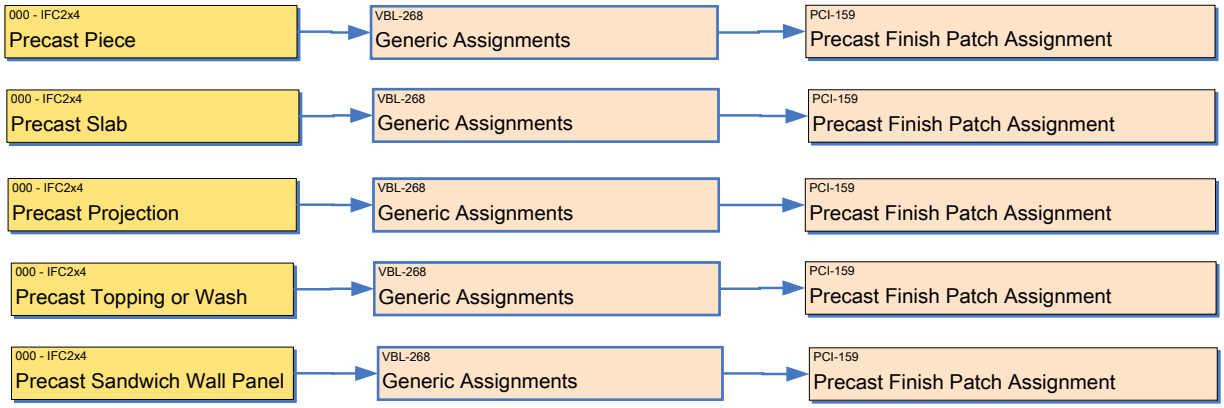
Perspective of a precast concrete sandwich wall panel. The sandwich wall's components including two precast concrete wythes, an insulation layer, reinforcing meshes, and its surface treatment are shown.

IFC Release Specific Concept Description (<IFC Release 2x3>)

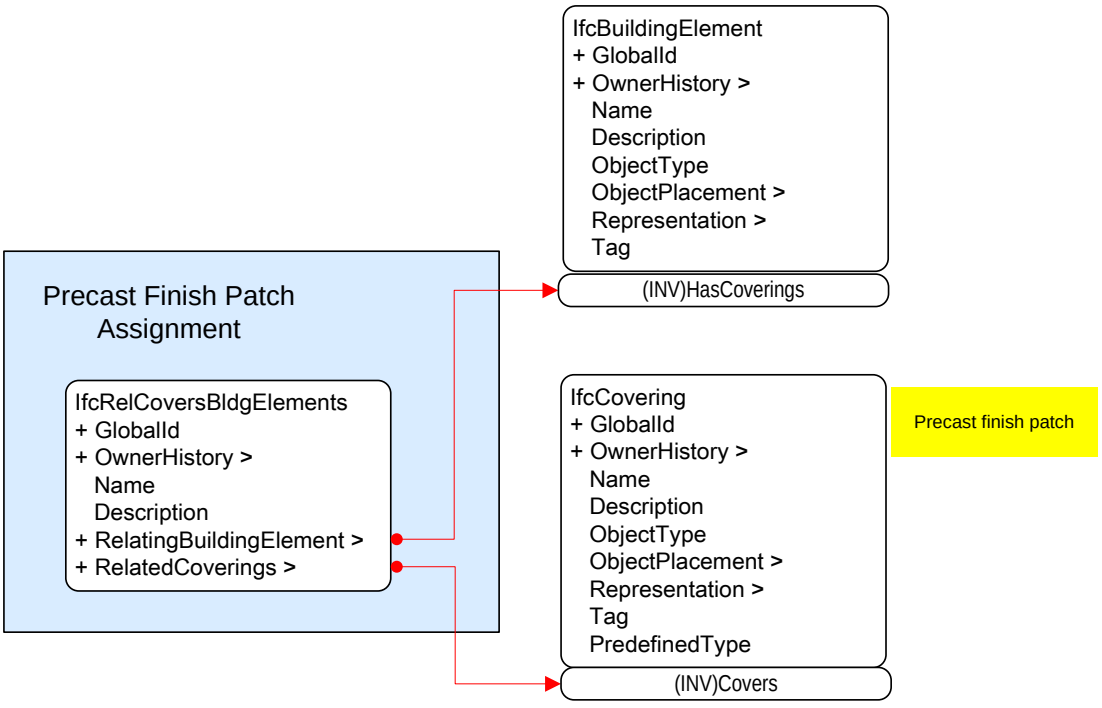
Precast Finish Patch Assignment

Reference	PCI-159	**Version**	1.1	**Status**	Draft
Relationships	This concept assigns the finish patch to the precast sandwich wall panel. A patch defines the placement, shape and area of each surface treatment type, used on precast concrete elements.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



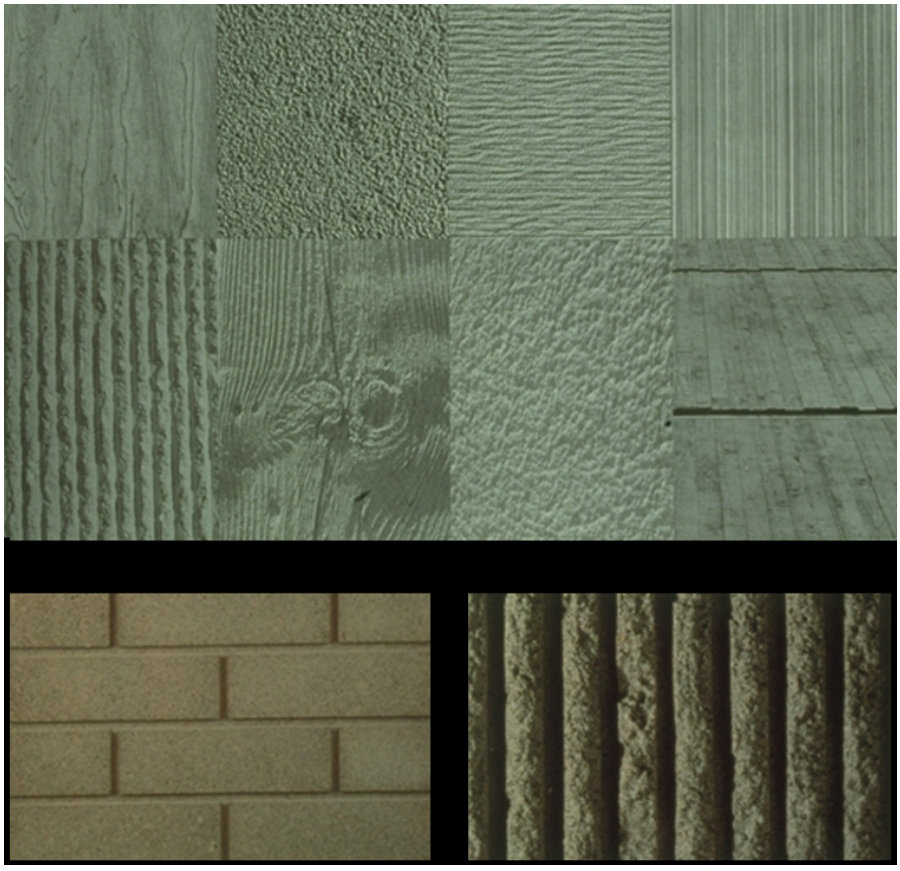
Instantiation diagram:



Implementation agreements:

IfcRelCoversBldgElements

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingBuildingElement	Must be subtype of IfcWall.
RelatedCoverings	Must be IfcCovering.



Patches with different surface treatment types and/or textures are shown on the precast concrete sandwich walls in the picture above.

Part 21 Example:

```
#151=IFCWALLSTANDARDCASE('34MYN1USRBAP8H0MGNBZLX',#42,'BASIC
WALL:GENERIC - 8":146541',$,'BASIC WALL:GENERIC - 8":249',#133,#150,'146541');
```

```
#300=IFCCOVERING
('14MYN1USRBAP8H0MGNBZLX',#43,'PRECASTFINISHPATCH',$,'FINISHPATCH',#1
40,#160,$,'146545');
#305=IFCRELCOVERSBUILDINGELEMENT
('54MYN1USRBAP8H0MGNBZLX',#42,'PRECASTFINISHPATCHASSIGNMENT',$,
#151,#300);
```

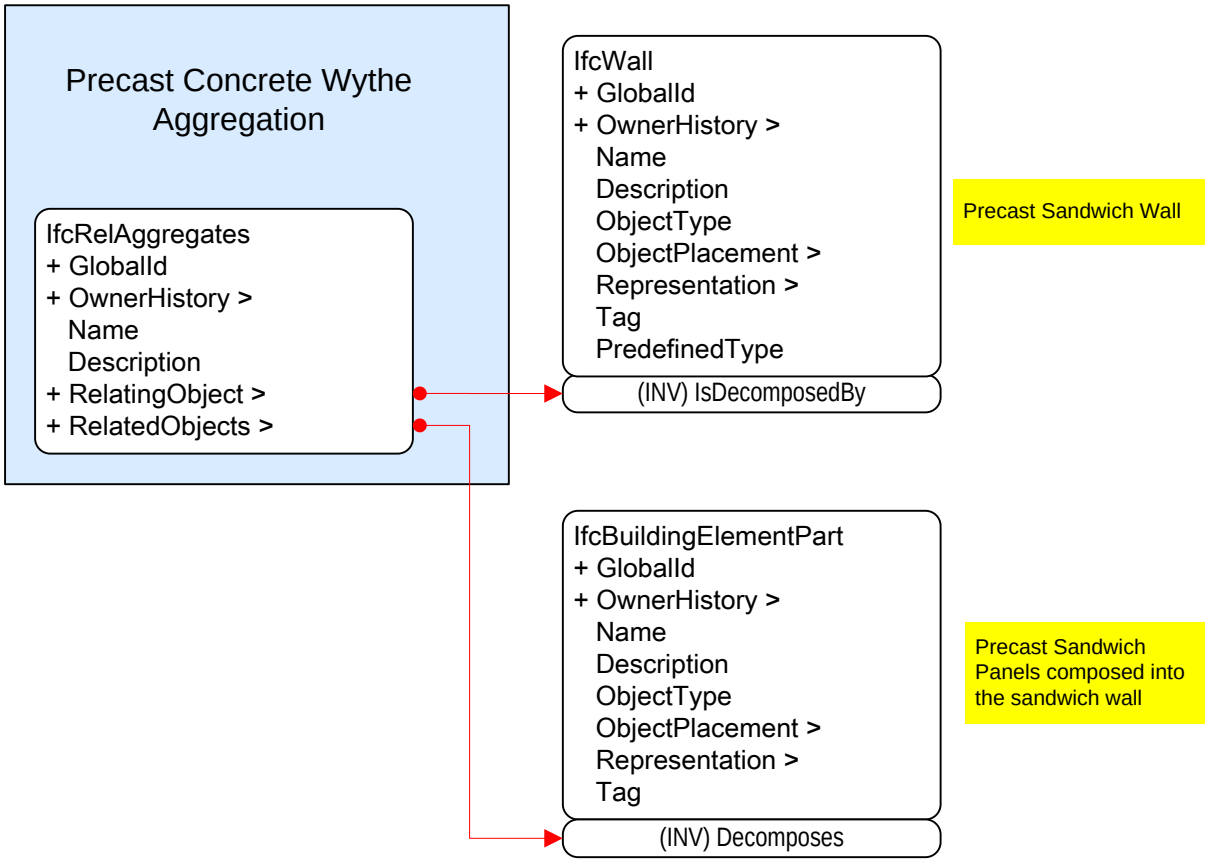
IFC Release Specific Concept Description (<IFC Release 2x3>)

Precast Concrete Wythe Aggregation

Reference	PCI-160	**Version**	1.1	**Status**	Draft
Relationships	Aggregates wythes within a precast sandwich wall panel.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram

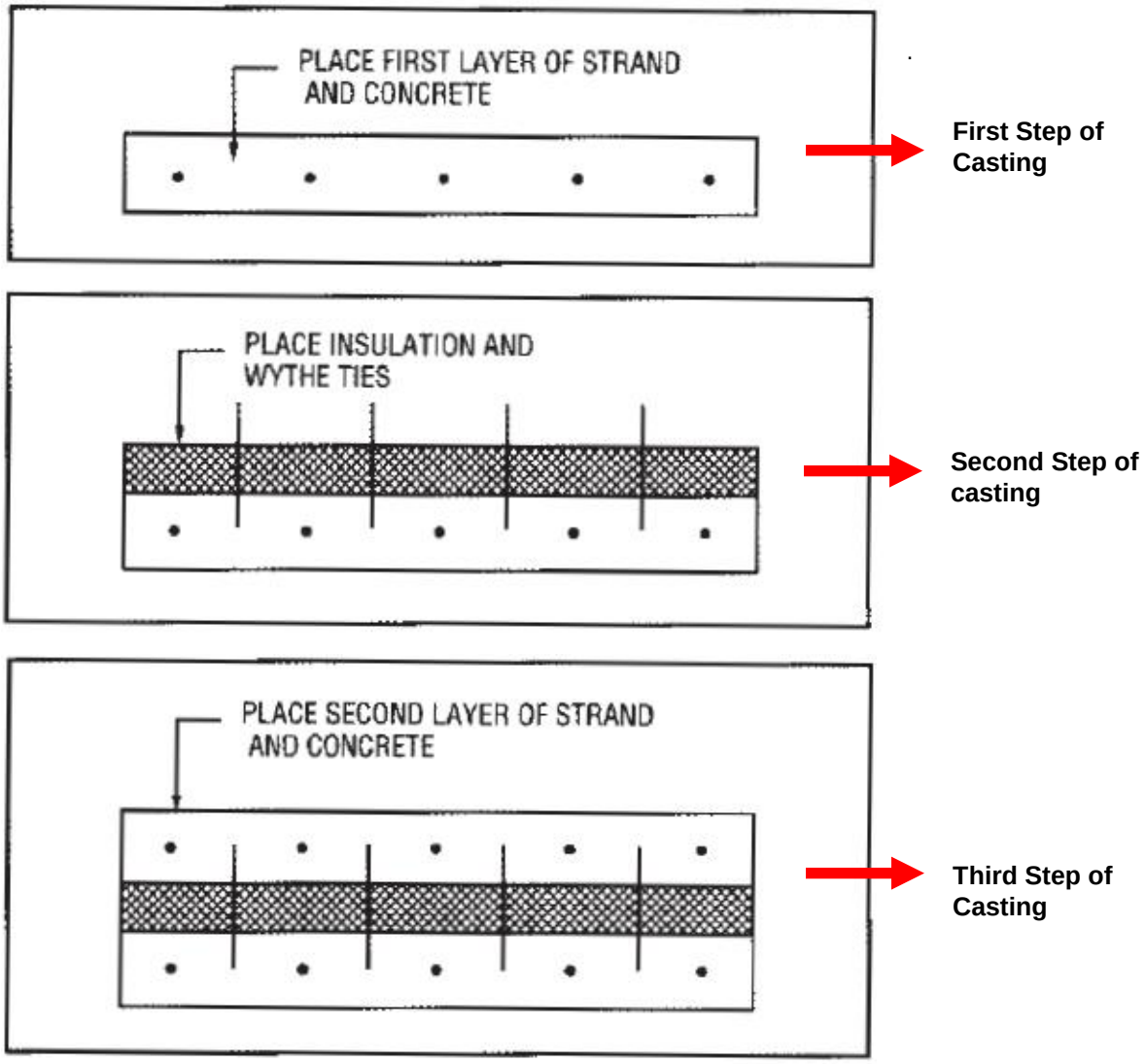


Implementation agreements:

IfcRelAggregates

Attribute	Implementation agreements
GlobalId	Must be provided

OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	Must be subtype of IfcWall.
RelatedObjects	Must be IfcBuildingElementPart.



Steps of aggregating two layers of wythes and the insulation layer.

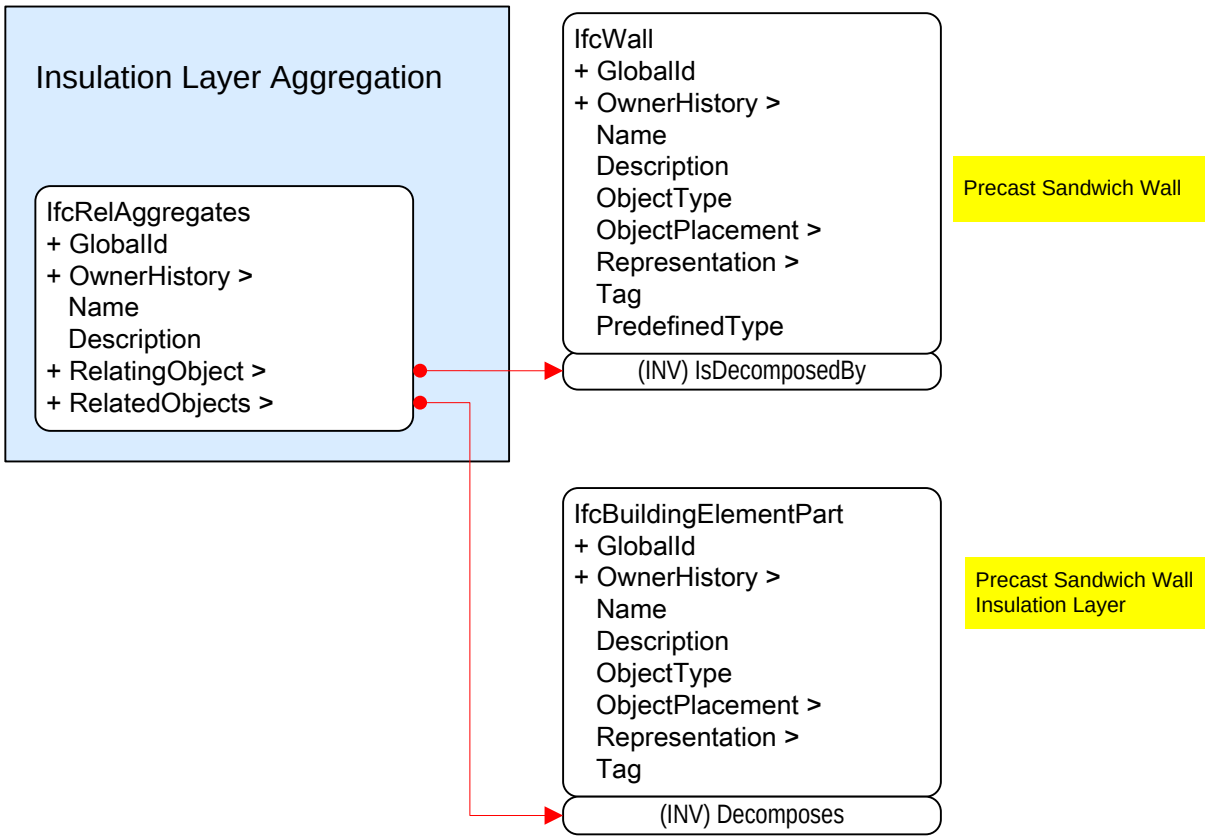
IFC Release Specific Concept Description (<IFC Release 2x3>)

Insulation Layer Aggregation

Reference	PCI-161	**Version**	1.1	**Status**	Draft
Relationships	Aggregates the insulation layer into precast concrete sandwich wall panel. The insulation layer is a cellular insulation which usually comes in one of the two forms of thermoplastic and thermosetting.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram

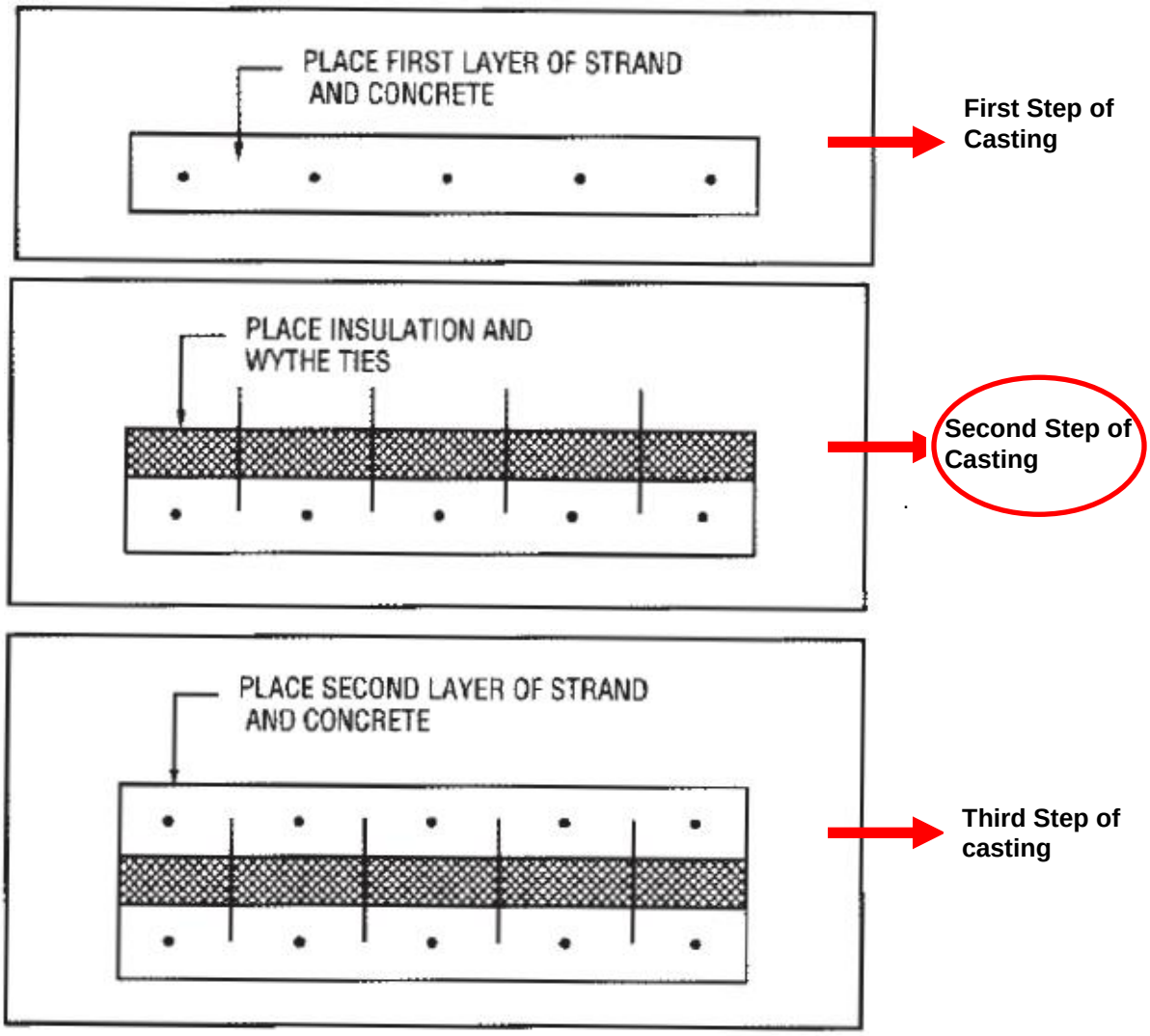


Implementation agreements:

IfcRelAggregates

Attribute	Implementation agreements

GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatingObject	Must be subtype of `IfcWall`.
RelatedObjects	Must be `IfcBuildingElementPart`. This entity refers to precast concrete sandwich wall insulation layer.



Steps of aggregating the insulation layer (second step) and the two concrete wythes.

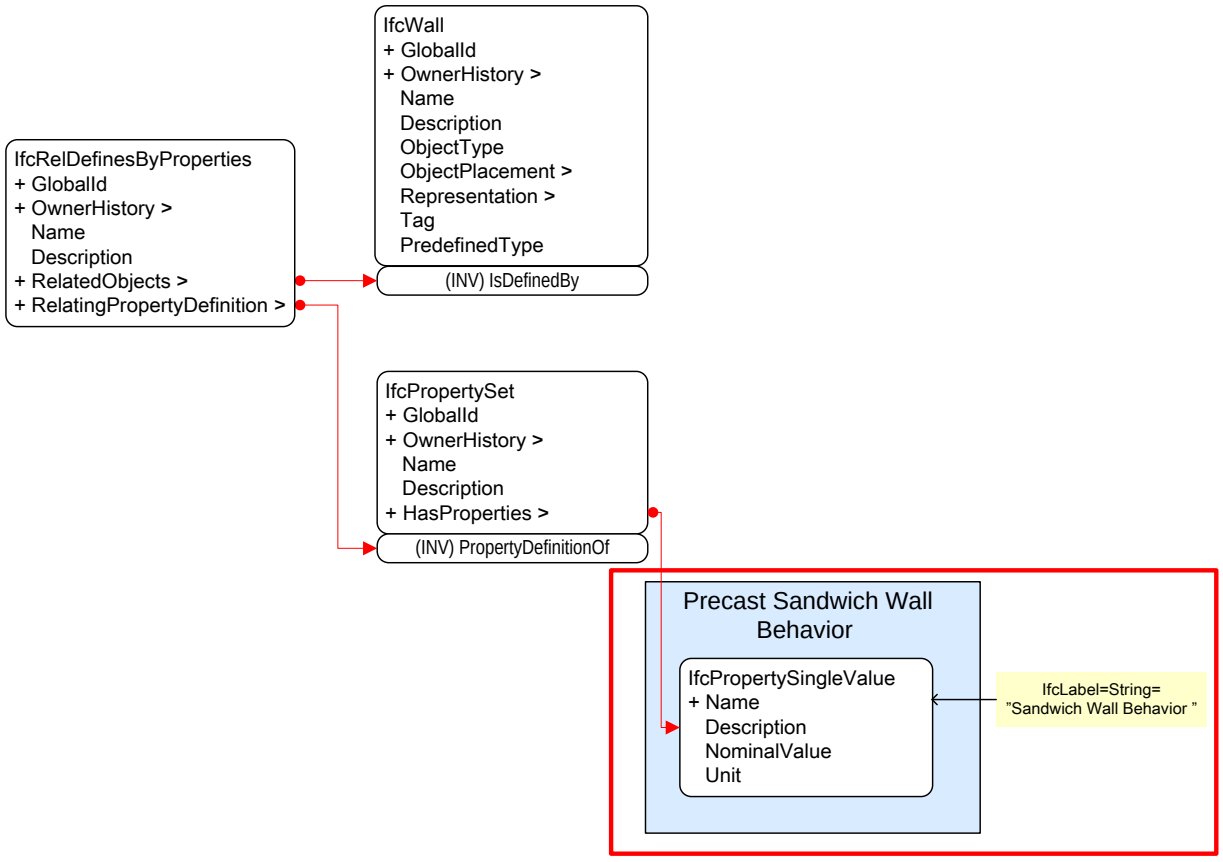
IFC Release Specific Concept Description (<IFC Release 2x3>)

Precast Sandwich Wall Behavior

Reference	PCI-162	**Version**	1.1	**Status**	Draft
Relationships	This concept determines the types of precast sandwich wall in terms of how the wythes are acting. When wythes act independently, the type is non-composite. When they act together to resist loads, the type is composite. And when they act as composite panels during shipping and erection and as non-composite panels for in-place loads, the type is semi-composite.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



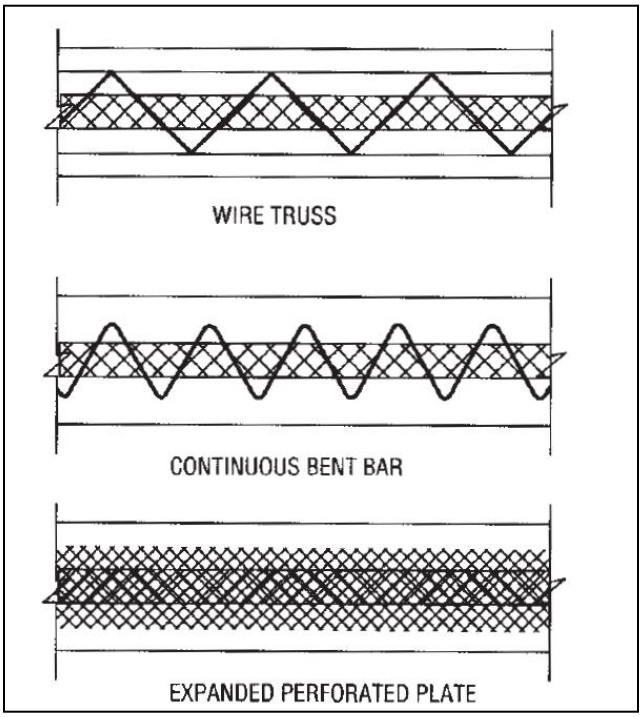
Implementation agreements:

IfcPropertySingleValue

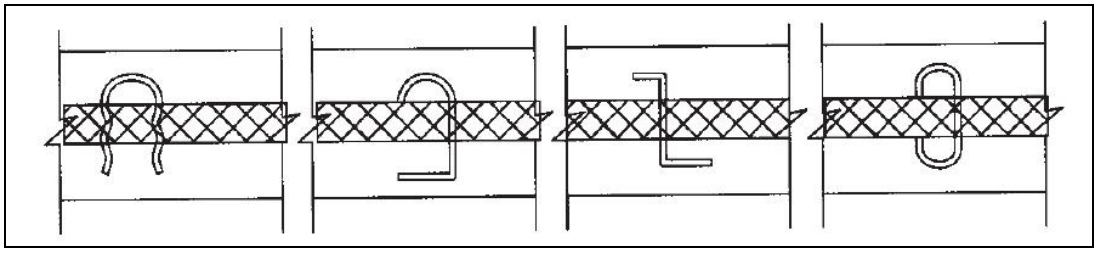
Attribute	Implementation agreements
Name	IfcLabel=String+ “Sandwich Wall Behavior”
Description	<Open>
NominalValue	Must be provided. It should be one of the following three options: “Composite”, Semi-Composite”, And “Non-Composite”.
Unit	Not Used.

.

Examples of different types of precast concrete sandwich walls:



Examples of composite precast concrete sandwich walls. One-way shear connectors in these examples make wythes act together and create the composite wall panels.



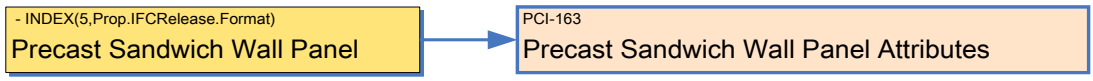
Examples of non-composite precast concrete sandwich walls. Non-shear connectors in these examples usually only resist tension and compression. In composite panels they are used as auxiliary connectors.

IFC Release Specific Concept Description (<IFC Release 2x3>)

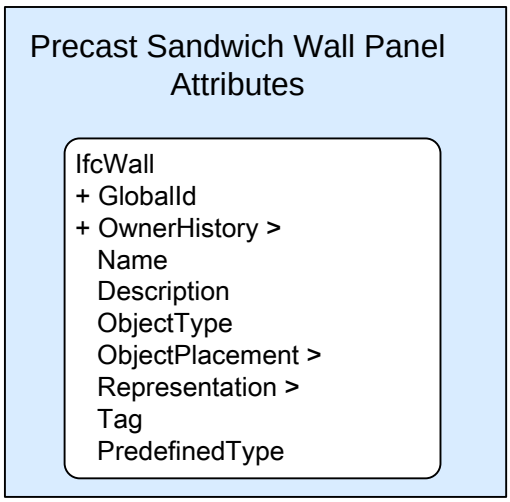
Precast Sandwich Wall Panel Attributes

Reference	PCI-163	**Version**	1.1	**Status**	Draft
Relationships	A precast sandwich wall panel is composed of two concrete wythes separated by an insulation layer. IfcWall is used to define its attributes.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram



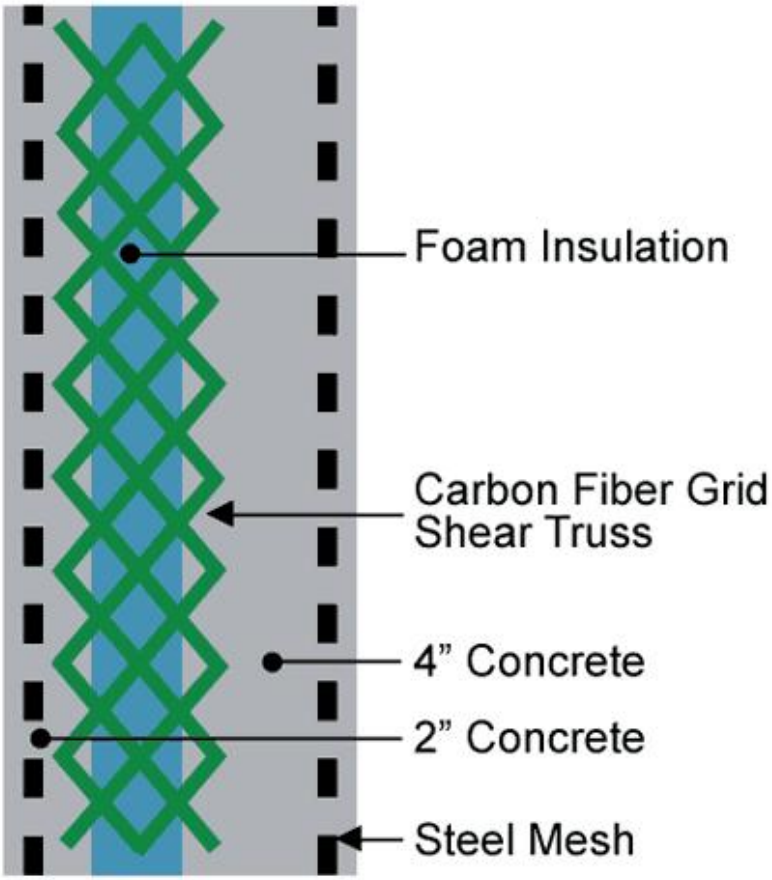
Implementation agreements:

IfcWall

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	The placement of precast sandwich wall can be local placement,absolute placement or placement relative to grid.

Representation	The geometric representation of IfcWall is provided by IfcProductDefinitionShape, allowing different types of representation.
Tag	Should be a unique and company specific label
PredefinedType	<Open>

.



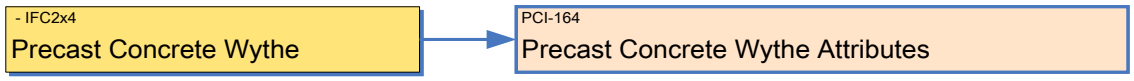
Precast concrete sandwich wall panel cross-section. Two concrete wythes, insulation layer, reinforcement mesh, and shear connectors are shown.

IFC Release Specific Concept Description (<IFC Release 2x3>)

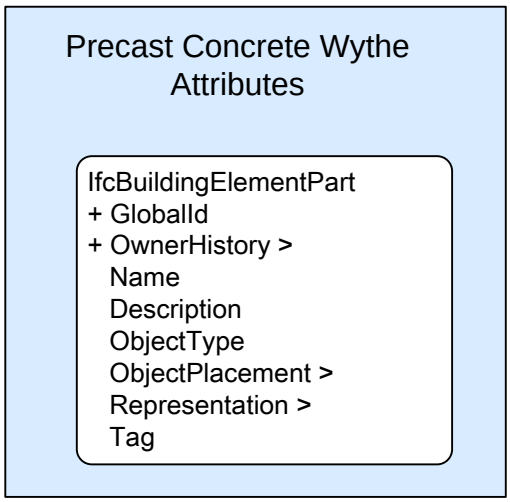
Precast Concrete Wythe Attributes

Reference	PCI-164	**Version**	1.1	**Status**	Draft
Relationships	A concrete wythe is one of the two concrete layers aggregated into a precast concrete sandwich wall. It is defined by IfcBuildingElementPart.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram

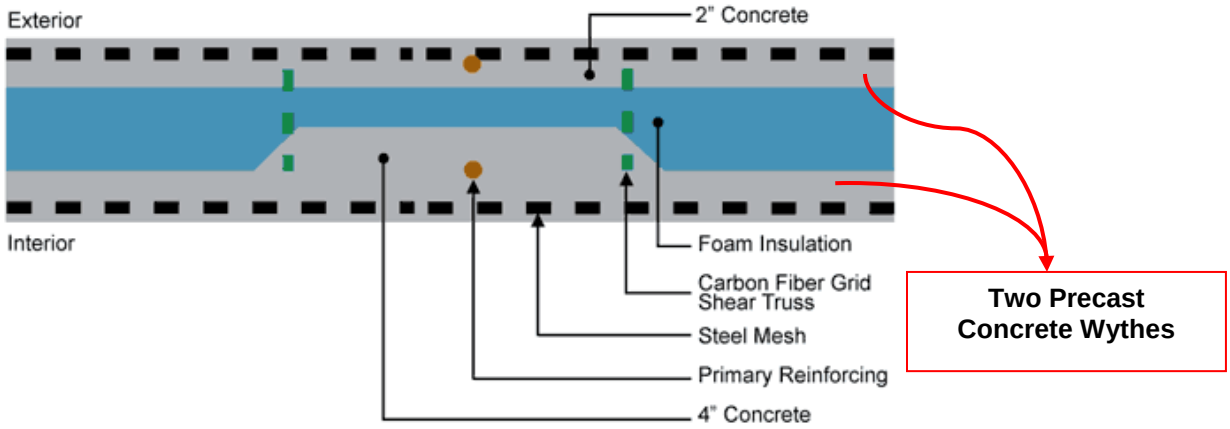


Implementation agreements:

IfcBuildingElementPart

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	Should be “Precast Concrete Wythe”.
ObjectPlacement	The placement of precast concrete wythe can be local placement, absolute placement or placement relative to grid.

Representation	The geometric representation of IfcBuildingElementPart is provided by IfcProductDefinitionShape, allowing different types of representation.
Tag	Should be a unique and company specific label



Wall Panel — Internal Pilaster Detail
Horizontal Section

Precast concrete sandwich wall panel horizontal section. Two concrete wythes, along with other sandwich wall components including insulation layer, reinforcement mesh, and shear connectors are shown.

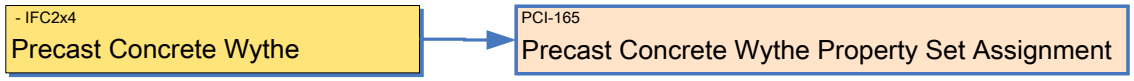
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)
The content of this document has to be certified by the IAI before becoming part of an official IFC Model View Definition.

IFC Release Specific Concept Description (<IFC Release 2x3>)

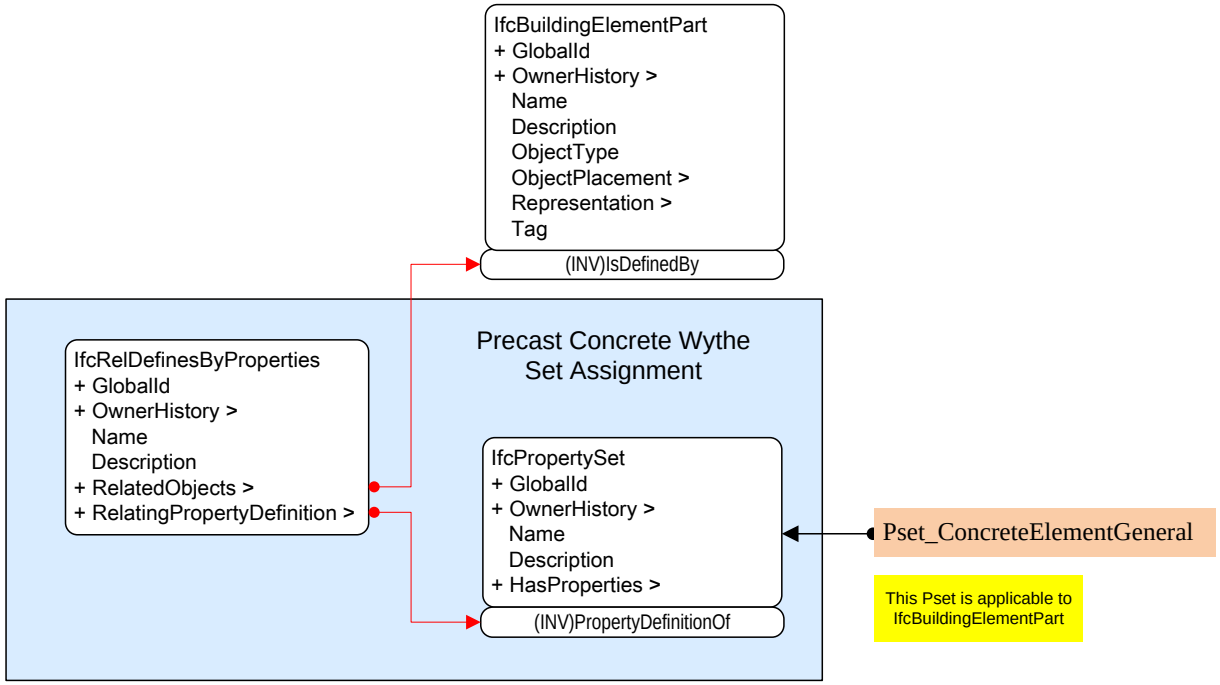
Precast Concrete Wythe Property Set Assignment

Reference	PCI-165	**Version**	1.1	**Status**	Draft
Relationships	Assigns different properties to the concrete wythes used in precast sandwich wall panels.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram:



Implementation agreements:

IfcRelDefinesByProperties

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>

RelatedObjects	Must be a subtype of IfcBuildingElementPart.
RelatingPropertyDefinition	A property set which is assigned to the sandwich wall panel.

IfcPropertySet

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	String= "Pset_ConcreteElementGeneral"
Description	<Open>
HasProperties	Contained set of properties like Pset_ConcreteElementGeneral.

Pset_ConcreteElementGeneral **Property Definitions:**

Name	Property Type	Data Type	Definition
StructuralClass	IfcPropertySingleValue	IfcLabel	The structural class defined for the concrete structure (e.g. '1').
EnvironmentalClass	IfcPropertySingleValue	IfcLabel	The environmental class for the concrete structure (e.g. 'Y1')
FireRating	IfcPropertySingleValue	IfcLabel	Fire rating given according to the national fire safety classification
ServiceLife	IfcPropertySingleValue	IfcTimeMeasure / TIMEUNIT	Expected service life (usually measured in years)
LifeCycleEnvironmentalLoad	IfcPropertySingleValue	IfcText	Description of the life-cycle environmental load
DimensionalAccuracyClass	IfcPropertySingleValue	IfcLabel	Classification designation of the dimensional accuracy requirement according to local standards.
ConstructionToleranceClass	IfcPropertySingleValue	IfcLabel	Classification designation of the on-site construction tolerances according to local standards.
ConstructionType	IfcPropertySingleValue	IfcLabel	Designator for whether the concrete element is constructed on site or prefabricated. Allowed values are: 'Insitu' vs 'Precast'

ConcreteCoverAtMainBars	IfcPropertySingleValue	IfcPositiveLengthMeasure / LENGTHUNIT	The protective concrete cover at the main reinforcing bars according to local building regulations.
ConcreteCoverAtLinks	IfcPropertySingleValue	IfcPositiveLengthMeasure / LENGTHUNIT	The protective concrete cover at the reinforcement links according to local building regulations.

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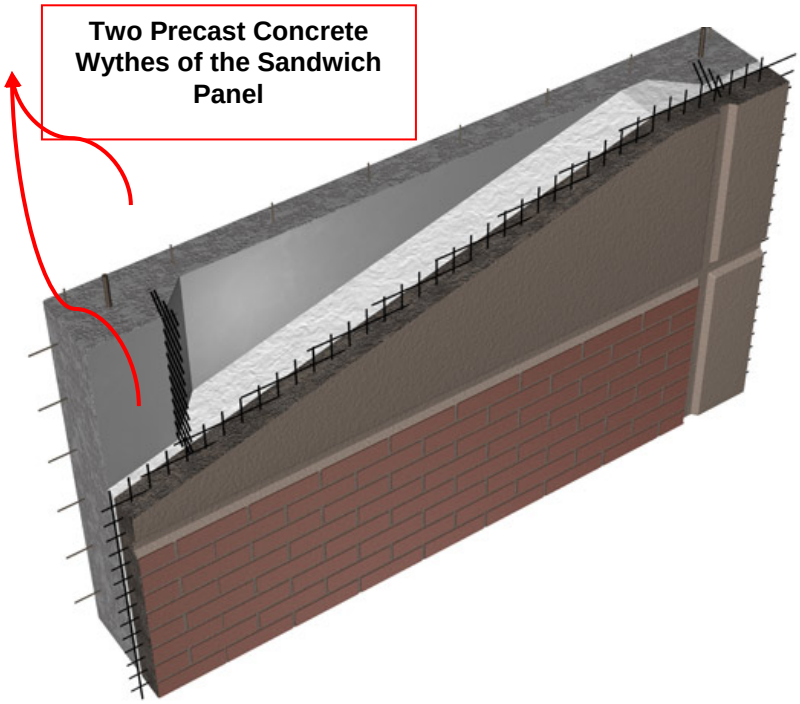
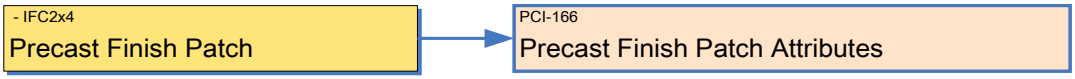
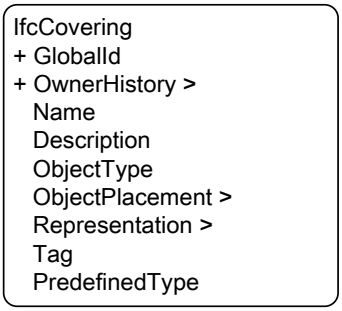


IFC Release Specific Concept Description (IFC2x3**)** Precast Finish Patch Attributes					
Reference	PCI-166	**Version**	1.1	**Status**	Draft
Relationships	Defines the relationship between a precast finish patch and its attributes.				
History	Fall, 2009; reviewed 16 November, 2012				
Authors	Ivan Panushev; Chuck Eastman (chuck.eastman@coa.gatech.edu)				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcCovering

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ObjectType	<Open>
ObjectPlacement	Should be relative to the entity it has been applied to: IfcBuildingElement.
Representation	Optional, if used it should be IfcProductRepresentation.
Tag	The tag should be a unique, and company specific label.
PredefinedType	Optional, if used it should be IfcCoveringTypeEnum.

Part 21 Example:	
#300=IFCCOVERING ('14MYN1USRBAP8H0MGNBZLX',#43,'PRECASTFINISHPATCH',$,'FINISHPATCH',#140,#160,$, '146545');	

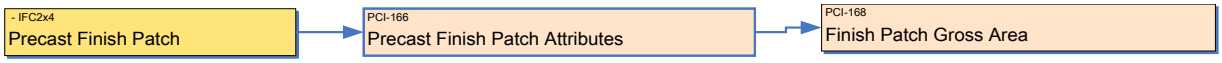
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)

IFC Release Specific Concept Description (<IFC Release 2x3>)

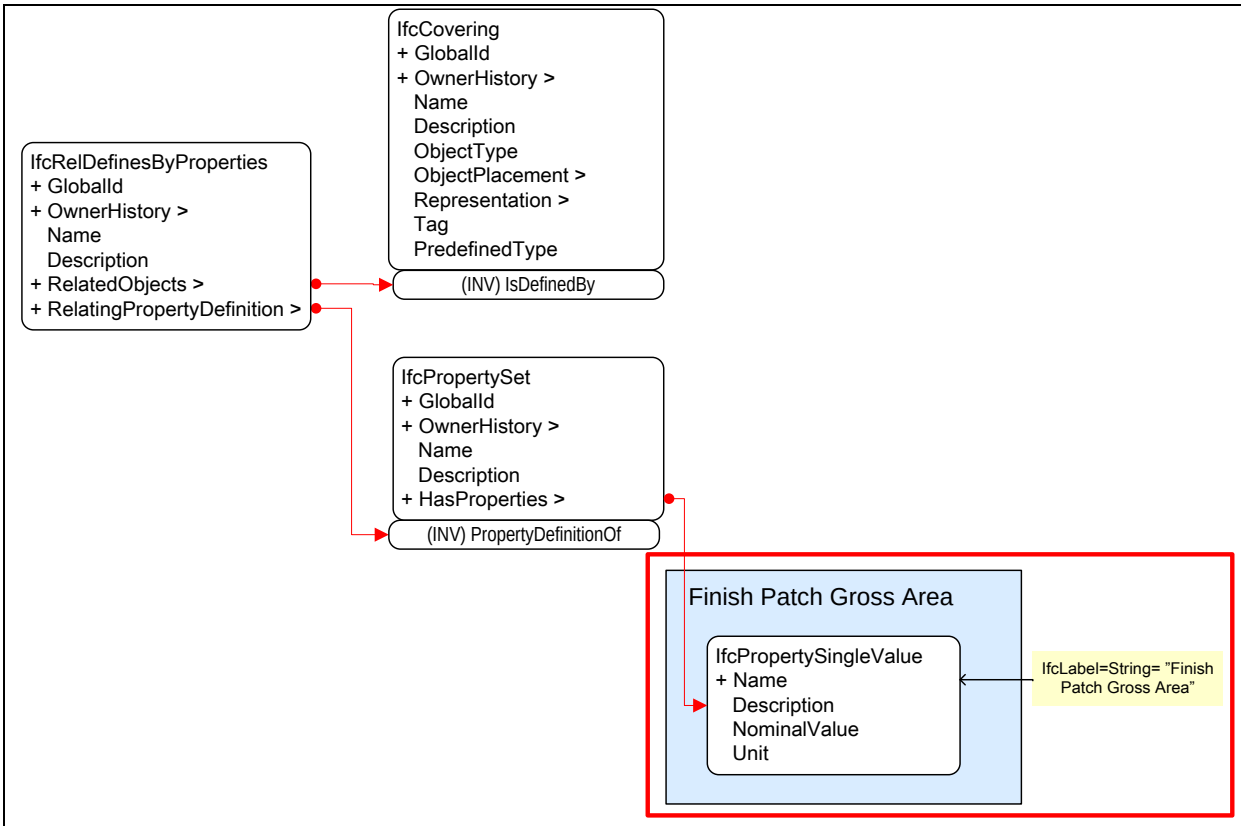
Finish Patch Gross Area

Reference	PCI-168	**Version**	1.1	**Status**	Draft
Relationships	Provides the gross area of a finish patch. A finish patch defines the placement, shape and area of each surface treatment type, used on precast concrete elements.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements:

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel= String= "Finish Patch Gross Area"
Description	<Open>
NominalValue	Must be provided.
Unit	<Open>

One surface treatment may be used in different finish patches. For purposes like material take-off the gross area of these patches are needed.

Part 21 File Example:

```
#300=IFCCOVERING
('14MYN1USRBAP8H0MGNBZLX',#43,'PRECASTFINISHPATCH',$,'FINISHPATCH',#140,#160,'146545');

#350=IFCRELDEFINESBYPROPERTIES('8A6KE4DSH0JEPQKKHBXURB',#42,$,$,(#300),#360);

#360=IFCPROPERTYSET('8GJ9L$OBH4XHADW0W9GGED',#42,'PSET_FINISHPATCHGROSSAREA',$,(#370))
;

#370=IFCPROPERTYSINGLEVALUE('FINISHPATCHGROSSAREA',$,IFCVALUE(28),IFCUNIT(SQUARE_METR
E));.
```

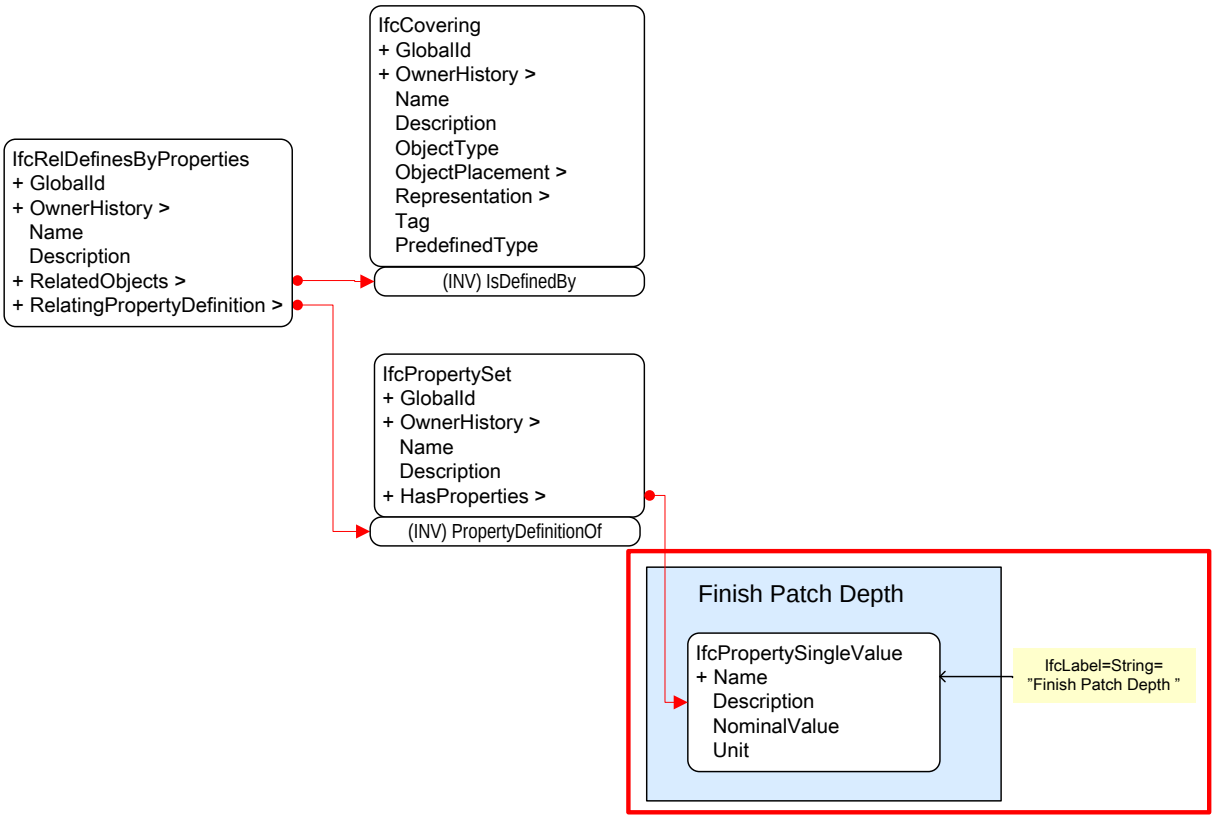
IFC Release Specific Concept Description (<IFC Release 2x3>)

Finish Patch Depth

Reference	PCI-169	**Version**	1.1	**Status**	Draft
Relationships	Provides the depth of a finish patch. A finish patch defines the placement, shape and area of each surface treatment type, used on precast concrete elements.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram

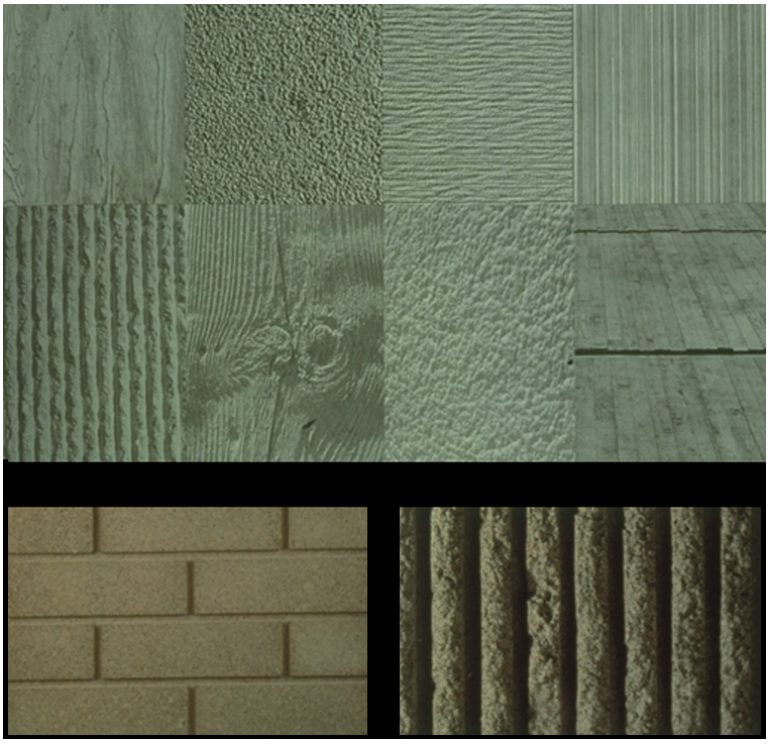


Implementation agreements:

IfcPropertySingleValue

Attribute	Implementation agreements
Name	IfcLabel= String= “Finish Patch Depth”
Description	<Open>
NominalValue	Must be provided.
Unit	<Open>

.



Examples of finish patches that have finishes with different depths.

Part 21 Example:

```
#300=IFCCOVERING
('14MYN1USRBAP8H0MGNBZLX',#43,'PRECASTFINISHPATCH',$,'FINISHPATCH',#140,#160,'146545');
#350=IFCRELDEFINESBYPROPERTIES('8A6KE4DSH0JEPQKKHBXURB',#42,$,$,(#300),#360);
#360=IFCPROPERTYSET('8GJ9L$OBH4XHADW0W9GGED',#42,'PSET_FINISHPATCHDEPTH',$,(#370));
#370=IFCPROPERTYSINGLEVALUE('FINISHPATCHDEPTH',$,IFCVALUE(0.005),IFCUNIT(METRE));
```

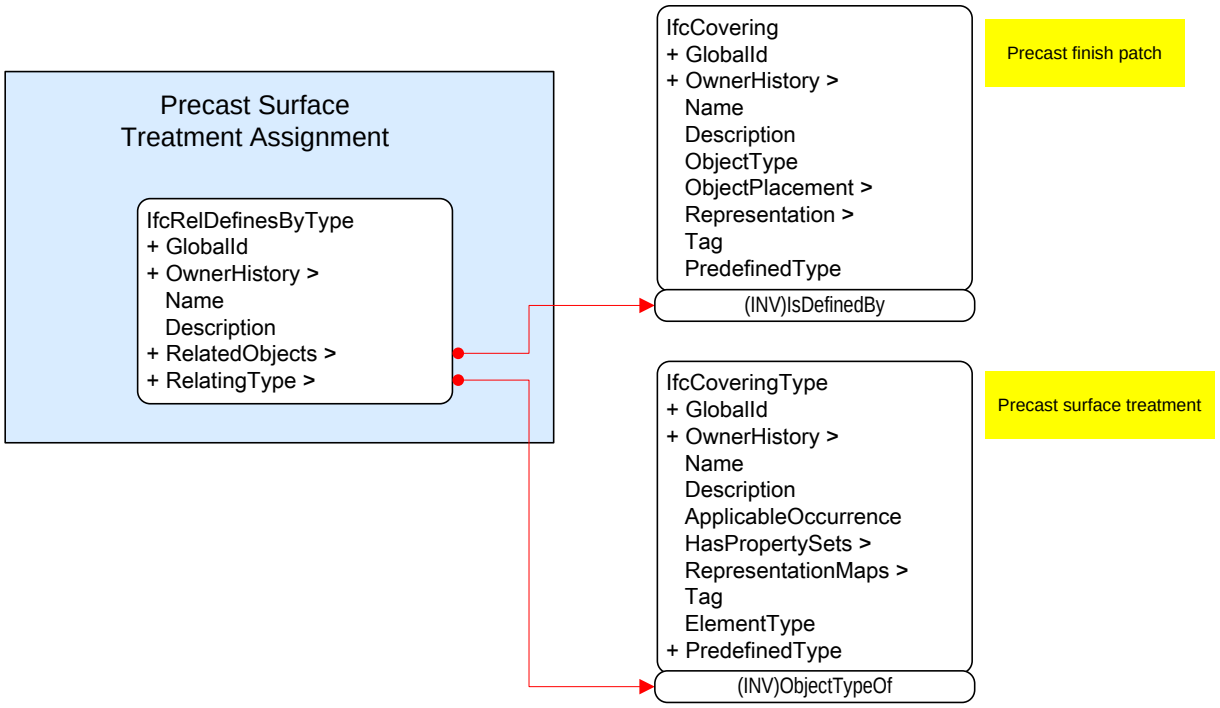
IFC Release Specific Concept Description (<IFC Release 2x3>)

Precast Surface Treatment Assignment

Reference	PCI-171	**Version**	1.1	**Status**	Draft
Relationships	Assigns the surface treatment to the precast finish patch. The surface treatment is the finish used on precast concrete element. It can be of variety of types depending on the design requirements, budget and other factors.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram

Instantiation diagram



Implementation agreements:

IfcRelDefinesByType

Attribute	Implementation agreements
GlobalId	Must be provided

OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
RelatedObjects	Must be IfcCovering. This entity refers to finish patch.
RelatingType	Must be IfcCoveringType. This entity refers to surface treatment.

.

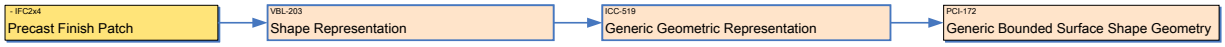
Precast concrete sandwich wall panels with different types of surface treatments assigned.

Part 21 Example File:

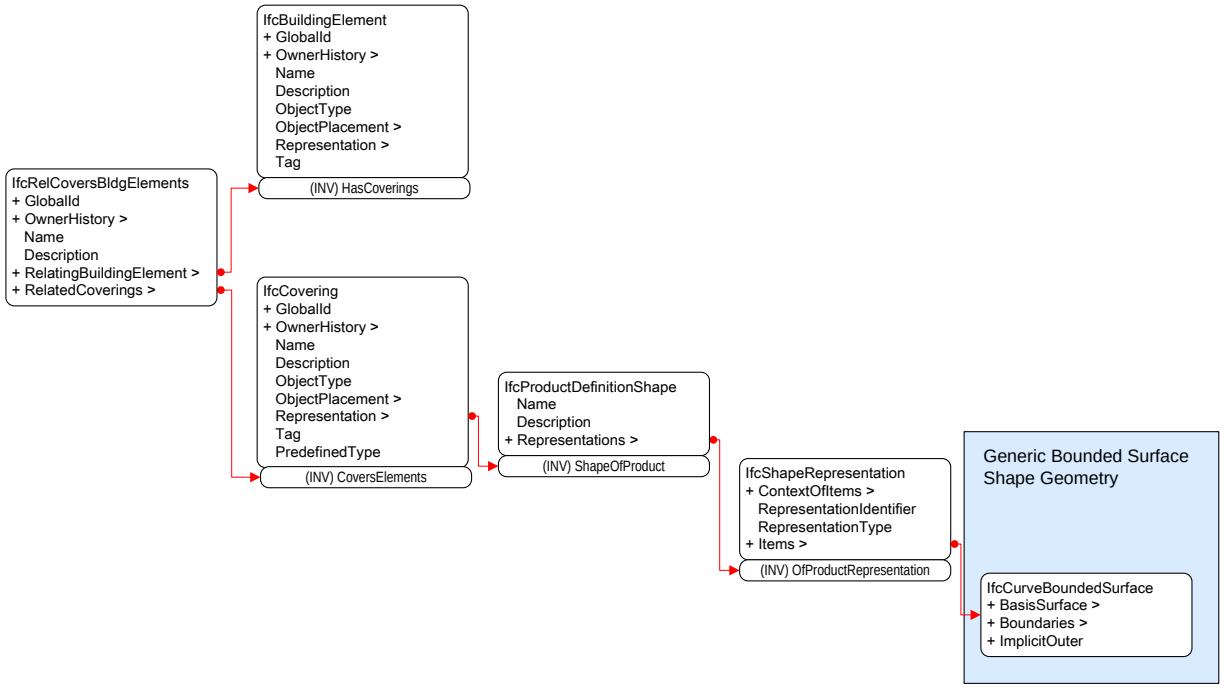
```
#300=IFCCOVERING
('14MYN1USRBAP8H0MGNBZLX',#43,'PRECASTFINISHPATCH',$,'FINISHPATCH',#140,#160,'1465
45');
#360=IFCCOVERINGTYPE('1DDPLCCG176GSKQFDKE08O',#20,SANDBLASTED',$,$,$,$,$,$,.NOTD
EFINED.);
#400=IFCRELDEFINESBYTYPE('2AXQNAAIT0XGPSJZD$JSFR',#20,$,$,(#300),#360);
```

IFC Release Specific Concept Description (IFC2x3**)** Generic Bounded Surface Geometry					
Reference	PCI-172	**Version**	1.1	**Status**	Draft
Relationships	Defines the relationship between a precast finish patch and its geometric representation.				
History	Revised November 16, 2012				
Authors	Ivan Panushev (ivan.panushev@gatech.edu)				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcCurveBoundedSurface

Attribute	Implementation agreements
BasicSurface	Should be subtype of IfcSurface. This is the surface where the bounded curve is placed.
Boundaries	Should be IfcBoundaryCurve according to the IFC2x4 Beta2 Specification: 1. Each curve in the set of Boundaries shall be closed. 2. No two curves in the set of Boundaries shall intersect. 3. At most one of the boundary curves may enclose any other boundary curve. If an IfcOuterBoundaryCurve is designated, only

	that curve may enclose any other boundary curve.
ImplicitOuter	Has to be BOOLEAN in accordance with IFC2x4 Beta2: 1. an IfcOuterBoundaryCurve, a closed composite curve on surface for the definition of an outer boundary, then the attribute ImplicitOuter has to be set to FALSE, or 2. by the implicit boundary of the bounded surface, e.g. the u1, u2, v1, v2 of IfcRectangularTrimmedSurface< then the attribute ImplicitOuter has to be set to TRUE.

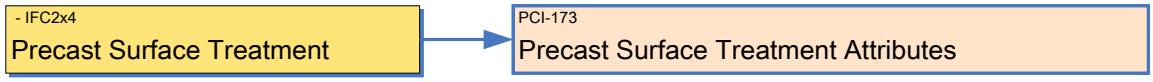
Part 21 Example:

#50=IFCCURVEBOUNDEDSURFACE(#40,(#140,#160,#170,#180),0)

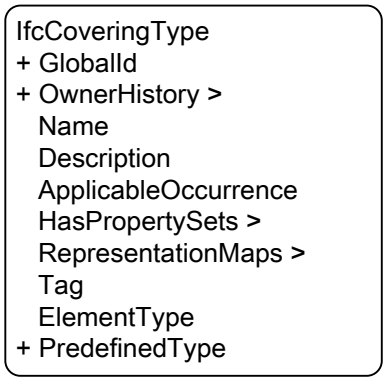
#60=IFCSHAPEREPRESENTATION(#36,'FINISHGEOMETRY','CURVE2D',(#50));

IFC Release Specific Concept Description (IFC2x3**)** Precast Surface Treatment Attributes					
Reference	PCI-173	**Version**	1.1	**Status**	Draft
Relationships	Defines the relationship between a precast finish parch and its attributes.				
History	Fall, 2009; reviewed 15 November, 2012				
Authors	Ivan Panushev (ivan.panushev@gatech.edu)				
Document Owner	Precast/Prestressed Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

IfcCovetingType

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data
Name	<Open>
Description	<Open>
ApplicableOccurence	<Open>
HasPropertySets	The property set must define the treatment attributes.
RepresentationMaps	Optional if representation is required at the type level.
Tag	<Open>
ElementType	<Open>
PredefinedType	Should be enumerated by using

	\IfcCoveringTypeEnum

Part 21 Example:

#360=IFCCOVERINGTYPE('1DDPLCCG176GSKQFDKE08O',#20,SANDBLASTED',$,$,$,$,$,$,.NOTDEFINED.);

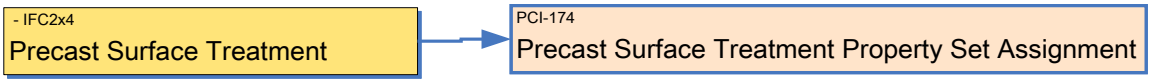
This document uses the official IFC Model View Definition Format version 1.1.0. of the IAI (www.iai-international.org)

IFC Release Specific Concept Description (<IFC Release 2x3>)

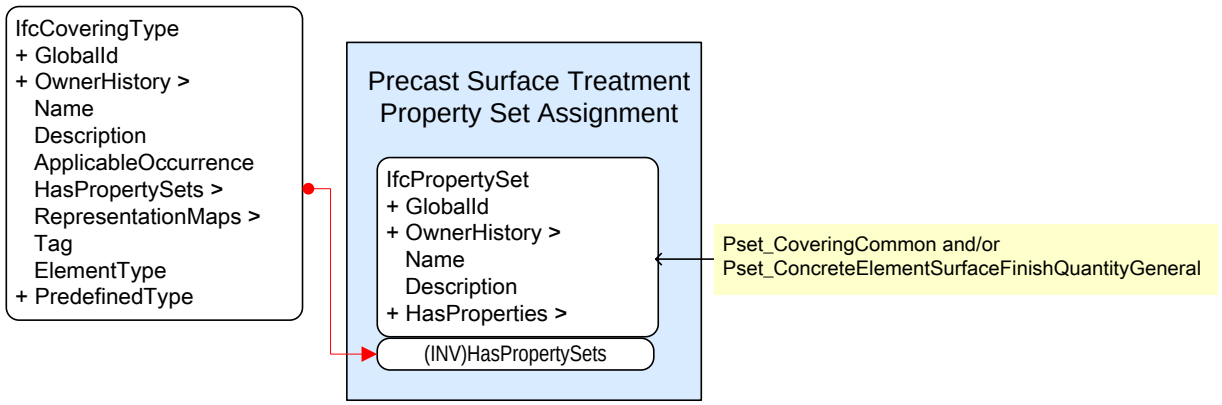
Precast Surface Treatment Property Set Assignment

Reference	PCI-174	**Version**	1.1	**Status**	Draft
Relationships	Assigns different properties like fire rating, fragility rating, acoustic rating and so on to the precast surface treatment.				
History	Revised Nov 18, 2012				
Authors	Shiva Aram				
Document Owner	GA Tech and Technion Precast NBIMS Team				

Usage in view definition diagram



Instantiation diagram



Implementation agreements:

IfcPropertySet

Attribute	Implementation agreements
GlobalId	Must be provided
OwnerHistory	Must be provided, but may contain dummy data

Name	String= "Pset_CoveringCommon" and/or "Pset_ConcreteElementSurfaceFinishQuantityGeneral"
Description	<Open>
HasProperties	Contained set of properties; Pset_CoveringCommon and/or Pset_ConcreteElementSurfaceFinishQuantityGeneral.

.

URL Link for Pset_CoveringCommon:

http://www.iai-tech.org/ifc/IFC2x4/alpha/html/psd/IfcSharedBldgElements/Pset_WallCommon.xml

URL Link for Pset_ConcreteElementSurfaceFinishQuantityGeneral:

http://www.buildingsmart-tech.org/ifc/IFC2x3/TC1/html/psd/IfcStructuralElementsDomain/Pset_ConcreteElementSurfaceFinishQuantityGeneral.xml

The following properties from **Pset_CoveringCommon** are mandatory:

- TotalThickness: Length measure of the thickness of the covering.
- Finish: Text including the specifications of the chosen finish.

Different precast surface treatments have specific properties in terms of finish type, thickness, texture, color, fire rating, acoustic rating and so on.

Part 21 Example:

```
#250=IFCPROPERTYSET('9GJ9L$OBH4XHADW0W9GGED',#42,'SURFAC
ETREATMENTPROPERTIES',$,(#83,#84,#85,#86));
#360=IFCCOVERINGTYPE('1DDPLCCG176GSKQFDKE08O',#20,SANDBLA
STED',$,$,#250,$,$,$,.NOTDEFINED.);
```

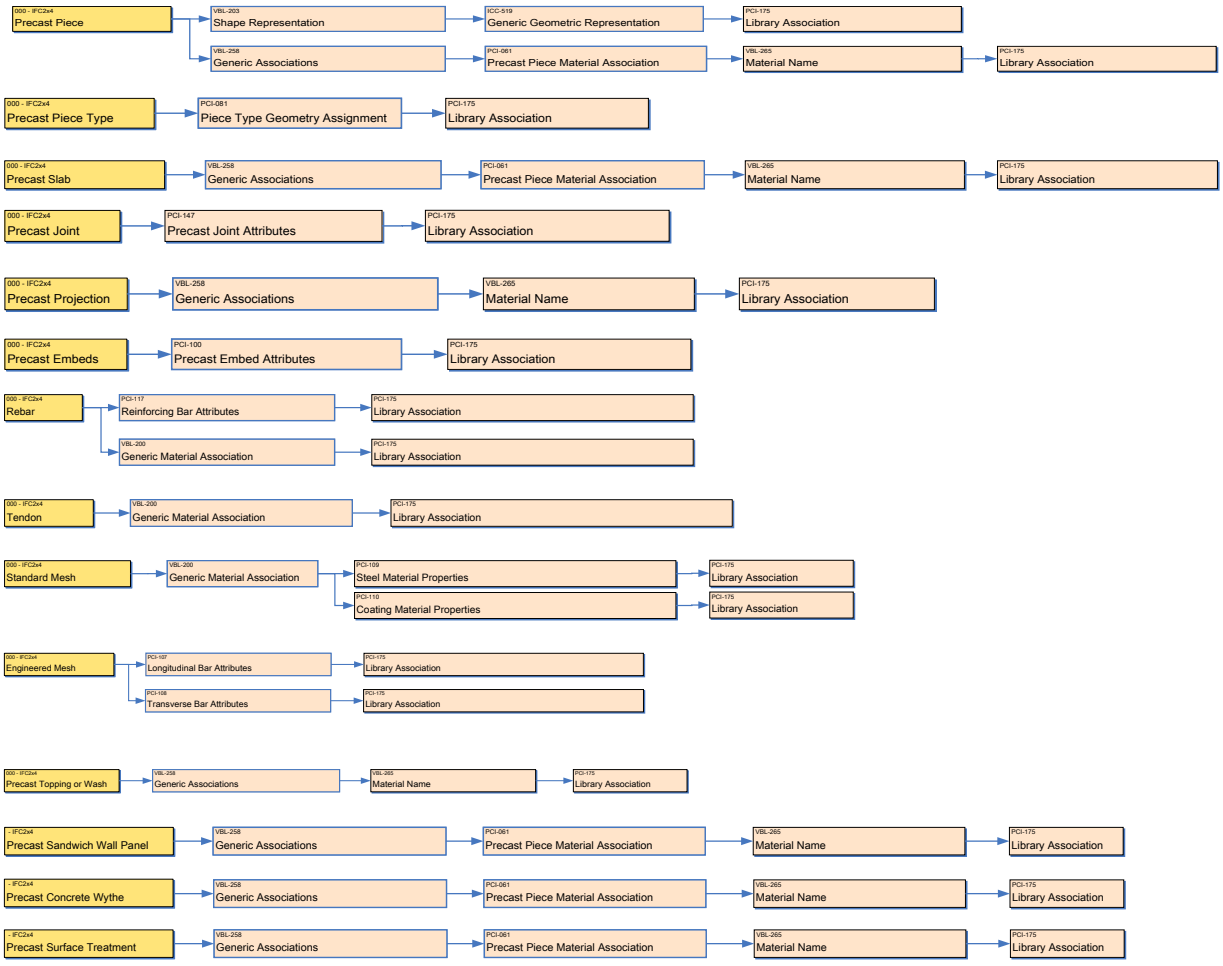
Add Material association with full dependencies

IFC Release Specific Concept Description (IFC Release 2x3)

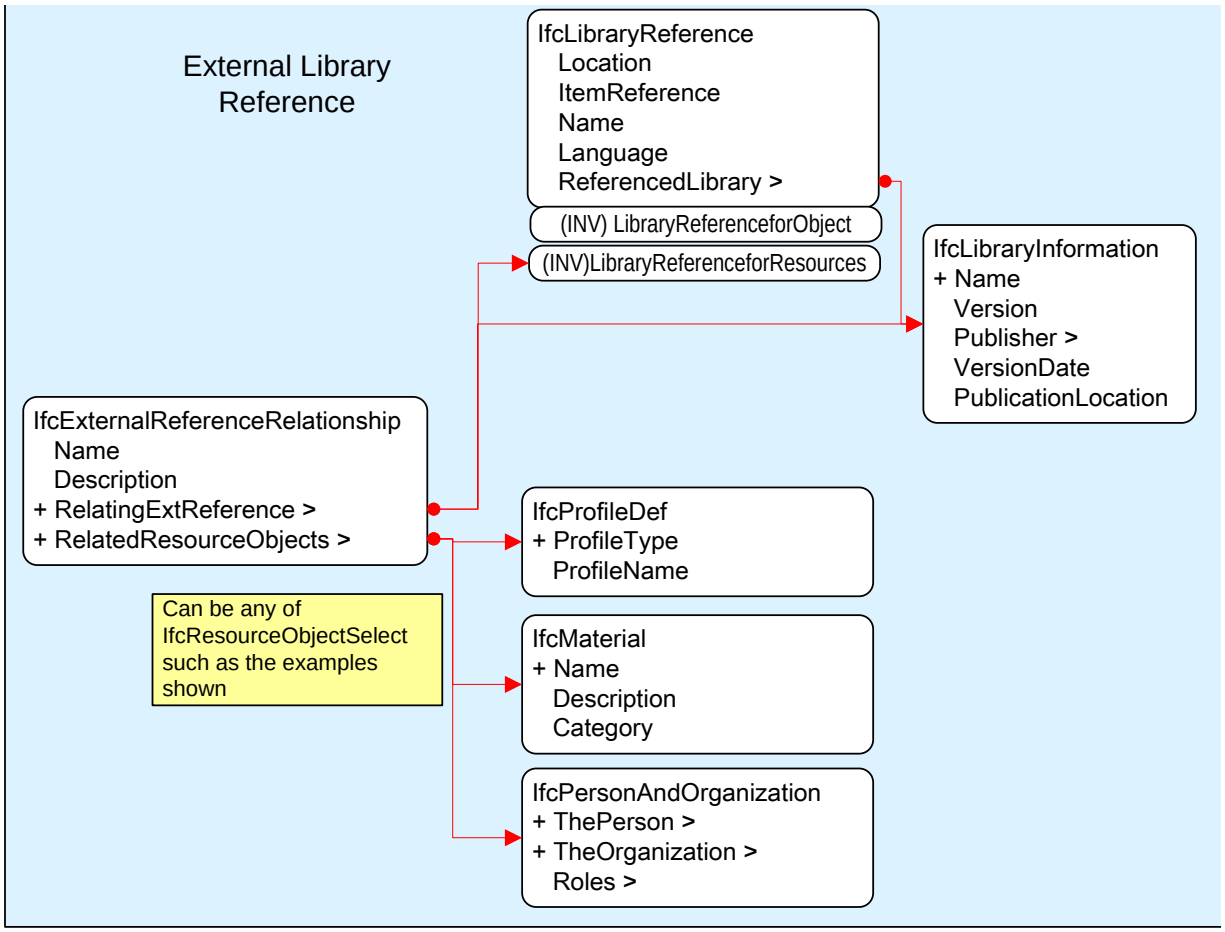
Library Association

Reference	PCI-175	**Version**	1.1	**Status**	Draft
Relationships	Library Association associates a an external library reference to the Object that it carries data for, such as Profile, material or Person and Organization.				
History	Created October 30, 2009				
Authors	Chuck Eastman				
Document Owner	PCI - Precast Concrete Institute				

Usage in view definition diagram



Instantiation diagram



Implementation agreements

Attribute	Implementation agreements
Name	<Optional> Name the identifies or qualifies the relationship.
Description	<Optional> description of the relaitonshipr
RelatingExtReference	Refers to the external reference providing the data
RelatedResourceObjects	Tags any of the objects defined by IfcResourceObjectSelect with an external reference, that provides the object with instance values of the type defined by the Select type
ReferencedLibrary	<Optional> Referenced Library, if not defined in IfcLibraryReference

IFcResourceObjectAssociationRelationship is used to associate an external library and its index to one opr more instances of the object types defined in IfcResourceObjectSelect. The instances accept the values associated in the external reference.

.

Example:

Part-21 file <to be added>