IFC STRUCTURAL TESTBED

TESTBED FOR EXCHANGE OF STRUCTURAL DESIGN MODELS AMONG DESIGN AND ANALYSIS APPLICATION

MODEL VERSION:

TEKLA STRUCTURES

1 TESTBED DESCRIPTION

The structural testbed is based on a modified original design of a stadium, where one section had been cut-out and additional element types had been added. It should represent a fair portion of elements used in structural modeling.

The testbed comprises:

- A common source model to testing the IFC exchange
- A description of the test model based on the structural modeling elements and attributes used
- A description of test criteria against which the result is validated
- A realization of the same test model in (at least) two structural modeling applications
- A set of IFC export files (from the source applications) with well documented export options
- A set of success/failure descriptions for external neutral test tools
    - In IFC syntax checker,
    - In IFC validation tools,
    - In IFC viewer
- A matrix of success/failure descriptions for import into other software
    - Matrix based on test criteria and importing software
    - Importing software is either:
        - Other BIM tools (architectural/ structural modelling software), or
        - Structural analysis software

1.1 Test model description

The first test model has been created in TEKLA structures It deals with the main elements:

- Column
- Beam
- Brace
- Wall
- Slab

The original test model has been created and exported to IFC using:

Name of application	Version number	Export options	Remarks
TEKLA Structures	13.0 Build 276359	IFC2x3; AUTO	File name: ifc_test2.ifc

Overview picture of the test model:

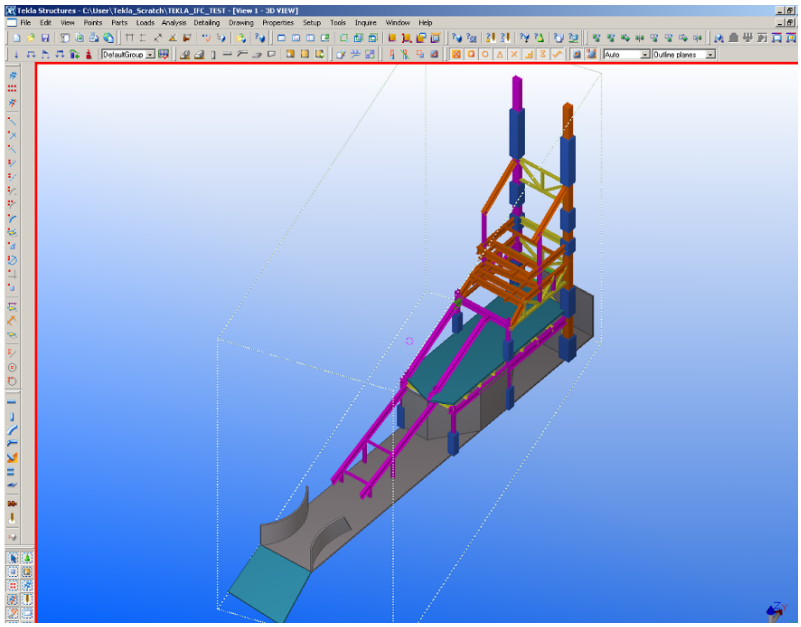


Figure 1: Perspective view of the test case 1

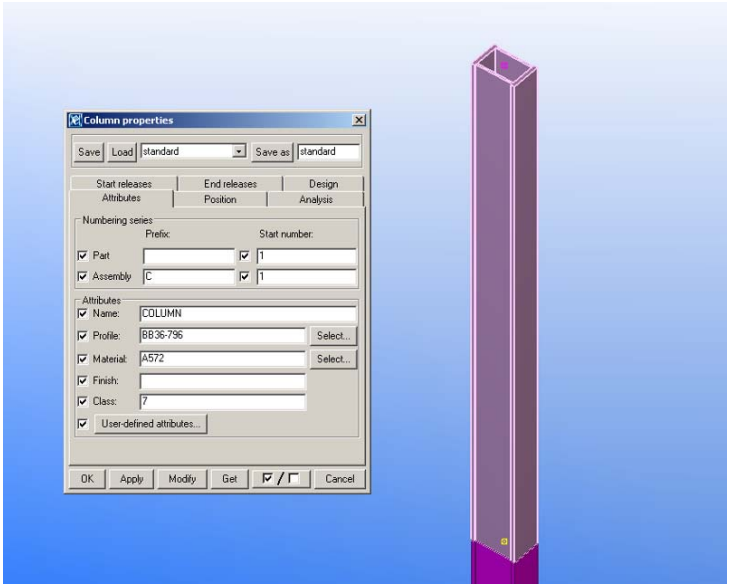


Figure 2: Detailed view of built-up column with properties

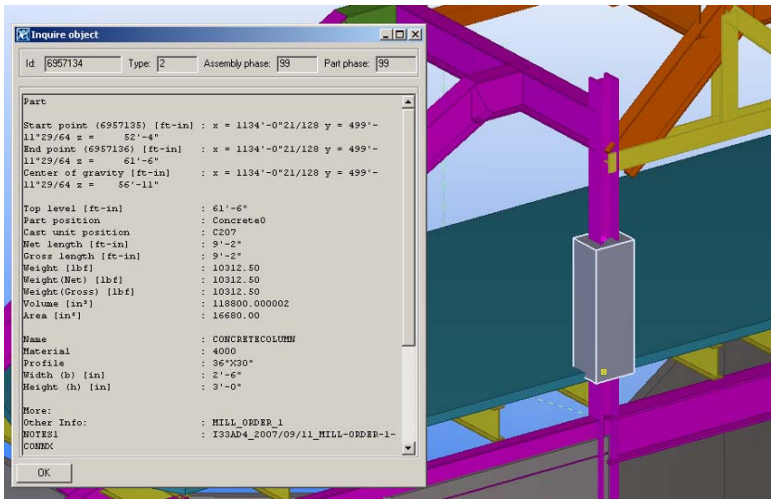


Figure 3: Detailed view of concrete column with properties

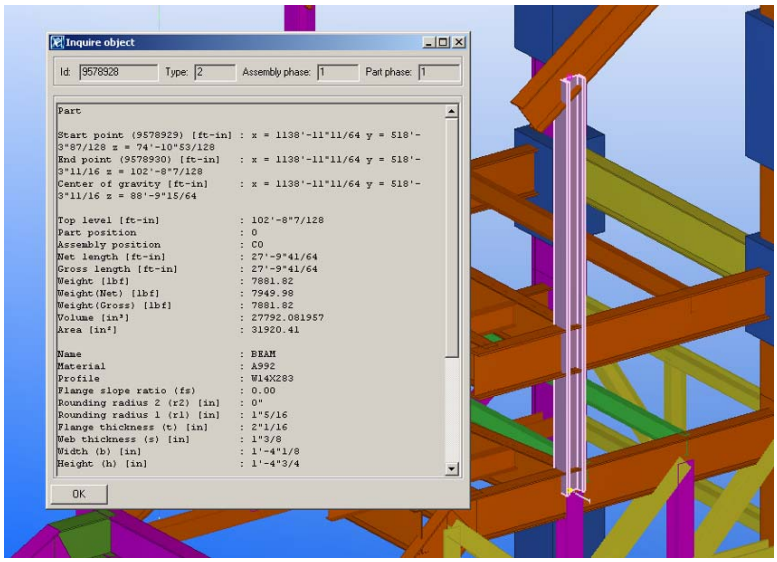


Figure 4: Detailed view of wide flange column with properties

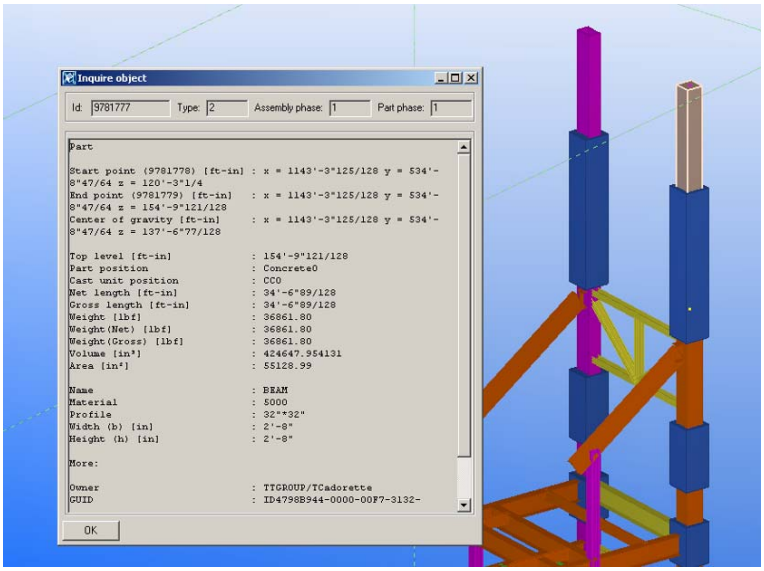


Figure 5: Detailed view of concrete column with properties

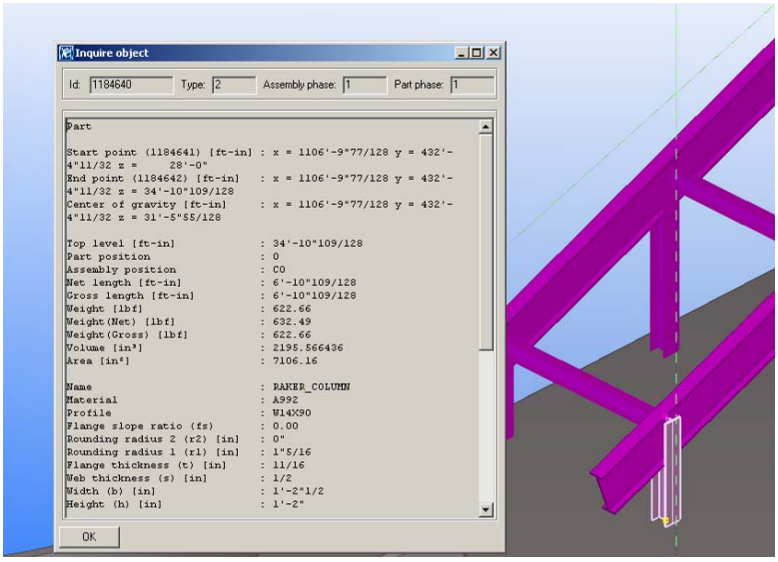


Figure 6: Detailed view of wide flange column with properties

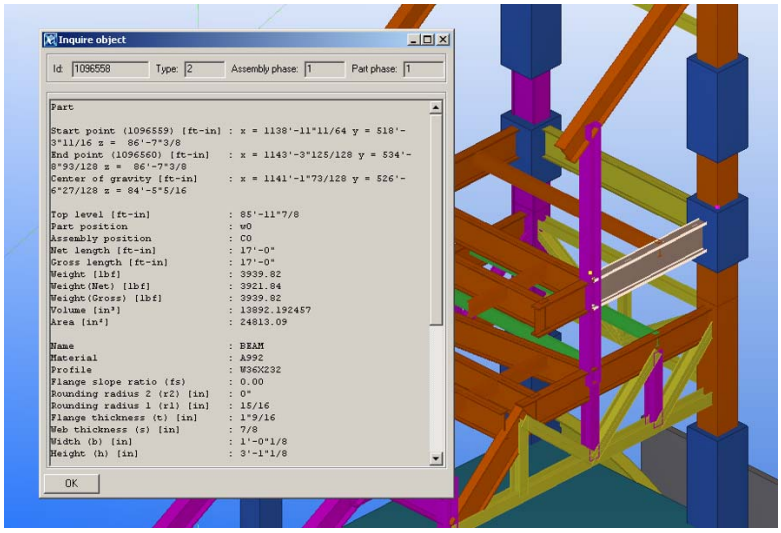


Figure 7: Detailed view of wide-flange beam with properties

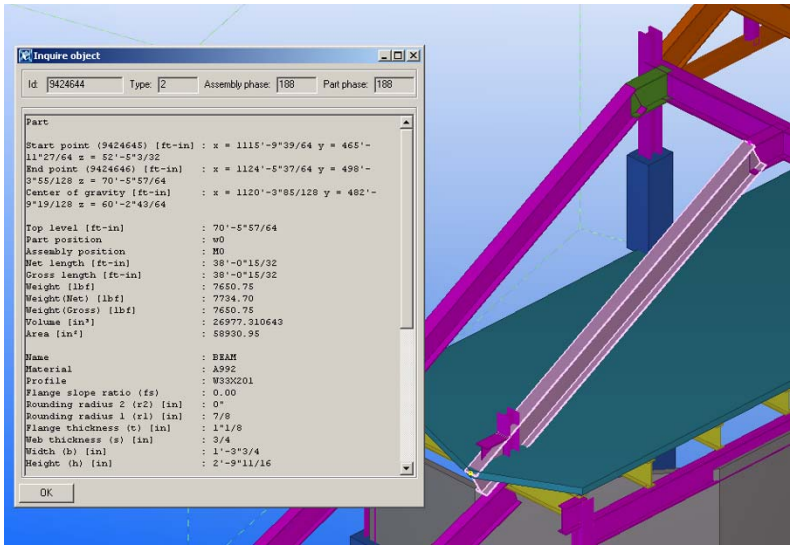


Figure 8: Detailed view of sloped wide-flange beam with properties

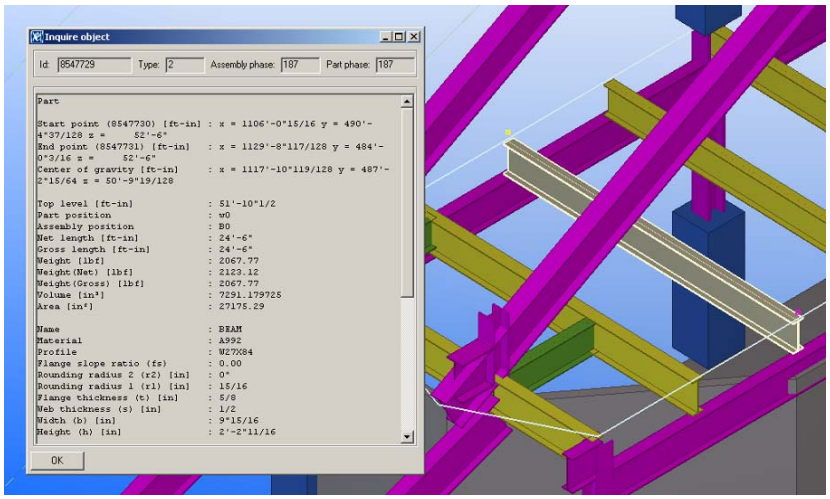


Figure 9: Detailed view of wide-flange beam with properties

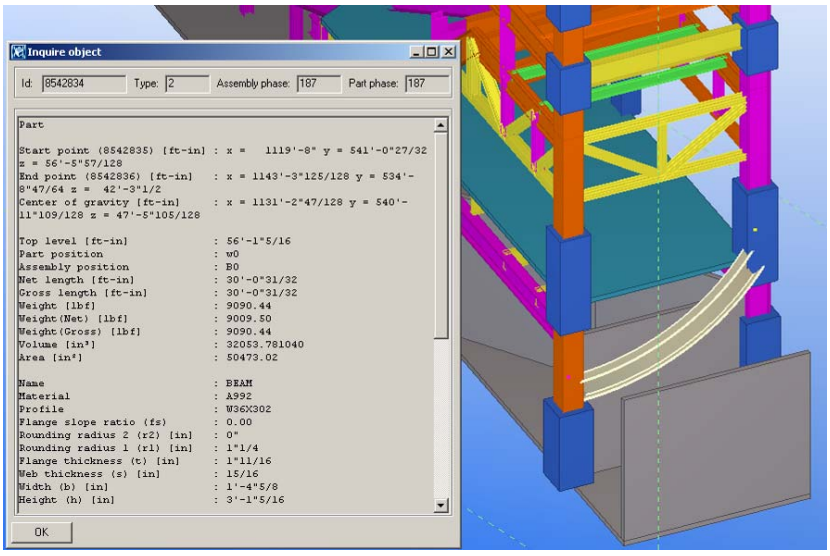


Figure 10: Detailed view of curved wide-flange beam with properties

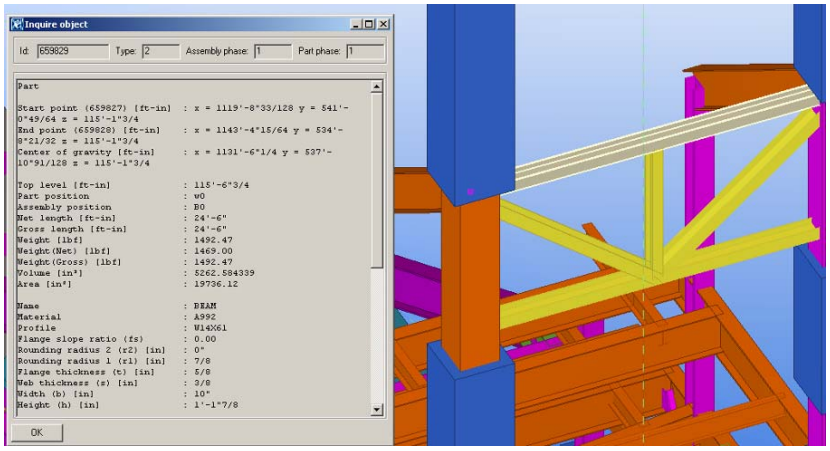


Figure 11: Detailed view of wide-flange beam with properties

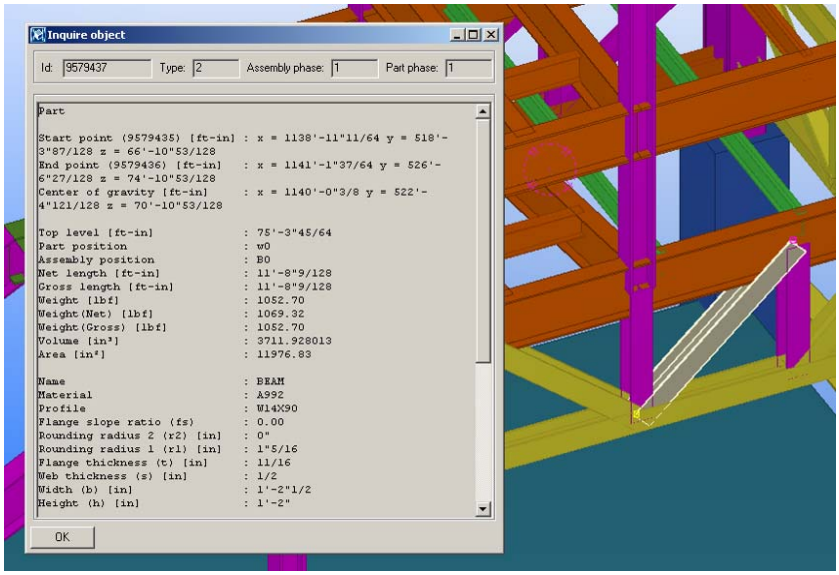


Figure 12: Detailed view of wide-flange brace with properties

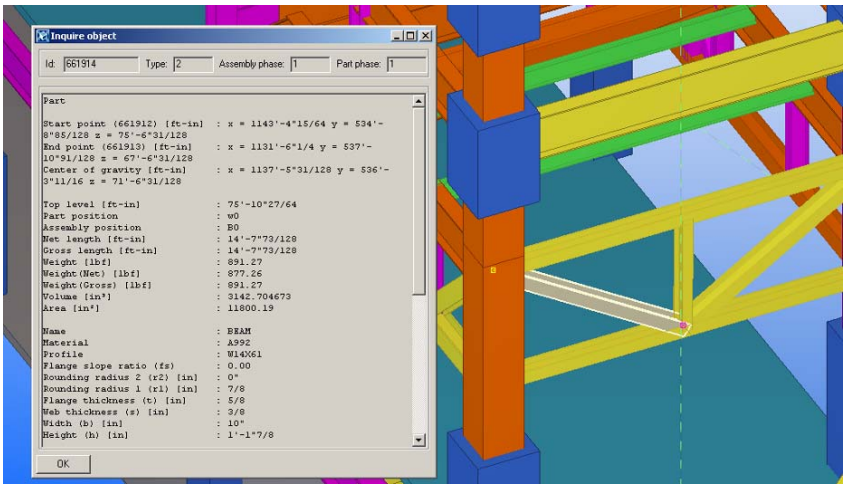


Figure 13: Detailed view of wide-flange brace with properties

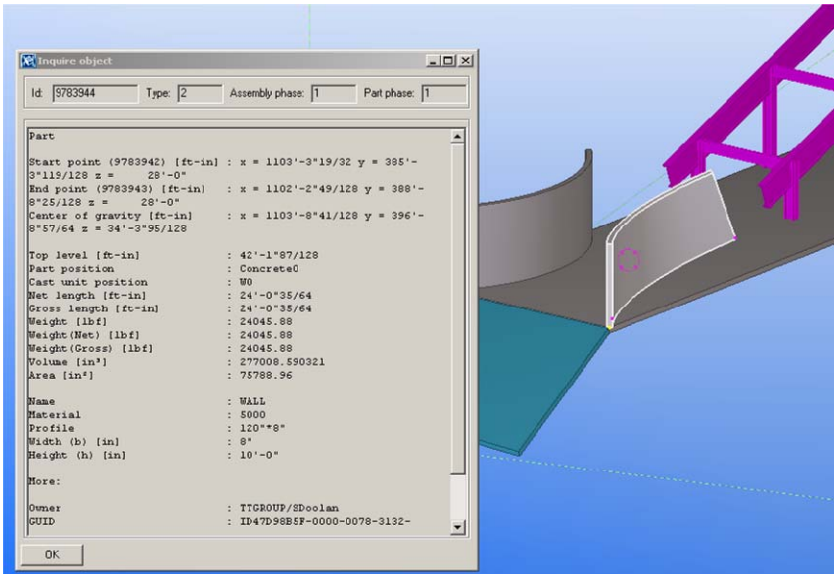


Figure 14: Detailed view of curved sloped wall with properties

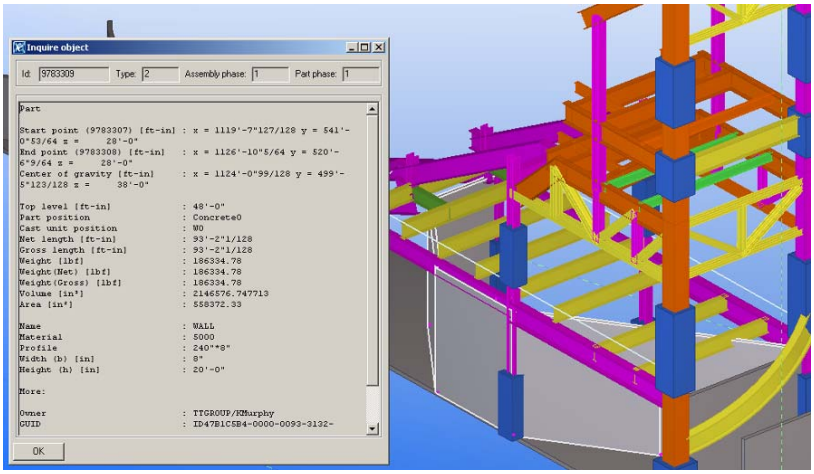


Figure 15: Detailed view of segmented wall with properties

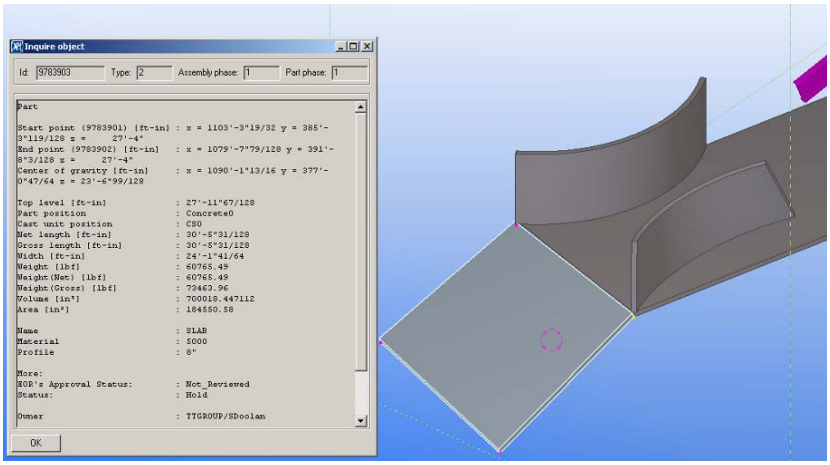


Figure 16: Detailed view of sloped slab with properties

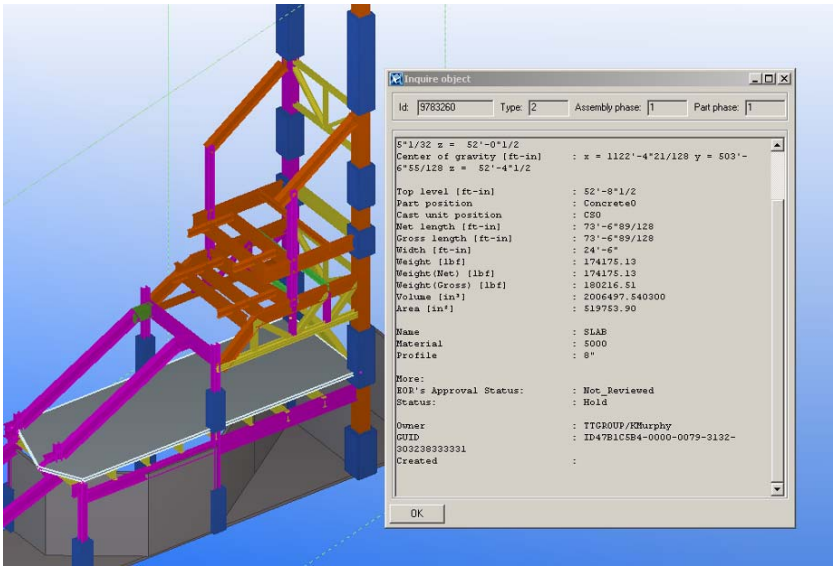


Figure 17: Detailed view of flat slab with properties

1.2 Description of the test model

The content of the test model and the important element and attribute information should be documented here. The testbed should later test that those exchange requirements are correctly exported and imported using the IFC protocol.

1.2.1 Building elements used

Main element types for the test model are:

Beams

Position (Start/End X,Y,Z coordinates)	Profile	Material	Grade	Length	Roll
(1138'-11"11/64, 518'-3"11/16, 86'-7"3/8); (1143'-3"125/128, 534'-8"93/128, 86'-7"3/8)	W36x232	Steel	A992	17'-0"	0
(1115'-9"39/64, 465'-11"27/64, 52'-5"3/32); (1124'-5"37/64, 498'-3"55/128, 70'-5"57/64)	W33x201	Steel	A992	38'-0"15/32	0
(1106'-0"15/16, 490'-4"37/128, 52'-6"); (1129'-8"117/128, 484'-0"3/16, 52'-6")	W27x84	Steel	A992	24'-6"	0
(1119'-8", 541'-0"27/32, 56'-5"57/128); (1143'-3"125/128, 534'-8"47/64, 42'-3"1/2)	W36x302	Steel	A992	30'-0"31/32	0
(1119'-8"33/128, 541'-0"49/64, 115'-1"3/4); (1143'-4"15/64, 534'-8"21/32, 115'-1"3/4)	W14x61	Steel	A992	24'-6"	0

Columns

Position (Start/End coordinates)	Profile	Material	Grade	Length	Roll
(1119'-7"127/128, 541'-0"53/64, 120'-3"1/4) ; (1119'-7"127/128, 541'-0"53/64, 154'-9"121/128)	BB36x796	Steel	A572	34'-6"89/128	-15
(1134'-0"21/128, 499'-11"29/64, 52'-4") ; (1134'-0"21/128, 499'-11"29/64, 61'-6")	36"x30"	Concrete	4000	9'-2"	-15
(1138'-11"11/64, 518'-3"87/128, 74'-10"53/128); (1138'-11"11/64, 518'-3"11/16, 102'-8"7/128)	W14x283	Steel	A992	27'-9"41/64	-15
(1143'-3"125/128, 534'-8"47/64, 120'-3"1/4); (1143'-3"125/128, 534'-8"47/64, 154'-9"121/128)	32"x32"	Concrete	5000	34'-6"89/128	-15
(1106'-9"77/128, 432'-4"11/32, 28'-0"); (1106'-9"77/128, 432'-4"11/32, 34'-10"109/128)	W14x90	Steel	A992	6'-10"109/128	-15

Braces

Position (Start/End coordinates)	Profile	Material	Grade	Length	Roll
(1138'-11"11/64, 518'-3"87/128, 66'-10"53/128); (1141'-1"37/64, 526'-6"27/128, 74'-10"53/128)	W14x90	Steel	A992	11'-8"9/128	0
(1143'-4"15/64, 534'-8"85/128, 75'-6"31/128); (1131'-6"1/4, 537'-10"91/128, 67'-6"31/128)	W14x61	Steel	A992	14'-7"73/128	0

Walls

Position (Start/End coordinates)	Profile	Material	Height	Length	
(1103'-3"19/32, 385'-3"119/128, 28'-0"); (1102'-2"49/128, 388'-8"25/128, 28'-0")	120"x8"	5000	10'-0"	24'-0"35/64	
(1119'-7"127/128, 541'-0"53/64, 28'-0"); (1126'-10"5/64, 520'-6"9/64, 28'-0")	240"x8"	5000	20'-0"	93'-2"1-128	

Slabs

Position (Start/End coordinates)	Profile	Material	Grade		
(1103'-3"19/32, 385'-3"119/128, 27'-4"); (1079'-7"79/128, 391'-8"3/128, 27'-4")	8"	5000			
(1119'-7"127/128, 541'-0"53/64, 52'-0"1/2); (1101'-9"89/128, 474'-5"1/32, 52'-0"1/2)	8"	5000			

1.2.2 Attribute content used

In addition to the proper export/ import of building elements the additional attribute content should be tested. Therefore a minimum of attributes relevant to the design phase should be created.

Object Category	Attribute name	Remark
Column	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements' path
	Roll	Rotation about an elements' major axis; axial rotation
Beam	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements' path
	Roll	Rotation about an elements' major axis; axial rotation
Brace	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements' path
	Roll	Rotation about an elements' major axis; axial rotation
Wall	Thickness	Dimension in the shortest direction (typically horizontal), taken normal to the surface defining wall height; may vary along length
	Material	Timber (stud), concrete, CMU, etc.
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. DFL2, 5000psi)
	Alignment	Location of wall insertion point in relation to its x-sectional centroid (center, left, right, etc.)

Slab	Thickness	Dimension in the shortest direction (typically vertical); may vary along length
	Material	Concrete (typically)
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. DFL2, 5000psi)

2 EXPORT TEST OF THE TEST MODEL

The export test contains various test procedures and criteria that should be performed by the applicant before submitting the test case for validation and approval. It includes the following steps:

- Export the IFC file
- Verify the IFC file for a correct header
- Verify the IFC file within a syntax checker
- Verify the IFC file for basic information, e.g. units, etc.
- Verify the IFC file within a free viewer

2.1 Verify the correct IFC file header

The IFC header has to contain the basic information about the application that created the exchange file. The IFC header can be accessed by opening the IFC file with a simple text editor.

Content of the IFC file header	Check correct information
ifc_test2.ifc	
ISO-10303-21; HEADER; FILE_DESCRIPTION(('IFC2X3.exp'),'2;1'); FILE_NAME('C:\\Documents and Settings\\SDoolan\\Desktop\\ifc_test2','2008-03-14T09:06:20',('Steel2 macro version:13.0 Build:276376,10.4.2007'),('Structural Designer'),'EXPRESS Data Manager version:20040806','Tekla Structures 13.0',''); FILE_SCHEMA(('IFC2X3')); ENDSEC;	Export date/time correct Correct IFC Schema

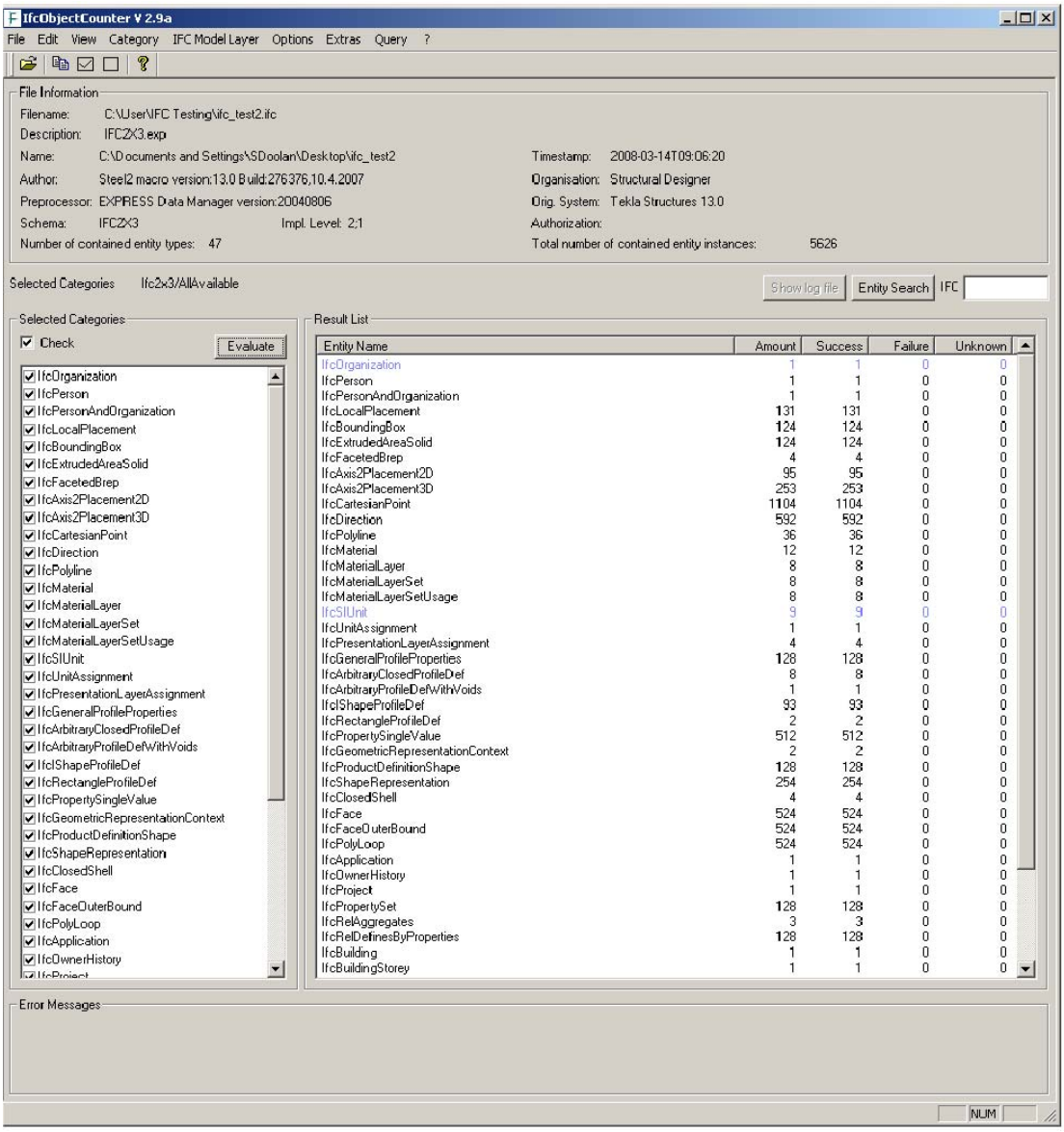
2.2 Verify within a syntax checker

Run the generated IFC file against a syntax checker. Make sure that there are no syntax errors against the IFC schema. If you are uncertain if a certain syntax error is produced erroneously, report the error together with the FC export file.

Example for a syntax checker is the *IfcObjCounter*.

See http://www.ifcwiki.org/index.php/Free_Software

Name of the IFC syntax checker	Version number, IFC schema version used	Results of the syntax check
IfcObjectCounter V2.9a	IFC2x3	No failures



2.3 Verify within a viewer

Choose one or several IFC viewers to verify the result. Verify both the geometry of the result, as well as the spatial structure and the attribute content.

Examples for a free viewer are the IfcStoreyView, the DDS Viewer or the Ifc Engine Viewer.

See http://www.ifcwiki.org/index.php/Free_Software

Figure 1: Check of geometry and beam properties

IFC viewer used	DDS viewer Version 6.4	
Check performed	**Checking results**	**Remarks**
Columns	Some geometry imports correctly	Built-up column profile does not display correctly; profile dimensions are in improper units compared to reference model; length measureable but not a property; material not available; grade available
Beams	Geometry imports correctly	Profile/grade available, Length measureable but not a property; material not available

Brace	Geometry imports correctly	Imports as beam; Profile/grade available, Length measureable but not a property; material unavailable
Wall	Geometry imports correctly	Height maps to “description”, thickness has improper units, Length measureable but not a property; grade maps to material name, no alignment and material
Slab	Geometry imports correctly	Thickness has improper units, grade maps to material name; material unavailable

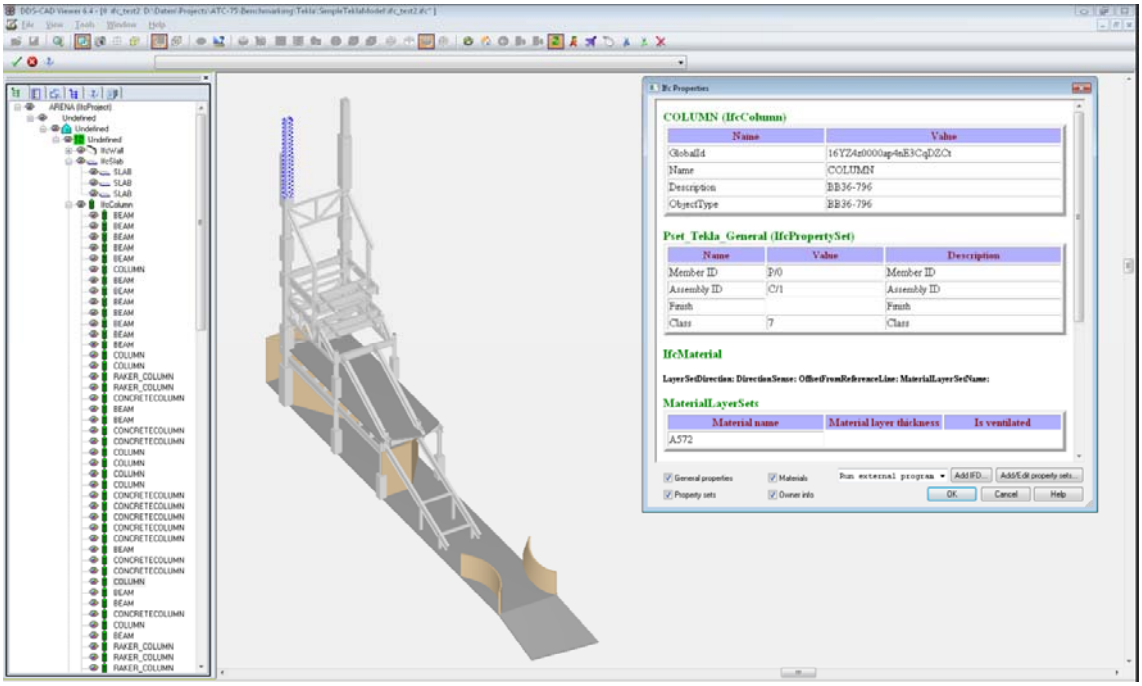


Figure 2: View of geometry with properties in DDS-CAD Viewer 6.4

3 IMPORT TEST OF TEST MODEL IN TARGET APPLICATION

The export file should be tested in a target application.

- An extended validation tool that includes the rules to check the conformance against the selected IFC view and the agreed implementer agreements for that IFC view.
- A series of import tests by importing the exported test case into other IFC certified applications (or applications that participates in the certification process).

3.1 Series of import tests

The content of the export file can be tested independently in viewers, the own application and by the validation tool. However in order to make sure, that the exchange with the appropriate target applications actually works, it needs to be checked manually by importing into target applications and by validating the information received by and made available to the target application.

3.1.1 Import into Autocad Architecture

Version number	IFC built	Remarks
AutoCAD Architecture 2008 B.219.0	IFC2x3 (ifc_test2.ifc)	Imports with no error messages; entire model is scaled very large and affects element profile dimensioning (see matrix)

Check performed	Checking results	Remarks
Columns	Geometry imports correctly	Only properties are length and profile; roll available but is 120 deg off;
Beams	Geometry imports correctly	Only properties are length and profile; roll available but is 120 deg off
Brace	Geometry imports correctly	Imports as beam; only properties are length and profile; roll available but is 120 deg off
Wall	Geometry imports correctly	Thickness reported in “width” field; alignment reported in “justify” field
Slab	Geometry imports correctly	Only property is thickness; boundary points are editable (see matrix)

Figure 2: Import test results summary in AutoCAD Architecture 2008

3.1.2 Import into Revit

Version number	IFC built	Remarks
Autodesk Revit Structure 2008.0.0	IFC2x3 (ifc_test2.ifc)	Error message on import

Check performed	Checking results	Remarks
Columns	Geometry imports correctly	No element properties; imports column as an architectural elements (see matrix)
Beams	Geometry imports correctly	Imports as “structural framing”; new family for each instance; profile only available from family and type fields; material incorrect (see matrix)
Brace	No geometry imported	Braces missing from model (see matrix)
Wall	Most geometry imports correctly	Some walls missing; no properties
Slab	Geometry imports correctly	Imported as “floor”, only thickness available

Figure 3: Import test results summary in Revit Structure 2008

4 FINAL TEST MATRIX

The final test matrix is available as an Excel table – see attached spreadsheet

IFC STRUCTURAL TESTBED

TESTBED FOR EXCHANGE OF STRUCTURAL DESIGN MODELS AMONG DESIGN AND ANALYSIS APPLICATION

MODEL VERSION:

REVIT STRUCTURE

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Name of application	Version number	Export options	Remarks
Revit Structures	20080321_1900	IFC2x2, IFC2x3, IFC ePlan Check	File name: myifc(Revit Objects)-2x3.ifc

Overview picture of the test model:

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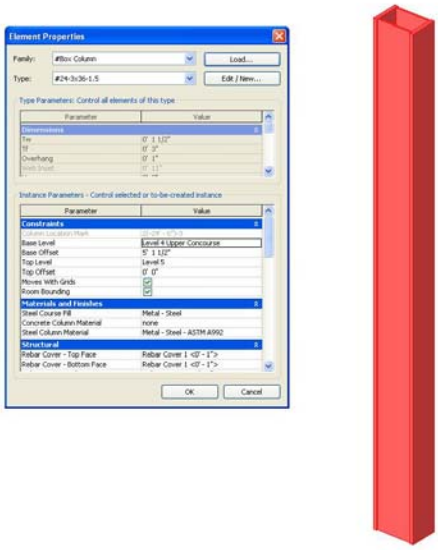

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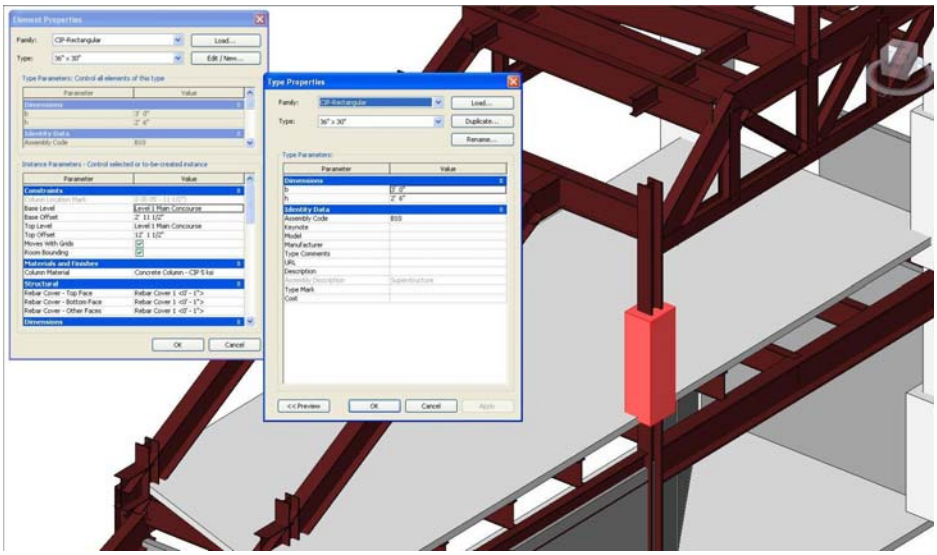


Figure 3: Detailed view of concrete column with properties

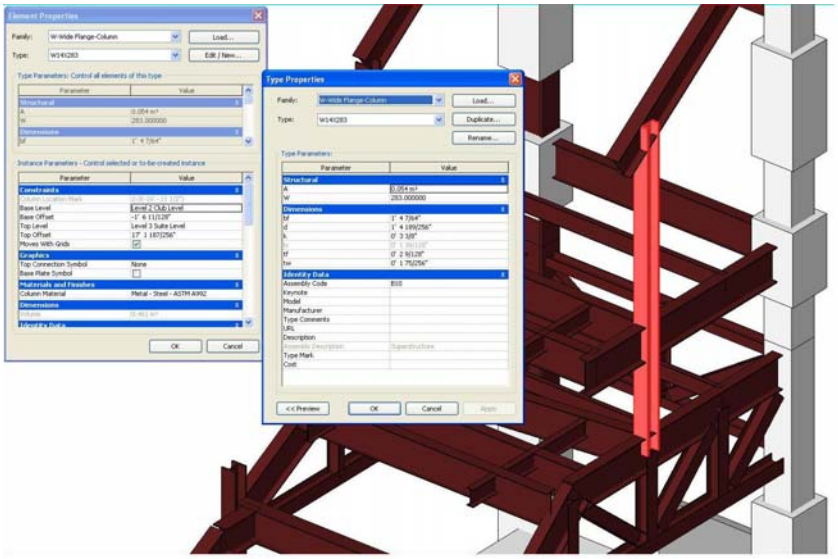


Figure 4: Detailed view of wide flange column with properties

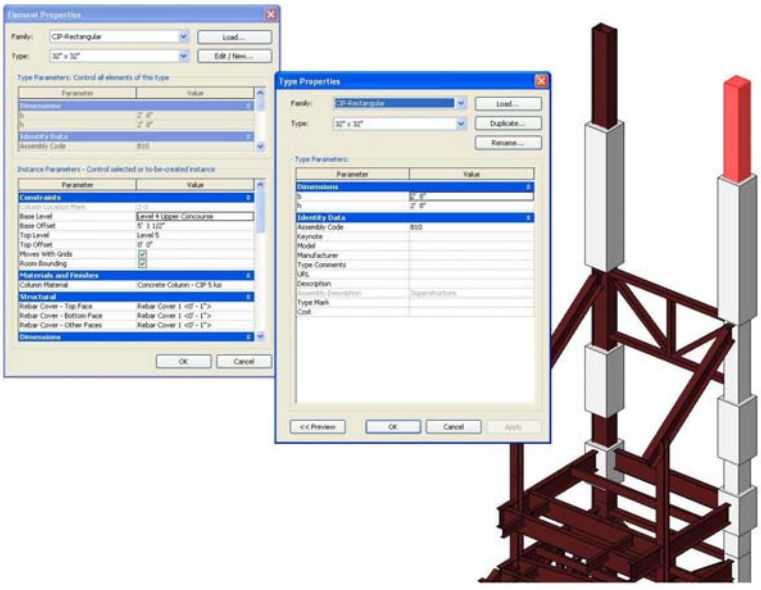


Figure 5: Detailed view of concrete column with properties

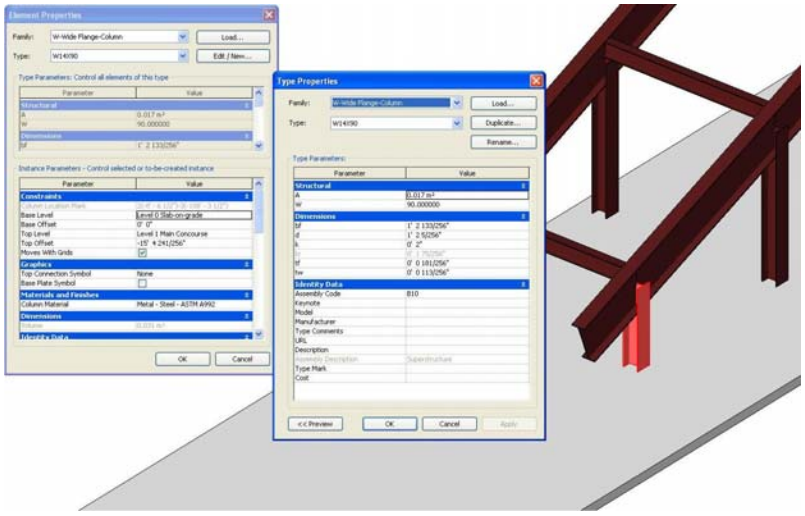


Figure 6: Detailed view of wide flange column with properties

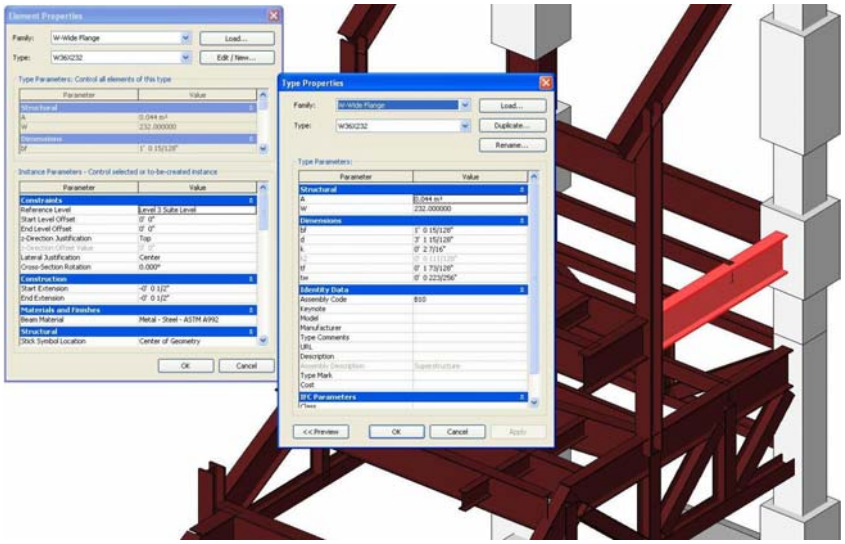


Figure 7: Detailed view of wide-flange beam with properties

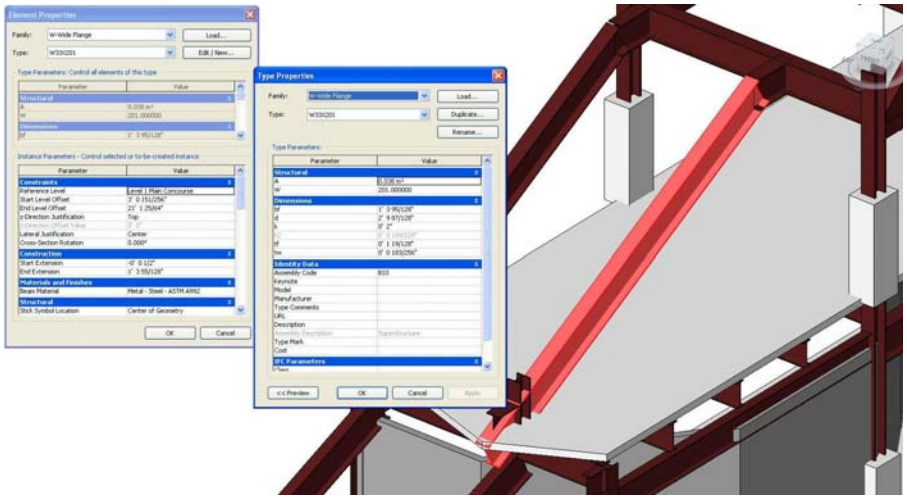
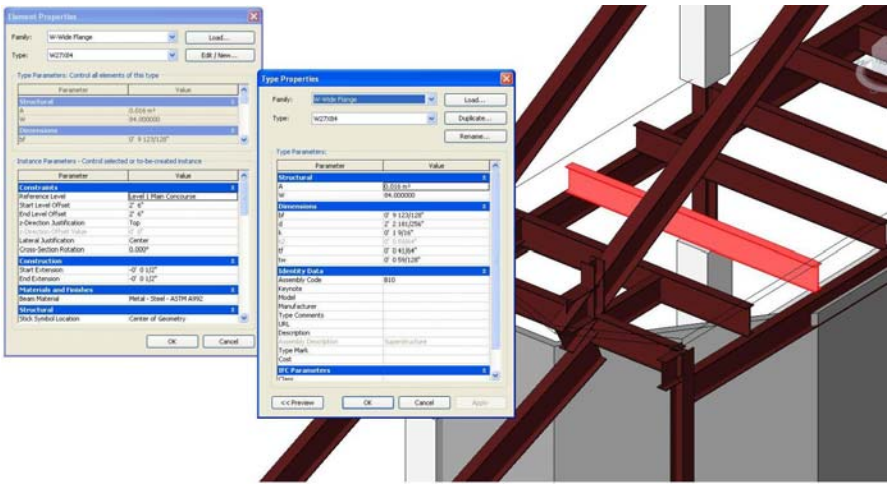


Figure 8: Detailed view of sloped wide-flange beam with properties



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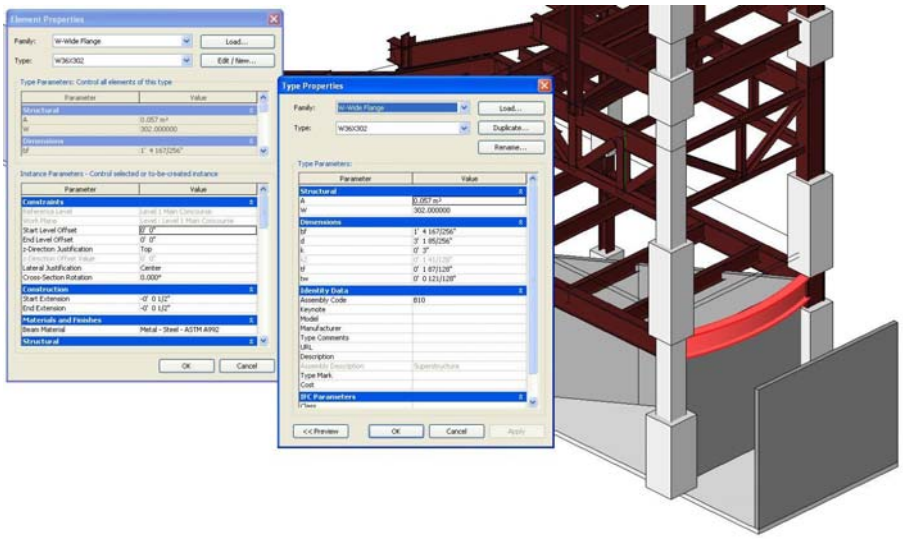


Figure 10: Detailed view of curved wide-flange beam with properties

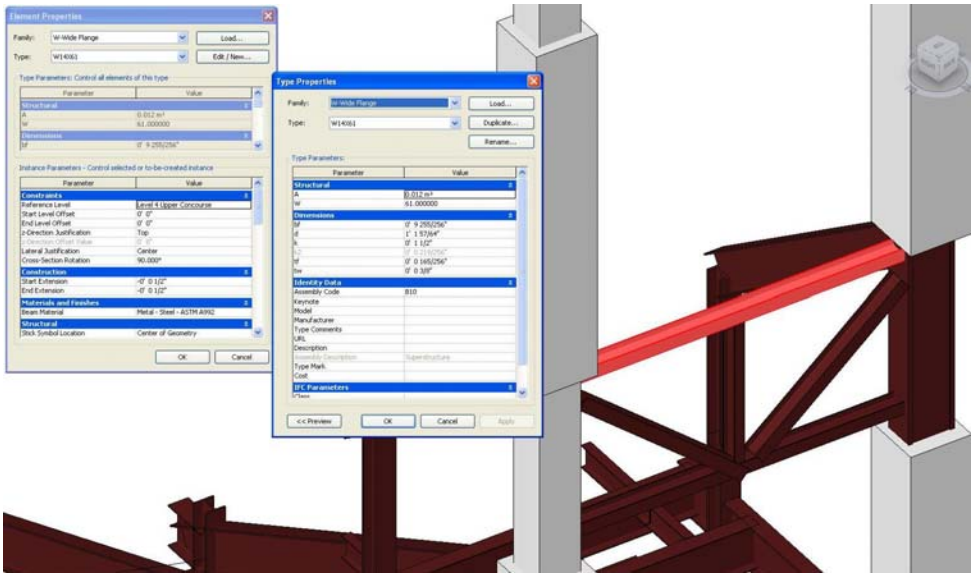


Figure 11: Detailed view of wide-flange beam with properties

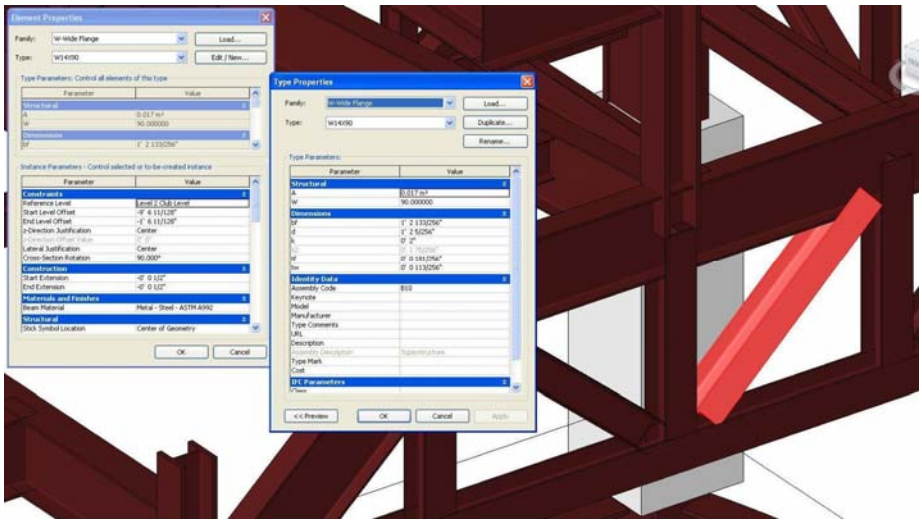


Figure 12: Detailed view of curved wide-flange brace with properties

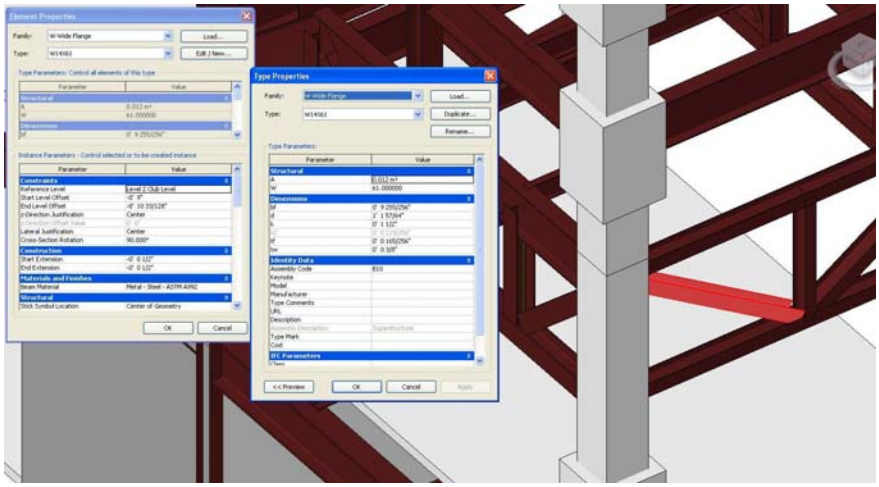


Figure 13: Detailed view of curved wide-flange brace with properties

(not applicable)

Figure 14: Detailed view of curved sloped wall with properties

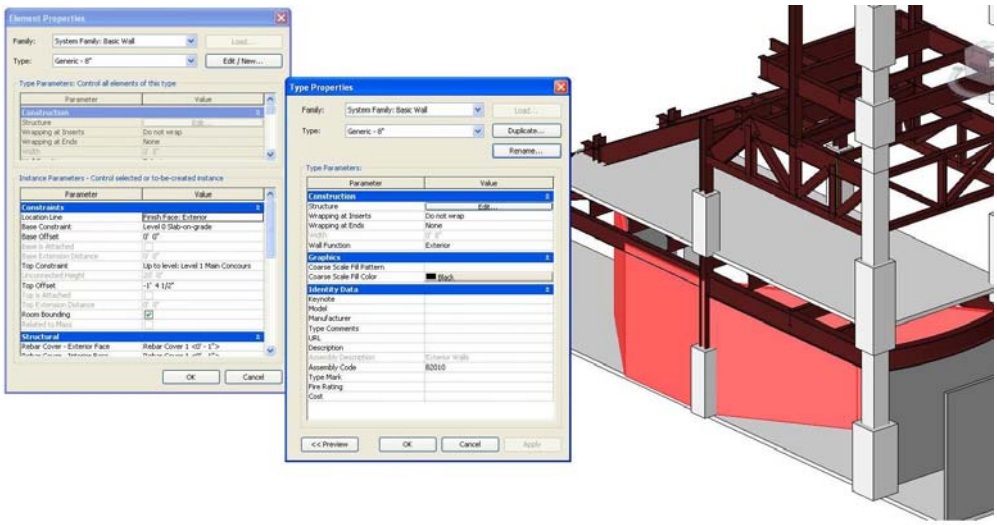


Figure 15: Detailed view of segmented wall with properties

(not applicable)

Figure 16: Detailed view of sloped slab with properties

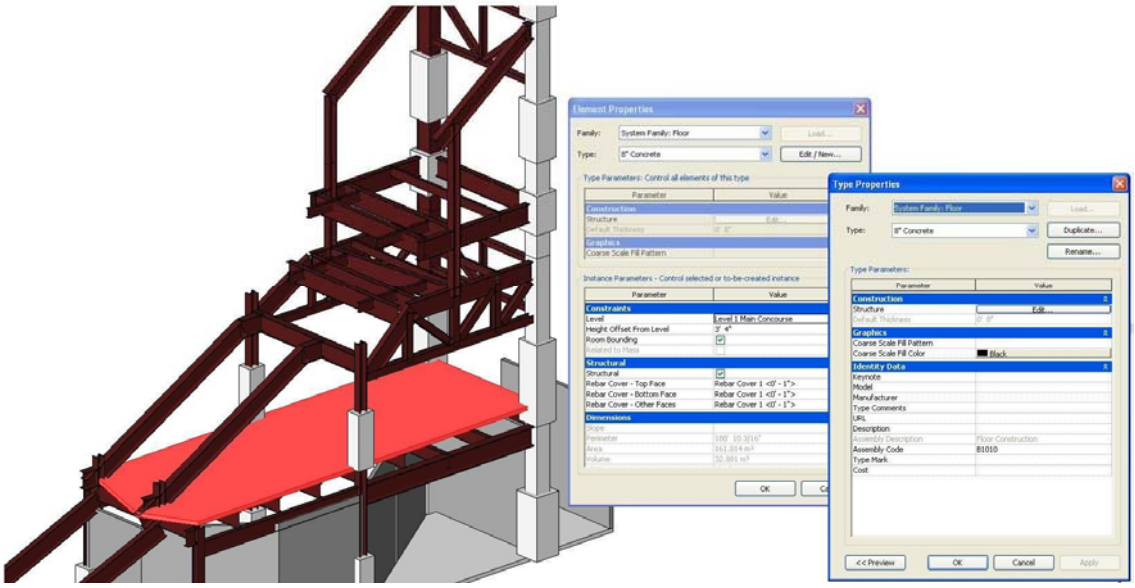


Figure 17: Detailed view of flat slab with properties

1.2 Description of the test model

The content of the test model and the important element and attribute information should be documented here. The testbed should later test that those exchange requirements are correctly exported and imported using the IFC protocol.

1.2.1 Building elements used

Main element types for the test model are:

Beams

Position (Start/End X,Y,Z coordinates)	Profile	Material	Grade	Length	Roll
(1138'-11"11/64, 518'-3"11/16, 86'-7"3/8); (1143'-3"125/128, 534'-8"93/128, 86'-7"3/8)	W36x232	Steel	A992	17'-0"	0
(1115'-9"39/64, 465'-11"27/64, 52'-5"3/32); (1124'-5"37/64, 498'-3"55/128, 70'-5"57/64)	W33x201	Steel	A992	70'-5"57/64	0
(1106'-0"15/16, 490'-4"37/128, 52'-6"); (1129'-8"117/128, 484'-0"3/16, 52'-6")	W27x84	Steel	A992	24'-6"	0
(1119'-8", 541'-0"27/32, 56'-5"57/128); (1143'-3"125/128, 534'-8"47/64, 42'-3"1/2)	W36x302	Steel	A992	30'-0"31/32	0
(1119'-8"33/128, 541'-0"49/64, 115'-1"3/4); (1143'-4"15/64, 534'-8"21/32, 115'-1"3/4)	W14x61	Steel	A992	24'-6"	0

Columns

Position (Start/End coordinates)	Profile	Material	Grade	Length	Roll
(1119'-7"127/128, 541'-0"53/64, 120'-3"1/4) ; (1119'-7"127/128, 541'-0"53/64, 154'-9"121/128)	BB36x796	Steel	A572	34'-6"89/128	-15
(1134'-0"21/128, 499'-11"29/64, 52'-4") ; (1134'-0"21/128, 499'-11"29/64, 61'-6")	36"x30"	Concrete	4000	9'-2"	-15
(1138'-11"11/64, 518'-3"87/128, 74'-10"53/128); (1138'-11"11/64, 518'-3"11/16, 102'-8"7/128)	W14x283	Steel	A992	27'-9"41/64	-15
(1143'-3"125/128, 534'-8"47/64, 120'-3"1/4); (1143'-3"125/128, 534'-8"47/64, 154'-9"121/128)	32"x32"	Concrete	5000	34'-6"89/128	-15
(1106'-9"77/128, 432'-4"11/32, 28'-0"); (1106'-9"77/128, 432'-4"11/32, 34'-10"109/128)	W14x90	Steel	A992	6'-10"109/128	-15

Braces

Position (Start/End coordinates)	Profile	Material	Grade	Length	Roll
(1138'-11"11/64, 518'-3"87/128, 66'-10"53/128); (1141'-1"37/64, 526'-6"27/128, 74'-10"53/128)	W14x90	Steel	A992	11'-8"9/128	0
(1143'-4"15/64, 534'-8"85/128, 75'-6"31/128); (1131'-6"1/4, 537'-10"91/128, 67'-6"31/128)	W14x61	Steel	A992	14'-7"73/128	0

Walls

Position (Start/End coordinates)	Profile	Material	Height	Length	
(1103'-3"19/32, 385'-3"119/128, 28'-0"); (1102'-2"49/128, 388'-8"25/128, 28'-0")	120"x8"	5000	10'-0"	24'-0"35/64	
(1119'-7"127/128, 541'-0"53/64, 28'-0"); (1126'-10"5/64, 520'-6"9/64, 28'-0")	240"x8"	5000	20'-0"	93'-2"1-128	

Slabs

Position (Start/End coordinates)	Profile	Material	Grade		
(1103'-3"19/32, 385'-3"119/128, 27'-4"); (1079'-7"79/128, 391'-8"3/128, 27'-4")	8"	5000			
(1119'-7"127/128, 541'-0"53/64, 52'-0"1/2); (1101'-9"89/128, 474'-5"1/32, 52'-0"1/2)	8"	5000			

1.2.2 Attribute content used

In addition to the proper export/ import of building elements the additional attribute content should be tested. Therefore a minimum of attributes relevant to the design phase should be created.

Object Category	Attribute name	Remark
Column	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	ASTM designation (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements' path
	Roll	Rotation about an elements' major axis; axial rotation
Beam	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	ASTM designation (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements' path
	Roll	Rotation about an elements' major axis; axial rotation
Brace	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	ASTM designation (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements' path
	Roll	Rotation about an elements' major axis; axial rotation
Wall	Thickness	Locally horizontal dimension in the shortest direction; may vary along length
	Material	Steel, concrete, CMU, etc.
	Grade	ASTM designation (i.e. A992, 5000psi)
	Alignment	Location of wall insertion point in relation to it's x-sectional centroid (center, left, right, etc.)
Slab	Thickness	Locally vertical dimension dimension in the shortest direction; may vary along length
	Material	Concrete (typically)
	Grade	ASTM designation (5000psi, etc.)

2 EXPORT TEST OF THE TEST MODEL

The export test contains various test procedures and criteria that should be performed by the applicant before submitting the test case for validation and approval. It includes the following steps:

- Export the IFC file
- Verify the IFC file for a correct header
- Verify the IFC file within a syntax checker
- Verify the IFC file for basic information, e.g. units, etc.
- Verify the IFC file within a free viewer

2.1 Verify the correct IFC file header

The IFC header has to contain the basic information about the application that created the exchange file. The IFC header can be accessed by opening the IFC file with a simple text editor.

Content of the IFC file header	Check correct information
Myifc(Revit Objects)-2x3.ifc	
ISO-10303-21; HEADER; FILE_DESCRIPTION(('IFC2X_PLATFORM'),'2;1'); FILE_NAME('P:\\Document\\Drafting\\SDOC\\ATC-75\\myifc(Revit Objects)-2x3(Build 1900).ifc','2008-06-05T09:43:02',(''),(''),'Revit Structure 2009 - 1.0','20080321_1900',''); FILE_SCHEMA(('IFC2X3')); ENDSEC;	Export date/time correct Correct IFC Schema

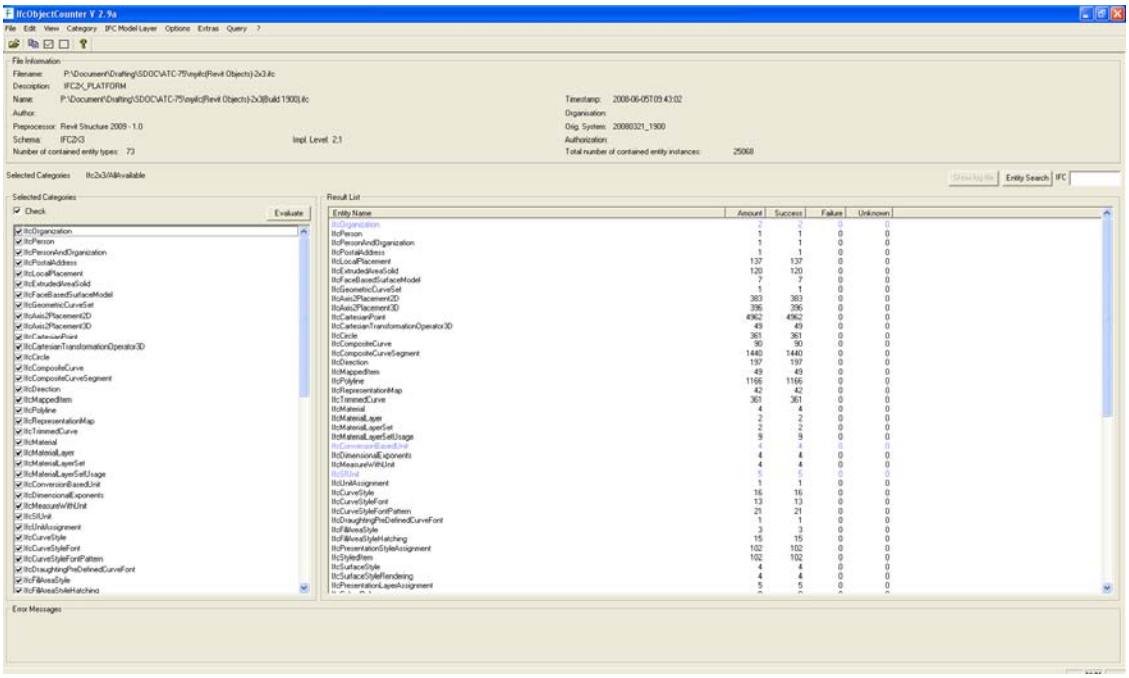
2.2 Verify within a syntax checker

Run the generated IFC file against a syntax checker. Make sure that there are no syntax errors against the IFC schema. If you are uncertain if a certain syntax error is produced erroneously, report the error together with the FC export file.

Example for a syntax checker is the *IfcObjCounter*.

See http://www.ifcwiki.org/index.php/Free_Software

Name of the IFC syntax checker	Version number, IFC schema version used	Results of the syntax check
IfcObjectCounter V2.9a	IFC2x3	No failures



2.3 Verify within a viewer

Choose one or several IFC viewers to verify the result. Verify both the geometry of the result, as well as the spatial structure and the attribute content.

Examples for a free viewer are the IfcStoreyView, the DDS Viewer or the Ifc Engine Viewer.

See http://www.ifcwiki.org/index.php/Free_Software

Figure 1: Check of geometry and beam properties

IFC viewer used	DDS Viewer Version 6.4	
Check performed	**Checking results**	**Remarks**
Columns	Geometry imports correctly	Length measureable but not a property; offsets from level given, but cannot determine top and bottom levels. Lengths different units than native model.
Beams	Geometry imports correctly	Profile/grade available, span and slope geometry are “off” by a very minute amount (slope is 6.64E-14 degrees)
Brace	Geometry imports correctly	Imports as beam. See other information for beams.
Wall	Geometry imports correctly	Material is not appropriately set.
Slab	Geometry imports correctly	Material is not appropriately set.

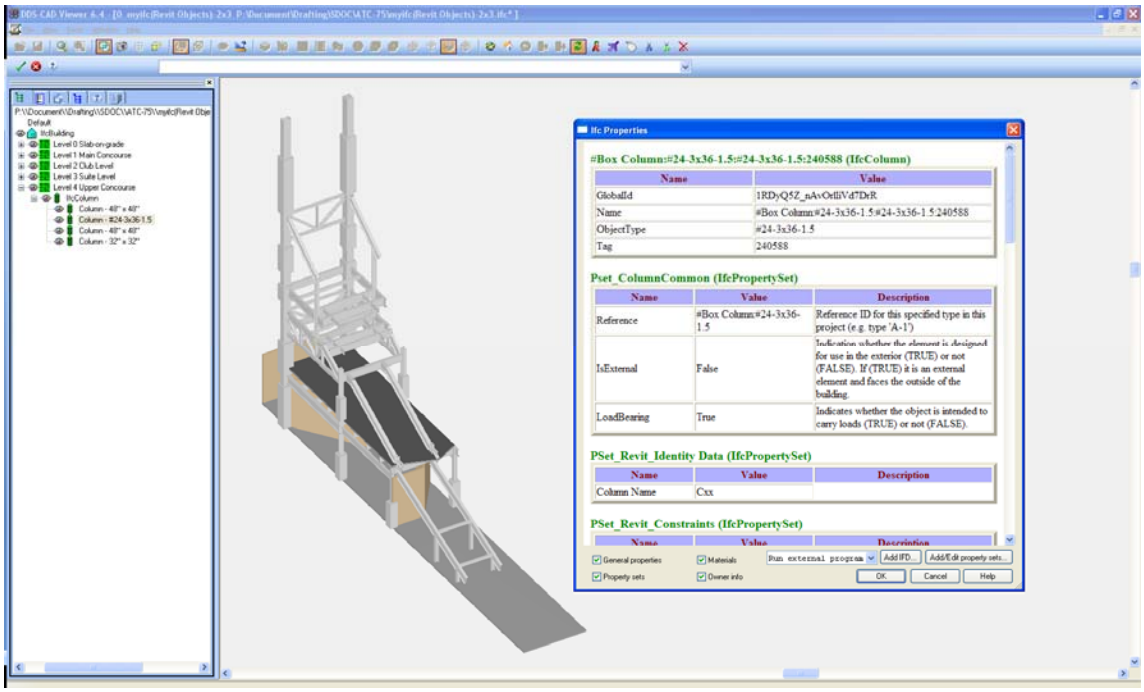


Figure 2: Check of geometry and column properties

3 IMPORT TEST OF TEST MODEL IN TARGET APPLICATION

The export file should be tested in a target application.

- An extended validation tool that includes the rules to check the conformance against the selected IFC view and the agreed implementer agreements for that IFC view.
- A series of import tests by importing the exported test case into other IFC certified applications (or applications that participates in the certification process).

3.1 Series of import tests

The content of the export file can be tested independently in viewers, the own application and by the validation tool. However in order to make sure, that the exchange with the appropriate target applications actually works, it needs to be checked manually by importing into target applications and by validating the information received by and made available to the target application.

4 FINAL TEST MATRIX

The final test matrix is available as an Excel table – see attached spreadsheet

IFC STRUCTURAL TESTBED

TESTBED FOR EXCHANGE OF STRUCTURAL DESIGN MODELS AMONG DESIGN AND ANALYSIS APPLICATION

MODEL VERSION:

BENTLEY STRUCTURAL

1 TESTBED DESCRIPTION

The structural testbed is based on a modified original design of a stadium, where one section had been cut-out and additional element types had been added. It should represent a fair portion of elements used in structural modeling.

The testbed comprises:

- A common source model to testing the IFC exchange
- A description of the test model based on the structural modeling elements and attributes used
- A description of test criteria against which the result is validated
- A realization of the same test model in (at least) two structural modeling applications
- A set of IFC export files (from the source applications) with well documented export options
- A set of success/failure descriptions for external neutral test tools
    - In IFC syntax checker,
    - In IFC validation tools,
    - In IFC viewer
- A matrix of success/failure descriptions for import into other software
    - Matrix based on test criteria and importing software
    - Importing software is either:
        - Other BIM tools (architectural/ structural modelling software), or
        - Structural analysis software

1.1 Test model description

The first test model has been created in Bentley Structural. It deals with the main elements:

- Column
- Beam
- Brace
- Wall
- Slab

The original test model has been created and exported to IFC using:

Name of application	Version number	Export options	Remarks
Bentley Structural	8.09.04.39	IFC2x3	File name: IFC_2X3_bentley.ifc

Overview picture of the test model:

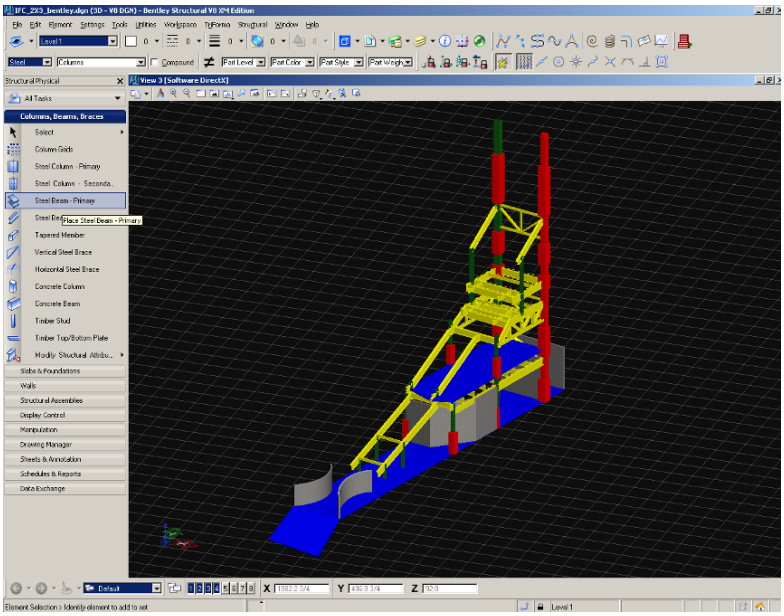


Figure 1: Perspective view of the test case 1

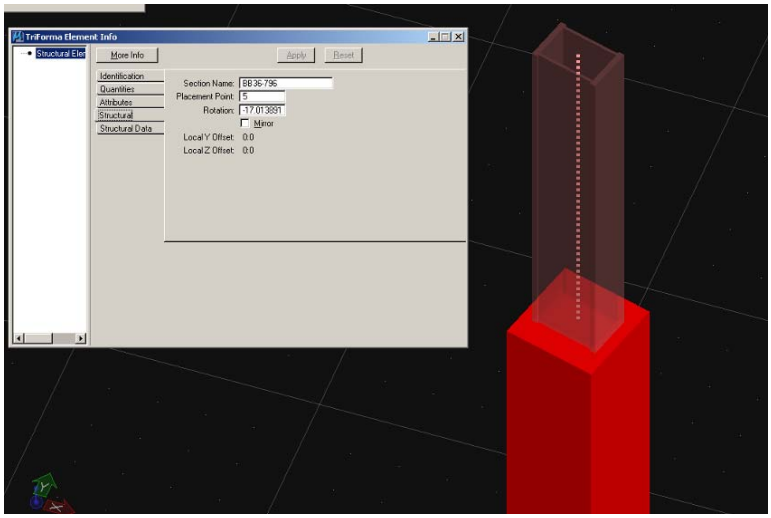


Figure 2: Detailed view of built-up column with properties

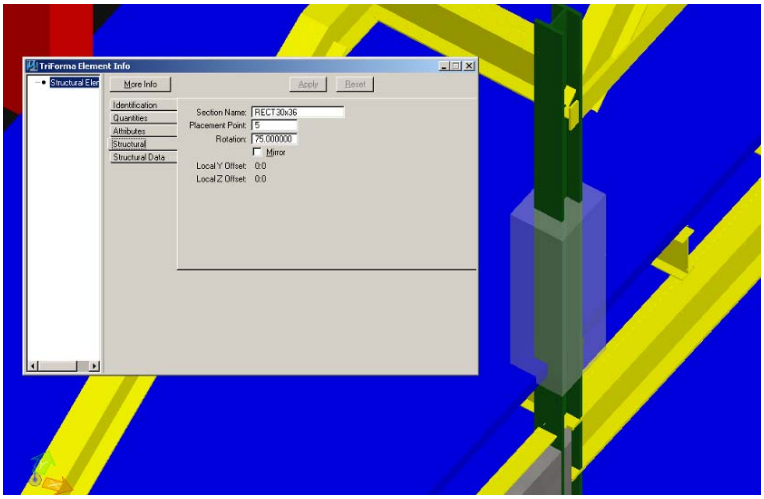


Figure 3: Detailed view of concrete column with properties

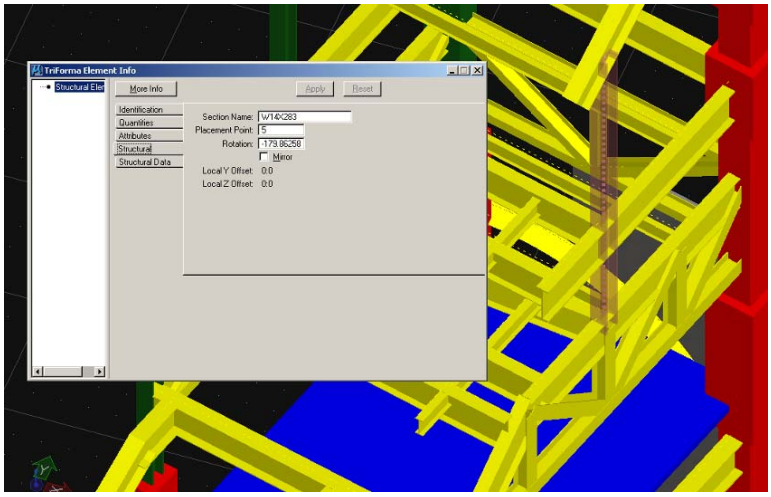


Figure 4: Detailed view of wide flange column with properties

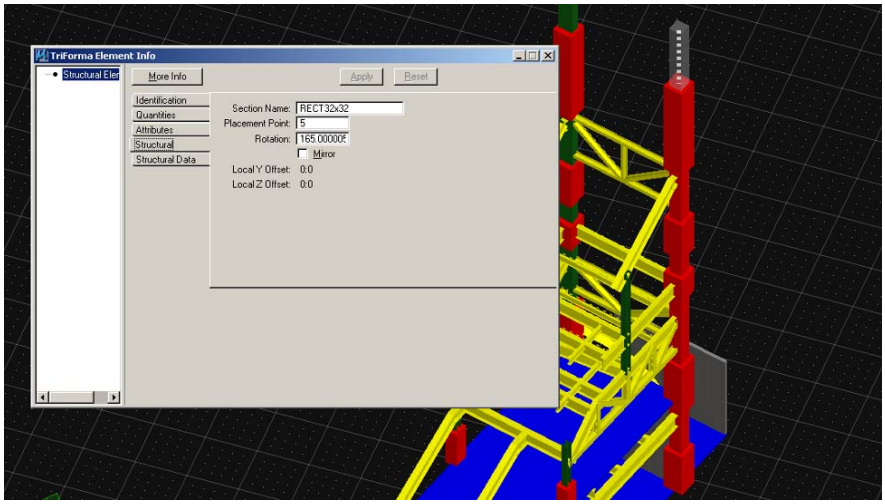


Figure 5: Detailed view of concrete column with properties

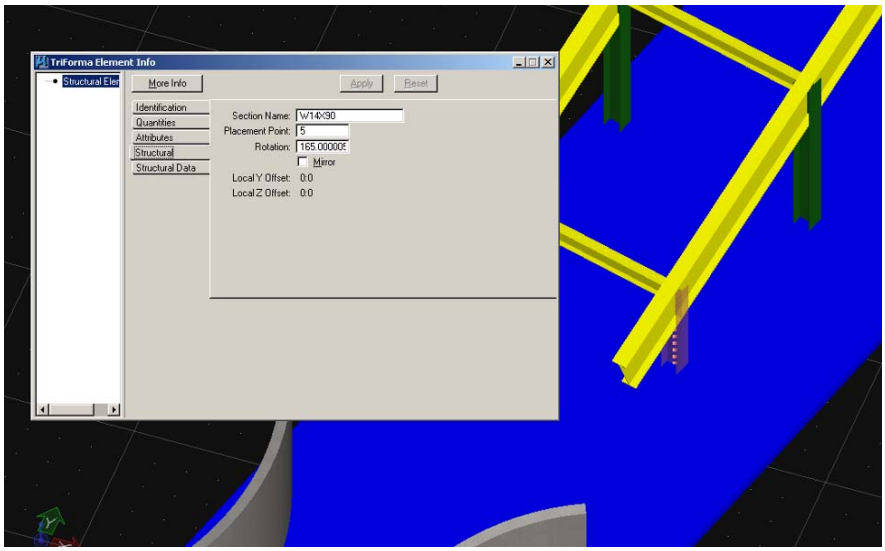


Figure 6: Detailed view of wide flange column with properties

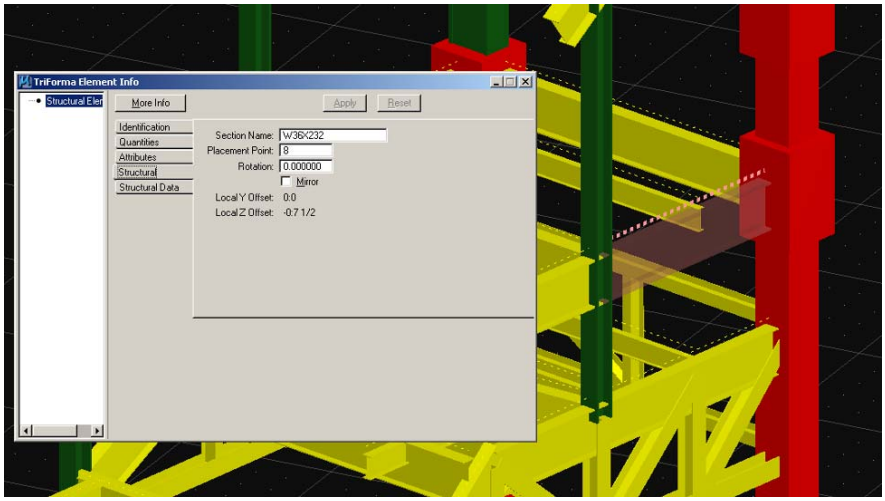


Figure 7: Detailed view of wide-flange beam with properties

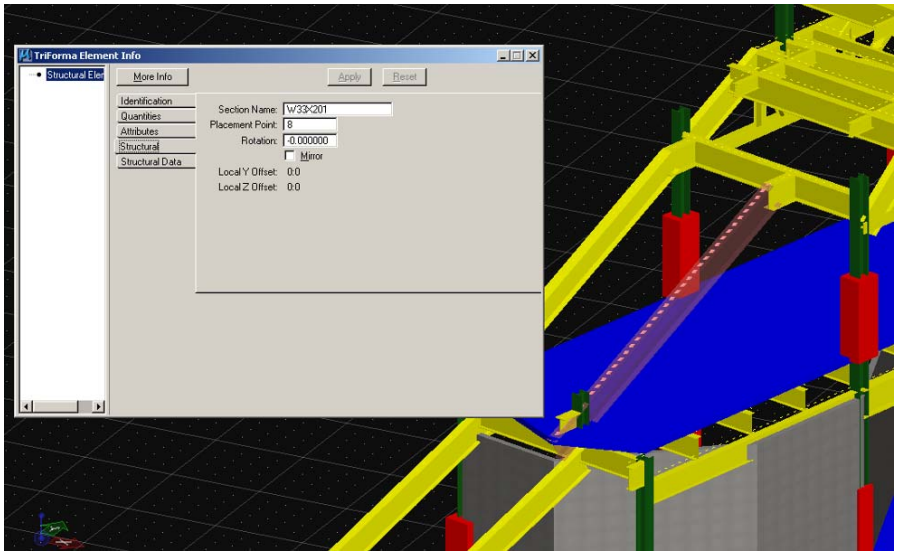


Figure 8: Detailed view of sloped wide-flange beam with properties

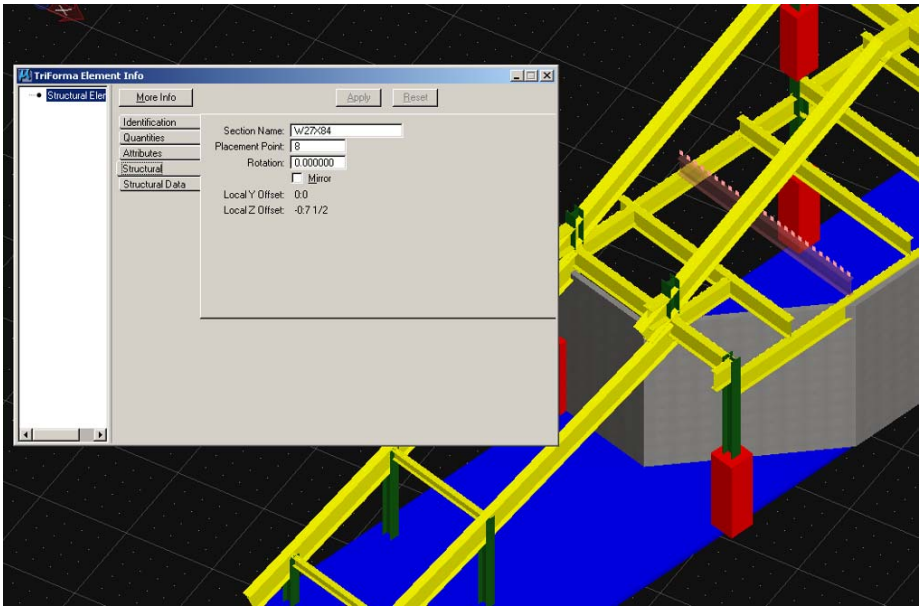


Figure 9: Detailed view of wide-flange beam with properties

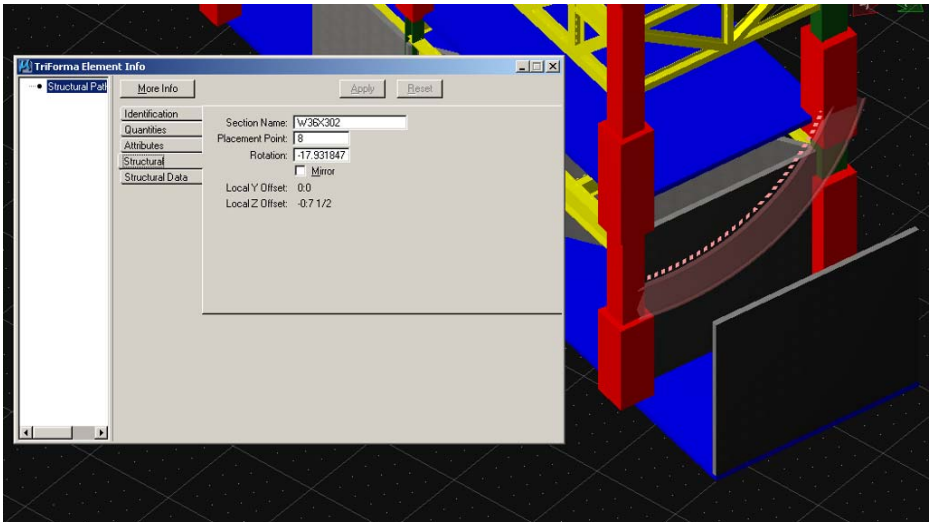


Figure 10: Detailed view of curved wide-flange beam with properties

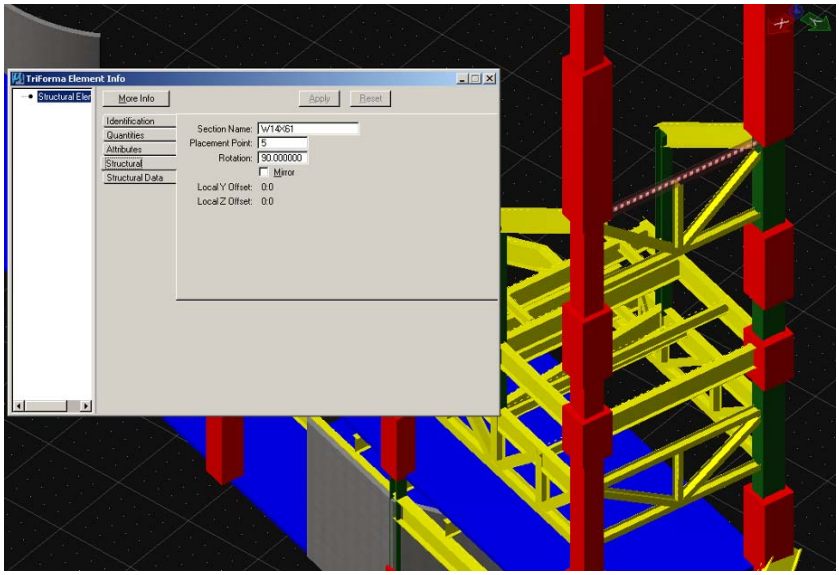


Figure 11: Detailed view of wide-flange beam with properties

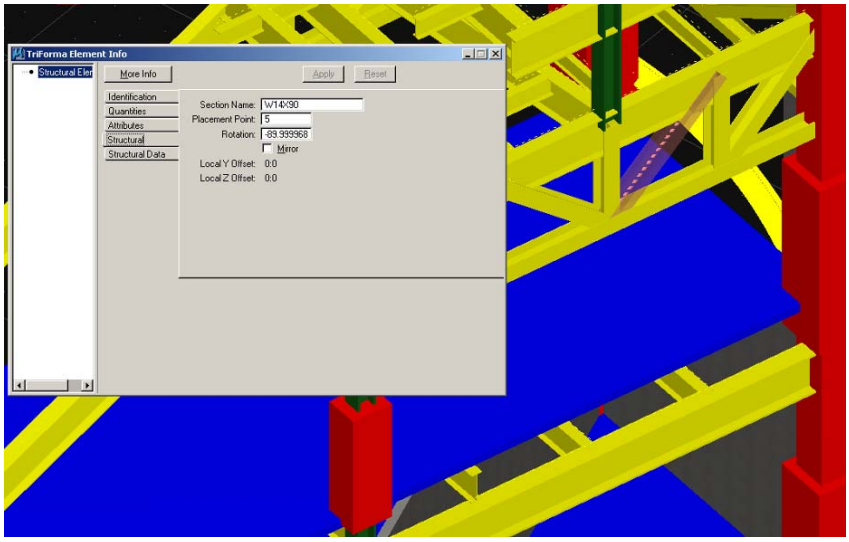


Figure 12: Detailed view of wide-flange brace with properties

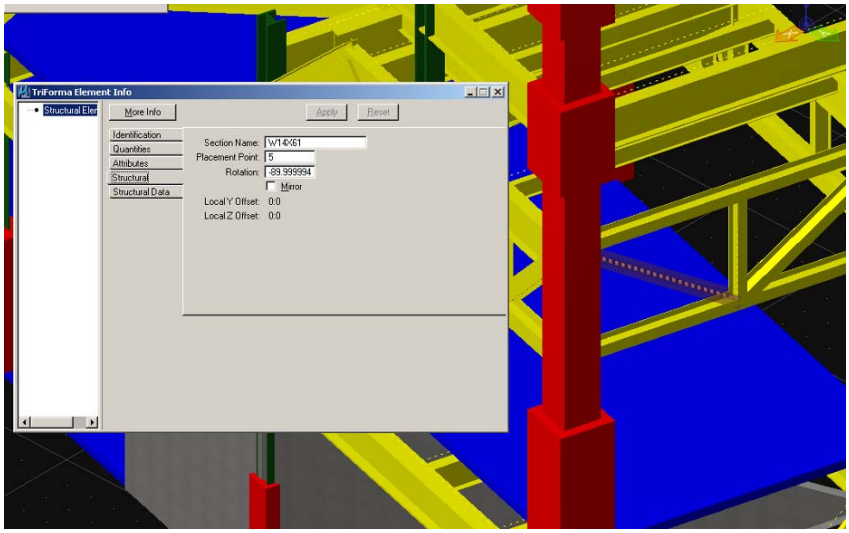


Figure 13: Detailed view of wide-flange brace with properties

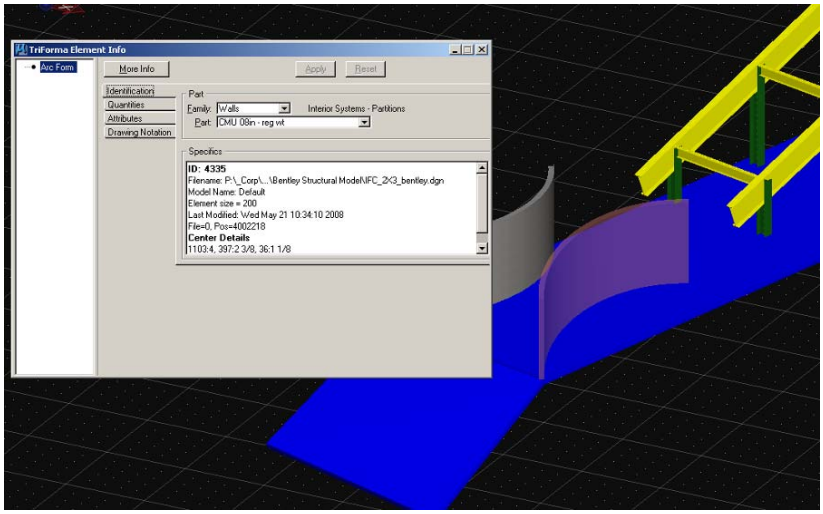


Figure 14: Detailed view of curved sloped wall with properties

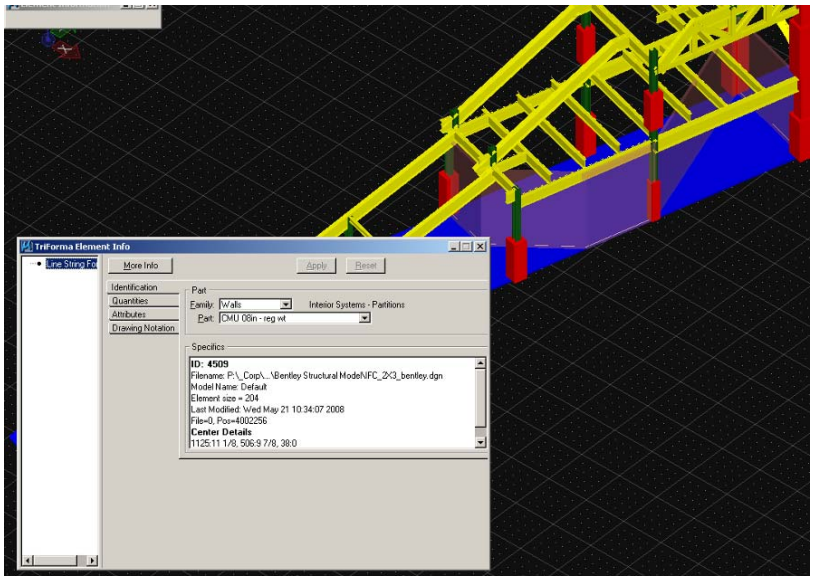


Figure 15: Detailed view of segmented wall with properties

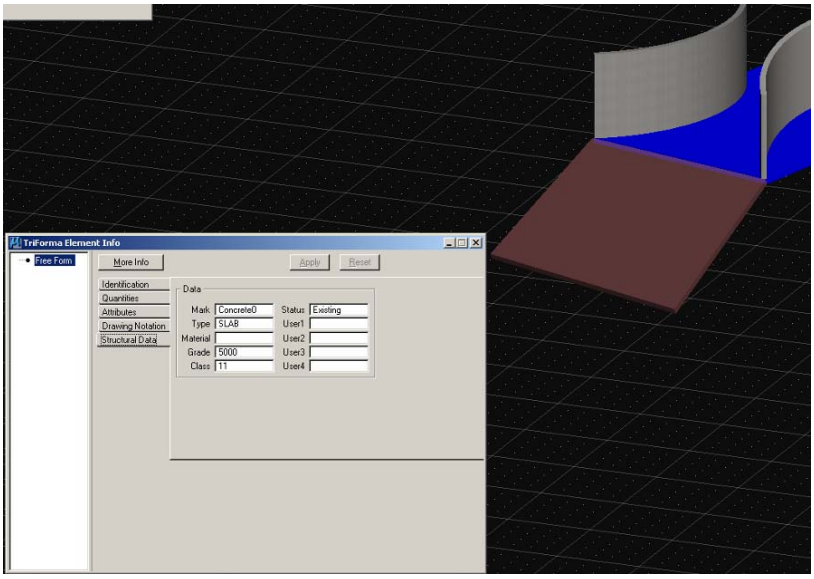


Figure 16: Detailed view of sloped slab with properties

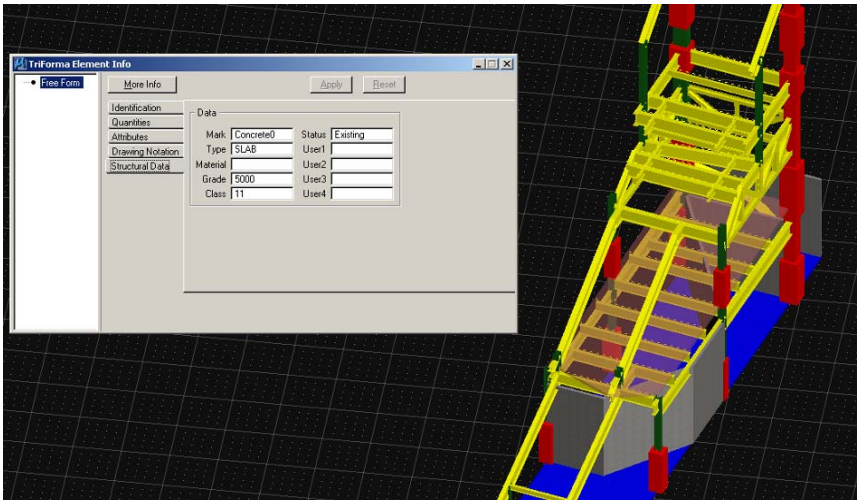


Figure 17: Detailed view of flat slab with properties

1.2 Description of the test model

The content of the test model and the important element and attribute information should be documented here. The testbed should later test that those exchange requirements are correctly exported and imported using the IFC protocol.

1.2.1 Building elements used

Main element types for the test model are:

Beams

Position (Origin X,Y,Z coordinates)	Profile	Material	Grade	Length	Roll
(1139'-5", 518'-2"1/8, 82'-3"1/4)	W36x232	Steel	A992	16’-11”63/64	0
(1116'-9"3/8, 467'-0"7/8, 49'-11"3/8)	W33x201	Steel	A992	38’-0”15/32	0
(1105'-11"5/8, 489'-11"1/2, 49'-0"1/4)	W27x84	Steel	A992	24’-5”63/64	0
(1143'-10"5/8, 536'-10"3/4, 39'-0"1/4)	W36x302	Steel	A992	30’-1”5/64	-17.93
(1119'-10", 541'-7"1/2, 114'-8"3/4)	W14x61	Steel	A992	24’-5”63/64	90

Columns

Position (Origin coordinates)	Profile	Material	Grade	Length	Roll
(1119'-8”, 541'-0"7/8, 120'-3"1/4)	BB36x796	Steel	A572	34’-6”11/16	-17.01
(1134'-10", 498'-2"1/8, 52'-4")	RECT30X36	Concrete	4000	9’-2”	75
(1138'-1"1/4, 517'-9"3/4, 74'-10"3/8)	W14x283	Steel	A992	27’-9”5/8	-179.86
(1144'-3"1/4, 533'-1"1/8, 120'-3"1/4)	32”x32”	Concrete	5000	34’-6”11/16	165
(1107'-2"1/2, 431'-7"1/2, 28'-0")	W14x90	Steel	A992	6’-10”27/32	165

Braces

Position (Start/End coordinates)	Profile	Material	Grade	Length	Roll
(1139'-4"5/8, 517'-9"1/8, 67'-3"3/4)	W14x90	Steel	A992	11’-8”1/16	-90
(1143'-3"3/8, 535'-4"1/8, 75'-10"3/8)	W14x61	Steel	A992	14’-7”9/16	-90

Walls

Position (Start/End coordinates)	Profile	Material	Height	Length	
(1103'-3"5/8, 385'-3”7/8, 28'-0")	120”x8”	CMU	9’-9”17/32	26’-9”15/32	
(1143'-4", 534'-8"3/4, 28'-0")	240”x8”	CMU	20’-0”	115’-10”57/64	

Slabs

Position (Start/End coordinates)	Profile	Material	Grade		
(1103'-3"5/8, 385'-3"7/8, 27'-4")	8”	5000			
(1119'-8", 541'-0"7/8, 52'-0"1/2)	8”	5000			

1.2.2 Attribute content used

In addition to the proper export/ import of building elements the additional attribute content should be tested. Therefore a minimum of attributes relevant to the design phase should be created.

Object Category	Attribute name	Remark
Column	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements’ path
	Roll	Rotation about an elements’ major axis; axial rotation
Beam	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements’ path
	Roll	Rotation about an elements’ major axis; axial rotation
Brace	Profile	Shape or cross-sectional description
	Material	Steel, concrete, timber, etc.
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. A992, 5000psi)
	Length	Distance from start to end point along an elements’ path
	Roll	Rotation about an elements’ major axis; axial rotation
Wall	Thickness	Dimension in the shortest direction (typically horizontal), taken normal to the surface defining wall height; may vary along length
	Material	Timber (stud), concrete, CMU, etc.
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. DFL2, 5000psi)
	Alignment	Location of wall insertion point in relation to its x-sectional centroid (center, left, right, etc.)
Slab	Thickness	Dimension in the shortest direction (typically vertical); may vary along length
	Material	Concrete (typically)
	Grade	Designation of alloy type, strength, or other material sub-category (i.e. DFL2, 5000psi)

2 EXPORT TEST OF THE TEST MODEL

The export test contains various test procedures and criteria that should be performed by the applicant before submitting the test case for validation and approval. It includes the following steps:

- Export the IFC file
- Verify the IFC file for a correct header
- Verify the IFC file within a syntax checker
- Verify the IFC file for basic information, e.g. units, etc.
- Verify the IFC file within a free viewer

2.1 Verify the correct IFC file header

The IFC header has to contain the basic information about the application that created the exchange file. The IFC header can be accessed by opening the IFC file with a simple text editor.

Content of the IFC file header	Check correct information
IFC_2X3_bentley.ifc	
ISO-10303-21; HEADER; /* Generated by software containing ST-Developer * from STEP Tools, Inc. (www.steptools.com) */ FILE_DESCRIPTION(/* description */ ('IFC2X_PLATFORM', 'MicroStation Triforma generated IFC File', 'Triforma IFC version 8.9.4.33','*Comments*'), /* implementation_level */ '2;1'); FILE_NAME(/* name */ 'IFC_2x3_bentley', /* time_stamp */ '2008-05-27T10:59:18-04:00', /* author */ ('SDoolan'), /* organization */ ('TT'), /* preprocessor_version */ 'ST-DEVELOPER v8', /* originating_system */ 'WinNT', /* authorisation */ 'Admin'); FILE_SCHEMA (('IFC2X3')); ENDSEC;	Export date/time correct Correct IFC Schema

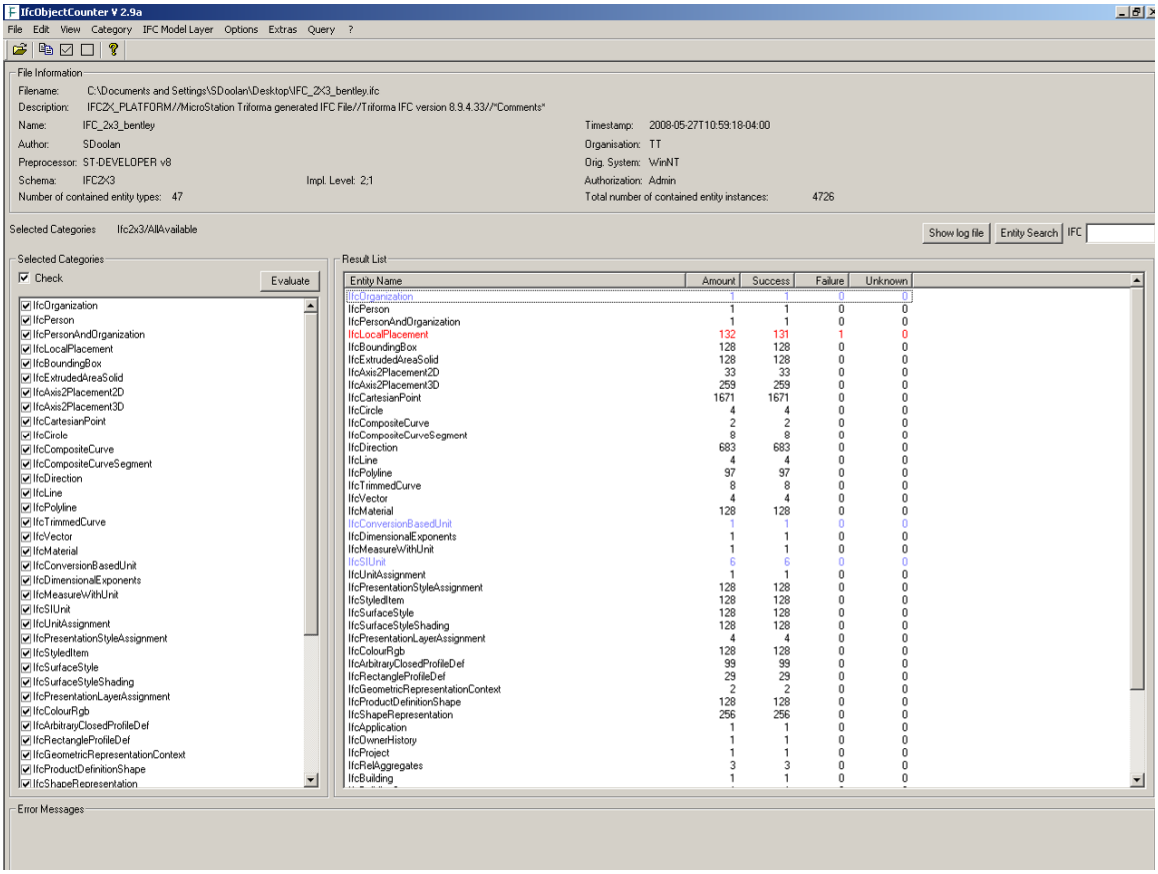
2.2 Verify within a syntax checker

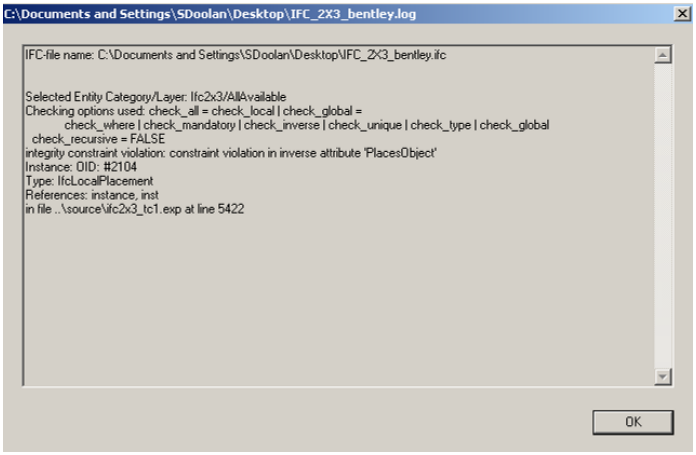
Run the generated IFC file against a syntax checker. Make sure that there are no syntax errors against the IFC schema. If you are uncertain if a certain syntax error is produced erroneously, report the error together with the FC export file.

Example for a syntax checker is the *IfcObjCounter*.

See http://www.ifcwiki.org/index.php/Free_Software

Name of the IFC syntax checker	Version number, IFC schema version used	Results of the syntax check
IfcObjectCounter V2.9a	IFC2x3	1 failure in IfcLocalPlacement





2.3 Verify within a viewer

Choose one or several IFC viewers to verify the result. Verify both the geometry of the result, as well as the spatial structure and the attribute content.

Examples for a free viewer are the IfcStoreyView, the DDS Viewer or the Ifc Engine Viewer.

See http://www.ifcwiki.org/index.php/Free_Software

IFC viewer used	DDS viewer Version 6.4	
Check performed	**Checking results**	**Remarks**
Columns	Geometry does not import correctly	Built-up column is geometrically incorrect; material property imported to “name” field
Beams	Geometry does not import correctly	Curved beam is geometrically incorrect; material imported to “name” field
Brace	Geometry imports correctly	Imports as beam; material property imported to “name” field
Wall	Geometry imports correctly	Only properties available is material and thickness; no other properties available
Slab	Geometry imports correctly	Material imported to “name” and “material name” fields; no other properties available

Figure 1: Test results summary for DDS viewer

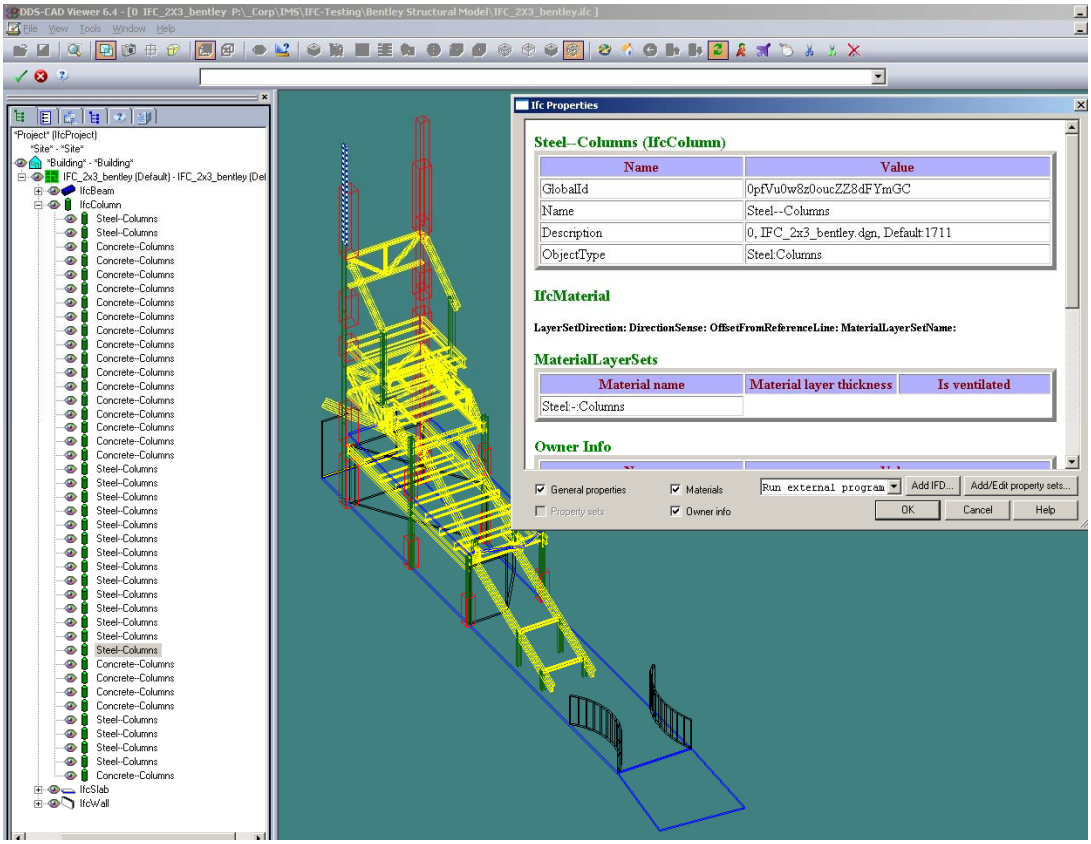


Figure 2: View of geometry with properties in DDS-CAD Viewer 6.4

3 IMPORT TEST OF TEST MODEL IN TARGET APPLICATION

The export file should be tested in a target application.

- An extended validation tool that includes the rules to check the conformance against the selected IFC view and the agreed implementer agreements for that IFC view.
- A series of import tests by importing the exported test case into other IFC certified applications (or applications that participates in the certification process).

3.1 Series of import tests

The content of the export file can be tested independently in viewers, the own application and by the validation tool. However in order to make sure, that the exchange with the appropriate target applications actually works, it needs to be checked manually by importing into target applications and by validating the information received by and made available to the target application.

3.1.1 Import into AutoCAD Architecture

Version number	IFC built	Remarks
AutoCAD Architecture 2008 B.219.0	IFC2x3 (IFC_2X3_bentley.ifc)	Imports with no error messages; model units incorrect (see matrix)

Check performed	Checking results	Remarks
Columns	Geometry does not import correctly	Properties available are roll and length; built-up members not imported correctly
Beams	Geometry does not import correctly	Properties available are roll and length; curved sections not imported correctly
Brace	Geometry imports correctly	Imports as beam; Properties available are roll and length
Wall	Geometry imports correctly	Properties available are material, width, justification, rotation and length.
Slab	Geometry imports correctly	Properties available are thickness and “run” (width).

Figure 1: Import test results summary in AutoCAD Architecture 2008

3.1.2 Import into Revit

Version number	IFC built	Remarks
Autodesk Revit Structure 2008.0.0	IFC2x3 (IFC_2X3_bentley.ifc)	Error messages on import; model units are incorrect

Check performed	Checking results	Remarks
Columns	Geometry does not import correctly	Imports columns as architectural elements (see matrix); new family for each instance; only property available is material; built-up column is geometrically incorrect
Beams	Geometry does not import correctly	Imports as “Steel: Beams”; new family for each instance; only property available is material; curved beam is geometrically incorrect
Brace	No geometry imported	Braces missing from model (see matrix)
Wall	Most geometry imports correctly	Some walls missing; height, length, thickness and material available for straight walls only
Slab	Geometry imports correctly	Imported as “floor”, only thickness available

Figure 2: Import test results summary in Revit Structure 2008

4 FINAL TEST MATRIX

The final test matrix is available as an Excel table – see attached spreadsheet