Chapter 6

Psets (PropertySets) V1.0 for IfcRoad

July. 01 2016

**Korea Institute of Civil Engineering
and Building Technology**

6. Psets(PropertySets) V1.0 for IfcRoad by KICT

A. <u>Road</u>

1. Pset_RoadBodyDesignParameter_K.xml

2. Pset_RoadElementDesignParameters_K.xml

3. Pset_RoadAlignmentDesignCommon_K.xml

4. Pset_RoadCurbCodeCommon_K.xml

5. Pset_RoadMedianstripDesignCommon_K.xml

6. Pset_RoadMedianstripManagement_K.xml

7. Pset_RoadPavementCommon_K.xml

8. Pset_RoadProjectMgmtCommon_K.xml

9. Pset_RoadShoulderCommon_K.xml

10. Pset_CaissonCommon_K.xml

11. Pset_CulvertCommon_K.xml

12. Pset_EarthworkElementCommon_K.xml

13. Pset_RetWallCommon_K.xml

B. <u>Bridge</u>

1. Pset_BridgeAbutmentCommon_K.xml

2. Pset_BridgeCableCommon_K.xml

3. Pset_BridgeCopingCommon_K.xml

4. Pset_BridgeDeckPlateCommon_K.xml

5. Pset_BridgeElementCommon_K.xml

6. Pset_BridgeGirderCommon_K.xml

7. Pset_BridgePierCommon_K.xml

8. Pset_BridgeProject_K.xml

9. Pset_BridgeSegmentCommon_K.xml

10. Pset_BridgeSpanCommon_K.xml

11. Pset_BridgeTowerCommon_K.xml

C. Tunnel

1. Pset_TunnelElementCommon_K.xml

2. Pset_TunnelLiningCommon_K.xml

3. Pset_TunnelLiningSegmentCommon_K.xml

4. Pset_TunnelProject_K.xml

D. Drainage

1. Pset_GutterFittingCommon_K.xml

2. Pset_GutterSegmentCommon_K.xml

E. Subsidiary Facilities

1. Pset_GuardCommon_K.xml

2. Pset_PavementAdditionCommon_K.xml

3. Pset_RoadSignEquipmentCommon_K.xml

Chapter 7
Qsets(QuantitySets) V1.0 for IfcRoad

July. 01 2016

**Korea Institute of Civil Engineering
and Building Technology**

7. Qsets(QuantitySets) V1.0 for IfcRoad by KICT

1. Qto_CaissonQuantities_K.xml

2. Qto_CulvertQuantities_K.xml

3. Qto_DistributionChamberElementBaseQuantities.xml

4. Qto_EarthworkElementQuantities_K.xml

5. Qto_FlowFittingQuantities_K.xml

6. Qto_FootingBaseQuantities.xml

7. Qto_GuardQuantities_K.xml

8. Qto_GutterFittingQuantities_K.xml

9. Qto_GutterSegmentQuantities_K.xml

10. Qto_PavementAdditionQuantities_K.xml

11. Qto_PipeSegmentBaseQuantities.xml

12. Qto_RetainingWallQuantities_K.xml

13. Qto_RoadCurbQuantities_K.xml

14. Qto_RoadMedianStripQuantities_K.xml

15. Qto_RoadPavementQuantities_K.xml

16. Qto_RoadShoulderQuantities_K.xml

17. Qto_RoadSignElementQuantities_K.xml

18. Qto_SiteBaseQuantities.xml

19. Qto_SiteQuantities_K.xml

20. Qto_SlabBaseQuantities.xml

21. Qto_WallBaseQuantities.xml

Chapter 8

IDM for QTO V0.9

July. 01 2016

Korea Institute of Civil Engineering and Building Technology

Korea Institute of Civil Engineering and Building Technology

buildingSMART alliance

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Draft of Information Delivery Manual (IDM) for Quantity Take-Off (QTO) in Road Projects at Detailed Design Phase

Table of Contents

1. Process Map

Name	**KICT – Quantity Take-Off in Road Projects at Detailed Design Phase**

Identifier	PM_Road_Design_to_QTO_v.1.0

Change Log		
2015-07-12	Initial creation version 0.8, draft for internal review	Hyounseok Moon hsmoon@kict.re.kr
2015-09-15	Edits creating version 0.9	Kibeom Ju kbju@kict.re.kr Hyounseok Moon hsmoon@kict.re.kr Changyoon Kim ckim@kict.re.kr Jisun Won wonjisun@kict.re.kr Geunha Cho cgh@kict.re.kr
2015-10-25	Modifications of ER, version 1.0	Hyounseok Moon hsmoon@kict.re.kr

Exchange Requirements	ER_Road_Design_to_QTO(Calculation)
	ER_Road_Design_to_QTO(Submission)
	ER_Road_Design_to_QTO(Client Review)

1.1 Overview

Quantity take-off (QTO) is an activity of assessing and measuring needed resources such as materials to complete construction projects. In the detailed design phase, more accurate and precise specifications for construction phase are prepared based on a previous quantity take-off report at conceptual design phase and other information about construction projects. Then, to calculate expected budget of the construction projects, a result of the quantity take-off process is utilized to determine whether the design meets the project budget. During this processes, multiple participants such as staff or technical consultants of client and staff of design team who are associated with quantity take-off and cost estimation exchange the data and report about construction projects.

Road facilities consist of road corridor model with earthwork operations, bridge, tunnel, and subsidiary facilities. However, above civil elements are not yet represented with civil entity in IFC4 (ISO16739) so that entities and their attributes for representing infrastructure facilities in a physical shape such as roads with earthwork has been currently developed by small working group (WG) for IfcRoad.

1.1.1 Scope of the IFC Road project

The main scope of the IFC Road project is to extend the product data model of road facilities with earthwork operations enabling open data access based on IFC4 (ISO16739) schema in order to secure interoperability in delivering the as-built design model to a government agency. In this project, the critical facility scope includes the spatial structure related to roads, roadways with cross-section views, earthwork operations with cut & fill, and drainage facilities.

The hierarchical division structure in the perspective of LODs (Level of Details) of the road facilities is divided into different levels of shape entities that are suitable for the delivery of as-built road models for a detailed design phase before preparing shop drawings in the construction process.

The IFC Road will provide a common definition layer for road extension schemas. The data model definition of the IFC Road includes:

· Spatial structure : structural spaces, referenced spaces considering geospatial coordinate reference system and the representations of IfcAlignment

- Structures : road facilities in earthworks, civil common, culverts, retaining walls, drainages, and subsidiary facilities that are grouped into shape entities for elements at the upper facility level
- Properties : common properties of a project from the design to the operation phase which are unique properties of each element
- Earthwork model : an original terrain model with IfcSite, cut & fill shape entities as an object shape

In Scope
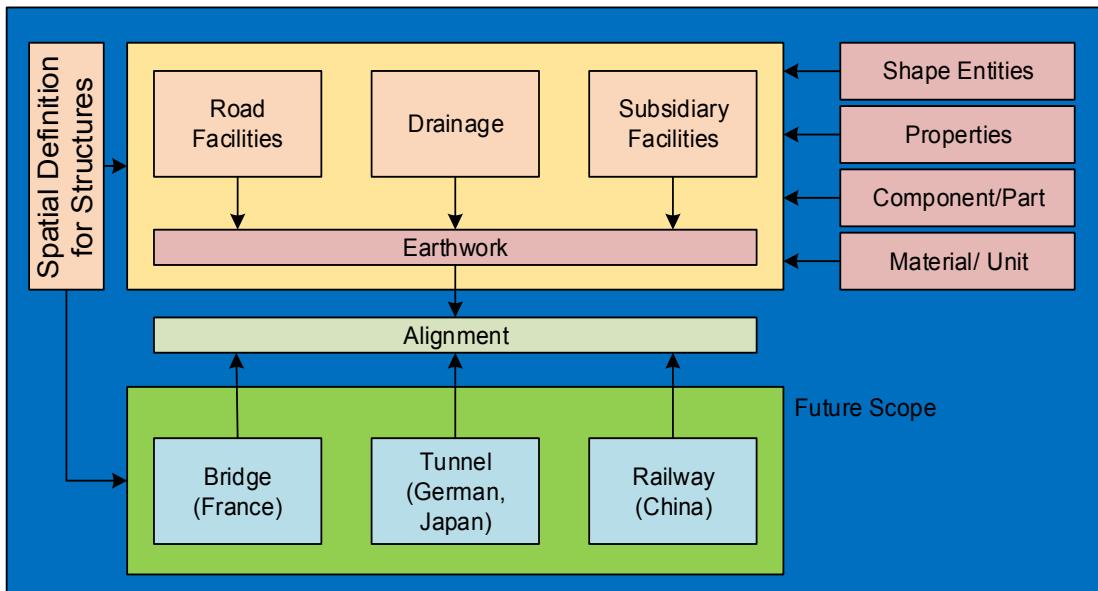
Figure 1: IfcRoad development scope

Those parts, shown in Figure 1, are in the scope of the IfcRoad project. Other parts, such as alignment, bridge, tunnel and railway etc. are out of scope of this project, but will be expanded later through the extension projects such IfcBridge, IfcTunnel, IfcRailway and IfcAlignment.

1.1.2 Quantity Take-Off in Road projects at Design Phase

As presented at the previous section, the scope of quantity take-off (QTO) in road projects at design phase includes the quantity of earthwork, road facilities, drainage facilities, and subsidiary facilities. In other words, the quantity take-off process is executed based on calculation and estimation of physical feature of the road projects. For this reason, this IDM for quantity take-off in road project at design phase only consider the physical model of the road projects which are developed by IFC-BIM software. Then, the total target cost of the road projects is estimated by designer and consultants of the client according to the cost database (DB).

In this process map, the design phase of the road projects is presented to show the quantity take-off processes using IFC-BIM data. The data for quantity take-off in road projects at design phase is transferred and received among technical staff or consultants of the client, client staff, and designer. The process map also presented type of reference data and BIM data for the quantity take-off in road projects.

1.2. Process Map : Quantity Take-Off of Road Projects at Design Phase

As presented on the very left side of the process map, the following process map is focusing on theses main actors in the quantity take-off of road projects at design phase:

- Client (Technical Staff or Consultants)
- Client (Client Staff)
- Designer

Client (Technical Staff or Consultants)

On the first lane of the process map, tasks of technical staff or consultants are presented. The technical staff or consultants who are hired by client check the submitted BIM model for QTO and QTO/Cost report. In these processes, the detailed comment of QTO/Cost analysis results are derived for appropriate decision of the client staff.

Client (Client Staff)

The third lane presented the tasks of the client staff. The client staff received the QTO/Cost analysis results and BIM models from the designer. Firstly, the client staff validate the submitted data to confirm the data has enough quality to conduct QTO and cost analysis. When the submitted data is good enough to conduct QTO and cost analysis, the submitted report and BIM data are passed to the technical staff or consultants of the client side, and then the estimation and calculation of quantity and cost processes are conducted.

Designer

On the very bottom lane of the process map, tasks of designers are presented. After the completion of the detailed design BIM data, the tasks of the designer are started. Prior to conduct estimation and calculation of quantity and cost of the road projects at the detailed design phase, the BIM model is
In these processes,
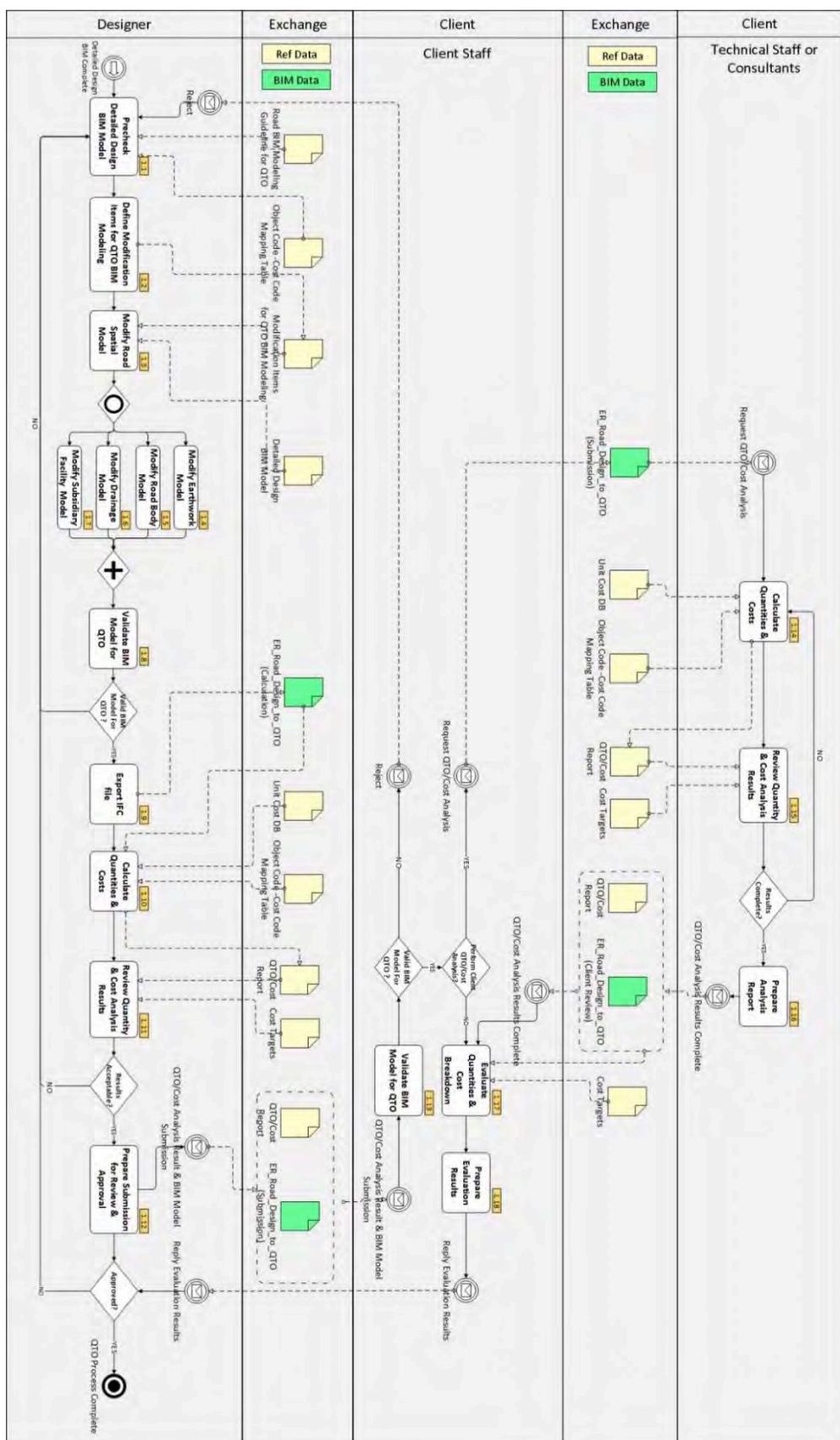
Figure 2: Process Map Illustration

1.2.1 Specification of Processes

1.2.1.1 Precheck Detailed Design BIM Model [1.1]

Type	Task	
Name	Precheck Detailed Design BIM Model	
Documentation	At this point the BIM model of detailed design phase is transferred to the appropriate designers to prepare the BIM data for QTO. The designers who are experts in the area of quantity take-off and cost estimation check the current quality of the BIM model prior to modification items for QTO BIM modeling task.	

1.2.1.2 Define Modification Items for QTO BIM Modeling [1.2]

Type	Task	
Name	Define Modification Items for QTO BIM Modeling	
Documentation	In this task, the designer defines necessary modification items for QTO BIM modelling. Based on the result of the previous precheck task, the designer identify modification items such as property and attribute of earthwork, road body, drainage, subsidiary model. Then, modification items list for QTO BIM modelling is developed for next Modify Road Spatial Model, **Modify Earthwork Model, Modify Road Body Model, Modify Drainage Model, Modify Subsidiary Facility Model** tasks.	

1.2.1.3 Modify Road Spatial Model [1.3]

Type	Task	
Name	Modify Road Spatial Model	
Documentation	In this task, the designer makes any necessary modifications to the road spatial model. Prior to modify earthwork, road body, drainage, and subsidiary facility model, the road spatial model is modified based on the **Modification Items List for QTO BIM Modeling** and **Detailed Design BIM Model**.	

1.2.1.4 Modify Earthwork Model [1.4]

Type	Task	
Name	Modify Earthwork Model	
Documentation	In this task, the designer makes any necessary modifications to the earthwork model. The detailed property and attribute of earthwork model is modified for the QTO and cost calculation. According to the condition of the road project BIM model, types, volumes, materials and other characteristics of earthwork BIM model are modified to calculate and estimate quantity and cost of the project.	

1.2.1.5 Modify Road Body Model [1.5]

Type	Task	
Name	Modify Road Body Model	
Documentation	In this task, the designer makes any necessary modifications to the road body model. The detailed property and attribute of earthwork model is	

	modified for the QTO and cost calculation. According to the condition of the road project BIM model, cross section, length, volumes, materials and other characteristics of road body BIM model are modified to calculate and estimate quantity and cost of the project.

1.2.1.6 Modify Drainage Model [1.6]

Type	Task	
Name	Modify Drainage Model	
Documentation	In this task, the designer makes any necessary modifications to the drainage model. The detailed property and attribute of earthwork model is modified for the QTO and cost calculation. According to the condition of the road project BIM model, types, length, volumes, materials and other characteristics of drainage BIM model are modified to calculate and estimate quantity and cost of the project.	

1.2.1.7 Modify Subsidiary Facility Model [1.7]

Type	Task	
Name	Modify Subsidiary Facility Model	
Documentation	In this task, the designer makes any necessary modifications to the subsidiary facility model. The detailed property and attribute of subsidiary facility model is modified for the QTO and cost calculation. According to the condition of the road project BIM model, types, length, volumes, materials and other characteristics of subsidiary BIM model are modified to calculate and estimate quantity and cost of the project.	

1.2.1.8 Validate BIM Model for QTO [1.8]

Type	Task	
Name	Validate BIM Model for QTO	
Documentation	After geometry, earthwork, road body, drainage, subsidiary facility model and any other modifications to the road project are made, the BIM is ready to be validated for quantity and cost analysis. Validation task will take place by exporting an IFC file and using a BIM model converter or checker.	

1.2.1.9 Export IFC file [1.9]

Type	Task	
Name	Export IFC file	
Documentation	After the BIM model has been prepared for quantity take-off and validated in Task 1.8, it is exported to IFC for QTO. In this task, all the required exchange requirements are prepared in **ER_Road_Design_to_QTO(Calculation).**	

1.2.1.10 Calculate Quantities & Costs [1.10]

Type	Task	
Name	Calculate Quantities & Costs	
Documentation	The internal staffs of the design team or cost estimation consultants will calculate quantities and costs of the road projects. The quantities and costs estimating applications or software are used to calculate quantities and costs	

| | of the road projects. At this time the **Unit Cost DB** and the **Object Code - Cost Code Mapping Table** are used as a reference data. Then, the **QTO/Cost Report** is submitted by designers. |

1.2.1.11 Review Quantity & Cost Analysis Results [1.11]

Type	Task	
Name	Review Quantity & Cost Analysis Results	
Documentation	At this task, all the exchange requirements of the **ER_Road_Design_to_QTO(Calculation)** should be derived. The result is evaluated based on **QTO/Cost Report** and **Target Cost** of the project to calculate and estimate the quantity and cost of road projects. After that, the results are analysed whether the results are acceptable or not.	

1.2.1.12 Prepare Submission for Review & Approval [1.12]

Type	Task	
Name	Prepare Submission for Review & Approval	
Documentation	After the designer is satisfied with a design, the designer will prepare a submission package for client review or approval. The designer may transfer the IFC model for the quantity and cost reports referencing the documents created in the quantity and cost analysis.	

1.2.1.13 Validate BIM Model for QTO [1.13]

Type	Task	
Name	Validate BIM Model for QTO	
Documentation	In this task, the received **ER_Road_Design_to_QTO(Submission)** and **QTO/Cost Report** are validated to conduct confirm process. When the BIM model is appropriate for QTO, received data from the designer is passed to evaluated quantity and cost breakdown. However, the BIM model is not appropriate for QTO, the received data is again transferred to the designer for **Precheck Detailed Design BIM Model.**	

1.2.1.14 Calculate Quantities & Costs [1.14]

Type	Task	
Name	Calculate Quantities & Costs	
Documentation	The technical staff or hired consultant verify the designer's quantity/cost results. The estimating application may use reference data such as **Unit Cost DB** and **Object Code-Cost Code Mapping Table** to prepare the cost estimate.	

1.2.1.15 Review Quantity & Cost Analysis Results [1.15]

Type	Task	
Name	Review Quantity & Cost Analysis Results	
Documentation	The results of the client quantity/cost analysis are obtained and evaluated. The results are reviewed to ensure accuracy.	

1.2.1.16 Prepare Analysis Report [1.16]

Type	Task	
Name	Prepare Analysis Report	
Documentation	After the client quantity/cost analysis results are approved, an analysis report is prepared to compare the results of the client analysis with those of the designer.	

1.2.1.17 Evaluate Quantities & Cost Breakdown [1.17]

Type	Task	
Name	Evaluate Quantities & Cost Breakdown	
Documentation	The client evaluate the analysis report submitted by technical staff or consultant. Using the completed QTO/cost analysis results and target cost information.	

1.2.1.18 Prepare Evaluation Results [1.18]

Type	Task	
Name	Prepare Evaluation Results	
Documentation	The client staff make a documentation of the quantities and cost analysis results. It includes detailed analysis from the client and recommendation and comments to the design team.	

1.2.2 Specification of Decision Point Gateways

1.2.2.1 Valid BIM Model for QTO?

Type	Decision Point
Name	Valid BIM Model for QTO
Documentation	The designer check the quality of BIM model to ensure that the BIM model includes all the input exchange requirements for QTO. This process is conducted by a BIM model checker. The rule based BIM model checker performed the decisions making whether the BIM is valid or not.

1.2.2.2 Results Acceptable?

Type	Decision Point
Name	Results Acceptable
Documentation	In this decision point gateway, the designer evaluates the quantity and cost analysis results and compares them to the target cost for the detailed design. When the results meet the target cost, the results are acceptable. If not, the BIM and other data are modified by the designer.

1.2.2.3 Valid BIM Model for QTO?

Type	Decision Point
Name	Valid BIM Model for QTO
Documentation	After the BIM model submitted to the client by the designer, client check the BIM model meets the requirements for QTO. This process is conducted by rule-based checker to evaluate the BIM data.

1.2.2.4 Perform Client QTO/Cost Analysis?

Type	Decision Point
Name	Perform Client QTO/Cost Analysis
Documentation	The client staff decide whether QTO and cost analysis are conducted by technical staff or consultants. The **ER_Road_Design_to_QTO(Submission)** is passed to the technical staff or consultants for estimating and calculating quantity and cost, when the client staff want to confirm the results from the designer. If not, the **Evaluate Quantities & Cost Breakdown** task is conducted.

1.2.2.5 Results Complete?

Type	Decision Point
Name	Results Complete
Documentation	The technical staff or consultant that is conducting the independent quantity/cost analysis decides of the results of their analysis are accurate and reliable, and confirm to the client's work order.

1.2.2.6 Approved?

Type	Decision Point
Name	Approved
Documentation	When the QTO/cost analysis result & BIM model submission package **(QTO/Cost Report** and **ER_Road_Design_to_QTO(Submission)**) is confirmed by the client, the QTO process is completed.

1.2.3 Specification of Event

1.2.3.1 Detailed Design BIM Complete

Type	Event
Name	Detailed Design BIM Complete
Documentation	The completed detailed design road BIM would be based for QTO processing at the beginning.

1.2.3.2 QTO/Cost Analysis Result & BIM Model Submission

Type	Event
Name	QTO/Cost Analysis Result & BIM Model Submission
Documentation	Designer submits prepared QTO/cost analysis result and BIM model to the client.

1.2.3.3 Reject

Type	Event
Name	Reject
Documentation	Decision of rejection by client who evaluated the BIM model for QTO submitted from the designer.

1.2.3.4 Request QTO/Cost Analysis

Type	Event
Name	Request QTO/Cost Analysis
Documentation	The client sends request to technical staff for evaluation of the BIM model for QTO.

1.2.3.5 QTO/Cost Analysis Results Complete

Type	Event
Name	QTO/Cost Analysis Results Complete
Documentation	Completion of QTO/Cost Analysis by technical staff.

1.2.3.6 Reply Evaluation Results

Type	Event
Name	Reply Evaluation Results
Documentation	The client sends QTO evaluation result to the designer.

1.2.3.6 QTO Process Complete

Type	Event
Name	QTO Process Complete
Documentation	The completion of entire QTO process in design phase.

1.2.4 Specification of Data Objects

1.2.4.1 Road BIM Modeling Guideline for QTO

Type	Library Data Object
Name	Road BIM Guideline for QTO
Documentation	This BIM guideline is referenced for QTO of the road BIM model. This guideline includes a process of QTO, units of objects (with spatial units), level of detail, data requirement for QTO, objects codes guide. The road BIM guideline for QTO is provided to the designer before detailed design phase.

1.2.4.2 Object Code -Cost Code Mapping Table

Type	Library Data Object
Name	Object Code -Cost Code Mapping Table
Documentation	This mapping table includes object codes for each road BIM objects and cost items codes that corresponded to each road BIM objects. The object codes are for identifying BIM objects. This code should be assumed as standard of construction information classification. The cost codes are for identifying cost items in each road BIM objects. Mapping table would be related to unit cost database, then estimated the cost of road.

1.2.4.3 Modification Items List for QTO BIM Modeling

Type	Library Data Object
Name	Modification Items List for QTO BIM Modeling
Documentation	This modification items list contains further required information or issue of supplementation which occurred through pre-checked road BIM model. The designer pre-check required information of road BIM model with reference QTO guideline. The modification items list includes status of object codes, QTO parameter, spatial data, etc.

1.2.4.4 Detailed Design BIM Model

Type	Library Data Object
Name	Detailed Design BIM Model
Documentation	The detailed design BIM model is based model which would be customized to QTO. The model would be modified missing or complimenting information referenced with modification items list.

1.2.4.5 Unit Cost DB

Type	Library Data Object
Name	Unit Cost DB
Documentation	The unit cost DB contains cost information of each cost item. This database assumed to be related cost codes and object codes for estimating cost of road. The database provides the unit cost information for calculating quantity of road objects and their each cost item.

1.2.4.6 QTO/Cost Report

Type	Library Data Object
Name	QTO/Cost Report
Documentation	The QTO/Cost report contains results of BIM based QTO and cost estimation of road. The results of QTO and cost estimation would be compared with target cost.

1.2.4.7 Target Cost

Type	Library Data Object
Name	Target Cost
Documentation	Target cost is the original presumed cost which set when the project begin. This would be compared with results of BIM based QTO and cost estimation.

1.2.4.8 ER_Road_Design_to_QTO (Calculation)

Type	Exchange Requirement Data Object
Name	ER_Road_Design_to_QTO (Calculation)
Documentation	Exchange requirement of complete set of QTO inputs for calculation of cost. This exchange includes the type of road objects for QTO, object parameters, object-code, road spatial information.

1.2.4.9 ER_Road_Design_to_QTO (Submission)

Type	Exchange Requirement Data Object
Name	ER_Road_Design_to_QTO (Submission)

Documentation	After cost estimating, designer submits the QTO/cost report with road BIM quantity take-off model to the client. This exchange includes further information for validation of road BIM QTO model. It contains the status of the validation which conducted by designer for submission.

1.2.4.10 ER_Road_Design_to_QTO (Client Review)

Type	Exchange Requirement Data Object
Name	ER_Road_Design_to_QTO (Client Review)
Documentation	This exchange includes client review for submitting QTO/cost report and road BIM quantity-take model.

2. Exchange Requirement

Name	KICT – Quantity Take-Off in Road Projects at Detailed Design Phase

Identifier	ER_Road_Design_to_QTO_v.1.0

Change Log		
2015-09-22	Initial creation version 0.9	Kibeom Ju kbju@kict.re.kr Hyounseok Moon hsmoon@kict.re.kr Changyoon Kim ckim@kict.re.kr Jisun Won wonjisun@kict.re.kr Geunha Cho cgh@kict.re.kr
2015-10-25	Modifications of ER, version 1.0	Hyounseok Moon hsmoon@kict.re.kr

Project Stage	0	Portfolio requirements	
	1	Conception of need	
	2	Outline feasibility	
	3	Substantive feasibility	
	4	Outline conceptual design	
	5	Full conceptual design	✔
	6	Coordinated design and procurement	✔
	7	Production information	
	8	Construction	
	9	Operation and maintenance	
	10	Disposal	

2.1 Overview

The scope of this exchange requirement is the exchange of information about road facilities, space, elemental quantities and element descriptions intended for use in preparation of quantity take-off and cost estimation. The purpose of the exchange requirement is to support the coordination of model quantities with the needs of the cost estimator preparing the cost estimate.

The exchange requirement assumes that a road model is available from which relevant geometric information required for a cost estimate can be derived. The level of required information is classified spatial, pavement, earthwork, drainage, subsidiary, excepted detailed component parts.

2.2 Exchange Requirements

2.2.1 Exchange Requirements for Road Design to QTO (Calculation)

buildingSMART International home of openBIM®	Exchange Requirements for Road Design to QTO (Calculation)					Mapping to IFC Definitions	
Element Group							
Element							
Property Group							
Property		Required	Optional	Data Type	Unit	**IfcRoad**	**IFC Model Representation**
ifc file (exchange file)							
Meta data							
header section							
file management							
file name	File Name	√		string			file_name in HEADER section
time_stamp	File Creation Time	√		string			file_name in HEADER section
author	Author	√		string			file_name in HEADER section
organization	Organization of Author	√		string			file_name in HEADER section
preprocessor_version	IFC Converter Version	√		string			file_name in HEADER section
originating_system	BIM File Software	√		string			file_name in HEADER section
IfcKernel							
Project							
Project	Project						IfcProject
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcProject.GlobalID
name	Name	√		IfcLabel			IfcProject.Name
object type	Object Type		√	IfcLabel			IfcProject.Description
description	Descriptions		√	IfcText			IfcProject.ObjectType
phase	Phase		√	IfcLabel			IfcProject.Phase
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
Project Unit Properties							
length unit	Length	√		ifcUnitEnum	m or mm		IfcProject.UnitsInContext (IfcUnitAssignment)
area unit	Area	√		ifcUnitEnum	m²		IfcProject.UnitsInContext (IfcUnitAssignment)
volume unit	Volume	√		ifcUnitEnum	m³		IfcProject.UnitsInContext (IfcUnitAssignment)
count unit	Count	√		ifcUnitEnum	ea		IfcProject.UnitsInContext (IfcUnitAssignment)
weight unit	Weight	√		ifcUnitEnum	kg or g		IfcProject.UnitsInContext (IfcUnitAssignment)
time unit	Time	√		ifcUnitEnum	seconds or days		IfcProject.UnitsInContext (IfcUnitAssignment)
Project Management Properties						*new Pset*	Pset_RoadProjectMgmtCommon_K
Road Name	Road Name		√	IfcLabel			
Section Name	Section Name		√	IfcLabel			
Management Authority	Authority		√	IfcLabel			

Exchange Requirements for Road Design to QTO (Calculation)					**Mapping to IFC Definitions**	
Element Group						
Element						
Property Group						
Property		Required	Optional	Data Type	Unit	**IfcRoad**	**IFC Model Representation**

Property		Required	Optional	Data Type	Unit	IfcRoad	IFC Model Representation
Road Type	Road Type		√	IfcLabel			
RoadLane Type	Road Lane Type		√	IfcLabel			
Construction Duration	Duration for Construction		√	IfcDuration	day		
Location Address	Location		√	IfcLabel			
Start Date	Start Date		√	IfcDate			
Finish Date	Finish Date		√	IfcDate			
Owner	Owner		√	IfcLabel			
Contractor (Construction)	Consturction Company		√	IfcLabel			
SubContractore1 (Engineering)	Design and Engineering Company		√	IfcLabel			
SubContractore1 (Supervision)	Supersisor		√	IfcLabel			
Total Project Cost	Total Project Cost		√	IfcMonetaryMeasure	Won		
Design Cost	Design Cost		√	IfcMonetaryMeasure	Won		
Construction Cost	Construction Cost		√	IfcMonetaryMeasure	Won		
Supervision Cost	Supervision Cost		√	IfcMonetaryMeasure	Won		
Road Desgin Paramenters						*new Pset*	Pset_RoadElementDesignParameters_K
Road Width	Width		√	IfcPositiveLengthMeasur	m		
Road Number (Count)	Number		√	IfcCountMeasure			
Station	Station		√	IfcLabel			
Length Between Stations	Section Distances		√	IfcPositiveLengthMeasur	m		
Chainage	Chaniage		√	IfcPositiveLengthMeasur	m		
Design Speed	Design Speed		√	IfcLinearVelocityMeasure	km/h		
Facility Limit	Facility Limit		√	IfcPositiveLengthMeasur	m		
Average Driving Speed	Averation Driving speed		√	IfcLinearVelocityMeasure	km/h		
Planned Elevation	Plannned Elevation		√	IfcPositiveLengthMeasur	m		
Ground Elevation	Ground Elevation		√	IfcPositiveLengthMeasur	m		
Earthwork Elevation	Earthwork Elevation		√	IfcPositiveLengthMeasur	m		
Super elevation	Superelevation		√	IfcPlaneAngleMeasure	°		
IfcSpatialElement							
Civil Spatial Boundary (Alignment Referencing Space)							
Curve linear Node Space	Curvlinear Node Space					*new Entity*	IfcCurvlinearNodeSpace_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcSpatialElement.GlobalID
name	Name	√		IfcLabel			IfcSpatialElement.Name
description	Descriptions		√	IfcText			IfcSpatialElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens

		Exchange Requirements for Road Design to QTO (Calculation)						Mapping to IFC Definitions	
Element Group									
	Element								
		Property Group							
		Property		Required	Optional	Data Type	Unit	**IfcRoad**	**IFC Model Representation**
		Alignment Referencing Properties							
		reference point on alignment	Reference Points	√		*under review*			
		reference point name	Reference Point Name	√		*under review*			
		cross section area (further define)	CrossSectionArea	√		*under review*			
		segment length	SegmentLength	√		*under review*			
	Vertical Subspace		Vertical Subspace					*new Entity*	IfcVerticalSubspace_K
		General Properties							
		global ID	Software Identify	√		IfcGloballyUniqueId			IfcSpatialElement.GlobalID
		name	Name	√		IfcLabel			IfcSpatialElement.Name
		description	Descriptions		√	IfcText			IfcSpatialElement.Description
		classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
		Alignment Referencing Properties							
		reference line	ReferenceLine	√		*under review*			
		vertical distance from alignment curve	VerticalDistances	√		*under review*			
		planar area (further define)	PlaneArea	√		*under review*			
	Linear Reference Space		Linear Reference Space					*new Entity*	IfcLinearRefSpace_K
		General Properties							
		global ID	Software Identify	√		IfcGloballyUniqueId			IfcSpatialElement.GlobalID
		name	Name	√		IfcLabel			IfcSpatialElement.Name
		description	Descriptions		√	IfcText			IfcSpatialElement.Description
		classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
		Alignment Referencing Properties							
		alignment curve	AlignmentCurve	√		*under review*			
		horizontal distance from alignment curve	HorizontalDistances	√		*under review*			
		longitudinal section area (further define)	VerticalArea	√		*under review*			
Civil Structure Element								*new Entity*	IfcCivilStructureElement_K
	Road		Road					*new Entity*	IfcRoad_K
		General Properties							
		global ID	Software Identify	√		IfcGloballyUniqueId			IfcProject.GlobalID
		name	Name	√		IfcLabel			IfcProject.Name
		object type	Object Type		√	IfcLabel			IfcProject.Description
		description	Descriptions		√	IfcText			IfcProject.ObjectType
		classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
IfcCivilElement									
Road Element								*new Entity*	IfcRoadElement_K

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Exchange Requirements for Road Design to QTO (Calculation)						**Mapping to IFC Definitions**	
Element Group							
Element							
Property Group							
Property		**Required**	**Optional**	**Data Type**	**Unit**	**IfcRoad**	**IFC Model Representation**
Road Body						*new Entity*	IfcRoadBody_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
Road Shoulder						*new Entity*	IfcRoadShoulder_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	TotalLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	CrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
volume value	UnitSectionVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
Road Median Strip						*new Entity*	IfcRoadMedianStrip_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	TotalLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	CrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue

Exchange Requirements for Road Design to QTO (Calculation)						Mapping to IFC Definitions	
Element Group							
Element							
Property Group							
Property		Required	Optional	Data Type	Unit	**IfcRoad**	**IFC Model Representation**
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
volume value	BlockNetVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
count value	UnitBlockCount	√		IfcCountMeasure	ea		IfcQuantityCount.CountValue
weight value	RebarGrossWeight	√		IfcMassMeasure	ton or kg		IfcQuantityWeight.WeightValue
Curb						*new Entity*	IfcCurb_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	TotalLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	CrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
volume value	UnitSectionVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
count value	TotalBlockCount	√		IfcCountMeasure	ea		IfcQuantityCount.CountValue
Road Pavement						*new Entity*	IfcRoadPavement_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	TotalLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
length value	UnitSectionLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
length value	TotalWidth	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
length value	TotalDepth	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	CrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue

Exchange Requirements for Road Design to QTO (Calculation)						**Mapping to IFC Definitions**	
Element Group							
Element							
Property Group							
Property		**Required**	**Optional**	**Data Type**	**Unit**	**IfcRoad**	**IFC Model Representation**
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
volume value	UnitSectionVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
Civil Structure Element						*new Entity*	IfcCivilStructureElement_K
Culvert						*new Entity*	IfcCulvert_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		string			
constuction type	ElementType	√		string			
length value	Length	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
length value	Width	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
length value	Height	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	CrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	OuterSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	InnerSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
count value	TotalCount	√		IfcCountMeasure	ea		IfcQuantityCount.CountValue
weight value	RebarGrossWeight	√		IfcMassMeasure	ton or kg		IfcQuantityWeight.WeightValue
Retaining Wall						*new Entity*	IfcRetainingWall_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	TotalLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue

Exchange Requirements for Road Design to QTO (Calculation)						Mapping to IFC Definitions	
Element Group							
Element							
Property Group							
Property		Required	Optional	Data Type	Unit	**IfcRoad**	**IFC Model Representation**
length value	UnitSectionLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	CrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	OuterSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
weight value	RebarGrossWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
Caisson						*new Entity*	IfcCaisson_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	Length	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
length value	Width	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
length value	Height	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	OuterSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	InnerSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
weight value	TotalGrossWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
weight value	RebarGrossWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
Subsidiary Facility						*new Entity*	IfcSubsidiaryFacility_K
Road Sign Element						*new Entity*	IfcRoadSignElement_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name

Exchange Requirements for Road Design to QTO (Calculation)						Mapping to IFC Definitions	
Element Group							
Element							
Property Group							
Property		**Required**	**Optional**	**Data Type**	**Unit**	**IfcRoad**	**IFC Model Representation**
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
count value	TotalCount	√		IfcCountMeasure	ea		IfcQuantityCount.CountValue
Guard						*new Entity*	IfcGuard_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	TotalLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
count value	TotalCount	√		IfcCountMeasure	ea		IfcQuantityCount.CountValue
weight value	TotalGrossWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
Pavement Addition						*new Entity*	IfcPavementAddition_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	Length	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	GrossSurfaceArea	√		IfcAreaMeasure	㎡		IfcQuantityArea.AreaValue
count value	TotalCount	√		IfcCountMeasure	ea		IfcQuantityCount.CountValue
Earthwork Element							
Site							IfcSite
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	Name	√		IfcLabel			IfcCivilElement.Name
object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
description	Descriptions		√	IfcText			IfcCivilElement.Description

				Exchange Requirements for Road Design to QTO (Calculation)				Mapping to IFC Definitions	

			Property		Required	Optional	Data Type	Unit	IfcRoad	IFC Model Representation
Element Group										
	Element									
		Property Group								
			classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
		QTO Properties								
			material	Material	√		IfcLabel			IfcMaterialDefinition.Name
			constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
			length value	GrossPerimeter	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
			area value	GrossArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
	Earthwork Element								*new Entity*	IfcEarthworkElement_K
		General Properties								
			global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
			name	Name	√		IfcLabel			IfcCivilElement.Name
			object type	Object Type		√	IfcLabel			IfcCivilElementType.ElementType
			description	Descriptions		√	IfcText			IfcCivilElement.Description
			classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
		QTO Properties								
			material	Material	√		IfcLabel			IfcMaterialDefinition.Name
			constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
			length value	GrossPerimeter	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
			length value	UnitSectionLength	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
			area value	CrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			area value	GrossArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
			volume value	UnitSectionVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
IfcDistributionElement										
Flow Segment										
	Pipe Segment									IfcPipeSegment
		General Properties								
			global ID	Software Identify	√		IfcGloballyUniqueId			IfcDistributionElement.GlobalID
			name	Name	√		IfcLabel			IfcDistributionElement.Name
			object type	Object Type		√	IfcLabel			IfcDistributionElementType.ElementType
			description	Descriptions		√	IfcText			IfcDistributionElement.Description
			classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
		QTO Properties								
			material	Material	√		IfcLabel			IfcMaterialDefinition.Name
			constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
			length value	Length	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue

				Exchange Requirements for Road Design to QTO (Calculation)					*Mapping to IFC Definitions*	
Element Group										
	Element									
		Property Group								
			Property		**Required**	**Optional**	**Data Type**	**Unit**	**IfcRoad**	**IFC Model Representation**
			area value	GrossCrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			area value	NetCrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			area value	OuterSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			weight value	GrossWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
			weight value	NetWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
		Gutter Segment							*new Entity*	IfcGutterSegment_K
			General Properties							
			global ID	Software Identify	√		IfcGloballyUniqueId			IfcDistributionElement.GlobalID
			name	Name	√		IfcLabel			IfcDistributionElement.Name
			object type	Object Type		√	IfcLabel			IfcDistributionElementType.ElementType
			description	Descriptions		√	IfcText			IfcDistributionElement.Description
			classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
			QTO Properties							
			material	Material	√		IfcLabel			IfcMaterialDefinition.Name
			constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
			length value	Length	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
			area value	CrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			area value	OuterSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
Flow Fitting										
	Flow Fitting									
			General Properties							
			global ID	Software Identify	√		IfcGloballyUniqueId			IfcDistributionElement.GlobalID
			name	Name	√		IfcLabel			IfcDistributionElement.Name
			object type	Object Type		√	IfcLabel			IfcDistributionElementType.ElementType
			description	Descriptions		√	IfcText			IfcDistributionElement.Description
			classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
			QTO Properties							
			material	Material	√		IfcLabel			IfcMaterialDefinition.Name
			constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
			length value	Length	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
			area value	GrossCrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			area value	NetCrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			area value	OuterSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
			weight value	GrossWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue

Exchange Requirements for Road Design to QTO (Calculation)						Mapping to IFC Definitions	
Element Group							
Element							
Property Group							
Property		Required	Optional	Data Type	Unit	**IfcRoad**	**IFC Model Representation**
weight value	NetWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
Gutter Fitting						*new Entity*	IfcGutterFitting_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcDistributionElement.GlobalID
name	Name	√		IfcLabel			IfcDistributionElement.Name
object type	Object Type		√	IfcLabel			IfcDistributionElementType.ElementType
description	Descriptions		√	IfcText			IfcDistributionElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	Length	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	GrossCrossSectionArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	OuterSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
weight value	GrossWeight	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
Distribution Chamber Element							
Distribution Chamber Element							
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcDistributionElement.GlobalID
name	Name	√		IfcLabel			IfcDistributionElement.Name
object type	Object Type		√	IfcLabel			IfcDistributionElementType.ElementType
description	Descriptions		√	IfcText			IfcDistributionElement.Description
classfication code	Classification Code	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	Material	√		IfcLabel			IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
area value	NetSurfaceArea	√		IfcAreaMeasure	m²		IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
volume value	NetVolume	√		IfcVolumeMeasure	m³		IfcQuantityVolume.VolumeValue
IfcBuildingElement							
Construction Common Element							
Slab							IfcSlab
General Properties							

				Required	Optional	Data Type	Unit	IfcRoad	IFC Model Representation

Exchange Requirements for Road Design to QTO (Calculation) — **Mapping to IFC Definitions**

Element Group
Element
Property Group

Property		Required	Optional	Data Type	Unit	IfcRoad IFC Model Representation
global ID	Software Identify	√		IfcGloballyUniqueId		IfcBuildingElement.GlobalID
name	Name	√		IfcLabel		IfcBuildingElement.Name
object type	Object Type		√	IfcLabel		IfcBuildingElementType.ElementType
description	Descriptions		√	IfcText		IfcBuildingElement.Description
classfication code	Classification Code	√		IfcIdentifier		IfcClassification.ReferenceTokens
QTO Properties						
material	Material	√		IfcLabel		IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel		IfcElementType / IfcPropertySetDefinition
length value	Width	√		IfcLengthMeasure	m or mm	IfcQuantityLength.LengthValue
length value	Length	√		IfcLengthMeasure	m or mm	IfcQuantityLength.LengthValue
length value	Depth	√		IfcLengthMeasure	m or mm	IfcQuantityLength.LengthValue
length value	Perimeter	√		IfcLengthMeasure	m or mm	IfcQuantityLength.LengthValue
area value	GrossArea	√		IfcAreaMeasure	m²	IfcQuantityArea.AreaValue
area value	NetArea	√		IfcAreaMeasure	m²	IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³	IfcQuantityVolume.VolumeValue
volume value	NetVolume	√		IfcVolumeMeasure	m³	IfcQuantityVolume.VolumeValue
weight value	GrossWeight	√		IfcMassMeasure	kg or g	IfcQuantityWeight.WeightValue
weight value	NetWeight	√		IfcMassMeasure	kg or g	IfcQuantityWeight.WeightValue
Wall						IfcWall
General Properties						
global ID	Software Identify	√		IfcGloballyUniqueId		IfcBuildingElement.GlobalID
name	Name	√		IfcLabel		IfcBuildingElement.Name
object type	Object Type		√	IfcLabel		IfcBuildingElementType.ElementType
description	Descriptions		√	IfcText		IfcBuildingElement.Description
classfication code	Classification Code	√		IfcIdentifier		IfcClassification.ReferenceTokens
QTO Properties						
material	Material	√		IfcLabel		IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel		IfcElementType / IfcPropertySetDefinition
length value	Length	√		IfcLengthMeasure	m or mm	IfcQuantityLength.LengthValue
length value	Width	√		IfcLengthMeasure	m or mm	IfcQuantityLength.LengthValue
length value	Height	√		IfcLengthMeasure	m or mm	IfcQuantityLength.LengthValue
area value	GrossFootprintArea	√		IfcAreaMeasure	m²	IfcQuantityArea.AreaValue
area value	NetFootprintArea	√		IfcAreaMeasure	m²	IfcQuantityArea.AreaValue
area value	GrossSideArea	√		IfcAreaMeasure	m²	IfcQuantityArea.AreaValue
area value	NetSideArea	√		IfcAreaMeasure	m²	IfcQuantityArea.AreaValue

Exchange Requirements for Road Design to QTO (Calculation)							Mapping to IFC Definitions	
Element Group								
Element								
Property Group								
Property		Required	Optional	Data Type	Unit		**IfcRoad**	**IFC Model Representation**
volume value	GrossVolume	√		IfcVolumeMeasure	m³			IfcQuantityVolume.VolumeValue
volume value	NetVolume	√		IfcVolumeMeasure	m³			IfcQuantityVolume.VolumeValue
weight value	GrossWeight	√		IfcMassMeasure	kg or g			IfcQuantityWeight.WeightValue
weight value	NetWeight	√		IfcMassMeasure	kg or g			IfcQuantityWeight.WeightValue
Footing								IfcFooting
General Properties								
global ID	Software Identify	√		IfcGloballyUniqueId				IfcBuildingElement.GlobalID
name	Name	√		IfcLabel				IfcBuildingElement.Name
object type	Object Type		√	IfcLabel				IfcBuildingElementType.ElementType
description	Descriptions		√	IfcText				IfcBuildingElement.Description
classfication code	Classification Code	√		IfcIdentifier				IfcClassification.ReferenceTokens
QTO Properties								
material	Material	√		IfcLabel				IfcMaterialDefinition.Name
constuction type	ElementType	√		IfcLabel				IfcElementType / IfcPropertySetDefinition
length value	Length	√		IfcLengthMeasure	m or mm			IfcQuantityLength.LengthValue
length value	Width	√		IfcLengthMeasure	m or mm			IfcQuantityLength.LengthValue
length value	Height	√		IfcLengthMeasure	m or mm			IfcQuantityLength.LengthValue
area value	CrossSectionArea	√		IfcAreaMeasure	m²			IfcQuantityArea.AreaValue
area value	OuterSurfaceArea	√		IfcAreaMeasure	m²			IfcQuantityArea.AreaValue
area value	GrossSurfaceArea	√		IfcAreaMeasure	m²			IfcQuantityArea.AreaValue
volume value	GrossVolume	√		IfcVolumeMeasure	m³			IfcQuantityVolume.VolumeValue
volume value	NetVolume	√		IfcVolumeMeasure	m³			IfcQuantityVolume.VolumeValue
weight value	GrossWeight	√		IfcMassMeasure	kg or g			IfcQuantityWeight.WeightValue
weight value	NetWeight	√		IfcMassMeasure	kg or g			IfcQuantityWeight.WeightValue

Exchange Requirements for Road Design to QTO (Calculation)						Mapping to IFC Definitions	
Element Group							
Element							
Property Group							
Property		**Required**	**Optional**	**Data Type**	**Unit**	**IfcRoad**	**IFC Model Representation**

2.2.2 Exchange Requirements for Road Design to QTO (Submission)

Exchange Requirements for Road Design to QTO (Submission)						Mapping to IFC Definitions	
Element Group							
Element							
Property Group							
Property		**Required**	**Optional**	**Data Type**	**Unit**	**IfcRoad**	**IFC Model Representation**
ifc file (exchange file)							
Meta data							
header section							
file management							
file name	File Name	√		string			file_name in HEADER section
time_stamp	File Creation Time	√		string			file_name in HEADER section
author	Author	√		string			file_name in HEADER section
organization	Organization of Author	√		string			file_name in HEADER section
preprocessor_version	IFC Converter Version	√		string			file_name in HEADER section
originating_system	BIM File Software	√		string			file_name in HEADER section

Exchange Requirements for Road Design to QTO (Calculation)					**Mapping to IFC Definitions**	
Element Group						
Element						
Property Group						
Property	**Required**	**Optional**	**Data Type**	**Unit**	**IfcRoad**	**IFC Model Representation**

2.2.3 Exchange Requirements for Road Design to QTO (Client Review)

Exchange Requirements for Road Design to QTO (Client Review)					**Mapping to IFC Definitions**	
Element Group						
Element						
Property Group						
Property	**Required**	**Optional**	**Data Type**	**Unit**	**IfcRoad**	**IFC Model Representation**
ifc file (exchange file)						
Meta data						
header section						
file management						
file name — File Name	√		string			file_name in HEADER section
time_stamp — File Creation Time	√		string			file_name in HEADER section
author — Author	√		string			file_name in HEADER section
organization — Organization of Author	√		string			file_name in HEADER section
preprocessor_version — IFC Converter Version	√		string			file_name in HEADER section
originating_system — BIM File Software	√		string			file_name in HEADER section

```
 OwnerHistory          :OPTIONAL IfcOwnerHistory;
 Name                  :OPTIONAL IfcLabel;
 Description           :OPTIONAL IfcText;
ENTITY IfcObjectDefinition
INVERSE
 HasAssignments        :SET OF IfcRelAssigns FOR RelatedObjects;
 Nests                 :SET [0:1] OF IfcRelNests FOR RelatedObjects;
 IsNestedBy            :SET OF IfcRelNests FOR RelatingObject;
 HasContext            :SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
 IsDecomposedBy        :SET OF IfcRelAggregates FOR RelatingObject;
 Decomposes            :SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
 HasAssociations       :SET OF IfcRelAssociates FOR RelatedObjects;
ENTITY IfcObject
 ObjectType            :OPTIONAL IfcLabel;
INVERSE
 IsDeclaredBy          :SET [0:1] OF IfcRelDefinesByObject FOR RelatedObjects;
 Declares              :SET OF IfcRelDefinesByObject FOR RelatingObject;
 IsTypedBy             :SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
 IsDefinedBy           :SET OF IfcRelDefinesByProperties FOR RelatedObjects;
ENTITY IfcProduct
 ObjectPlacement       :OPTIONAL IfcObjectPlacement;
 Representation        :OPTIONAL IfcProductRepresentation;
INVERSE
 ReferencedBy          :SET OF IfcRelAssignsToProduct FOR RelatingProduct;
ENTITY IfcElement
 Tag                   :OPTIONAL IfcIdentifier;
INVERSE
 FillsVoids            :SET [0:1] OF IfcRelFillsElement FOR RelatedBuildingElement;
 ConnectedTo           :SET OF IfcRelConnectsElements FOR RelatingElement;
 IsInterferedByElements :SET OF IfcRelInterferesElements FOR RelatedElement;
 InterferesElements    :SET OF IfcRelInterferesElements FOR RelatingElement;
 HasProjections        :SET OF IfcRelProjectsElement FOR RelatingElement;
 ReferencedInStructures :SET OF IfcRelReferencedInSpatialStructure FOR RelatedElements;
 HasOpenings           :SET OF IfcRelVoidsElement FOR RelatingBuildingElement;
 IsConnectionRealization:SET OF IfcRelConnectsWithRealizingElements FOR RealizingElements;
 ProvidesBoundaries    :SET OF IfcRelSpaceBoundary FOR RelatedBuildingElement;
 ConnectedFrom         :SET OF IfcRelConnectsElements FOR RelatedElement;
 ContainedInStructure  :SET [0:1] OF IfcRelContainedInSpatialStructure FOR RelatedElements;
ENTITY IfcElementComponent
ENTITY IfcTunnelElementPart_K
PredefinedType            :OPTIONAL IfcTunnelElementPartTypeEnum_K;
END_ENTITY;
```

10.3.10 IfcTunnelElementPartType_K

Description

IfcTunnelElementPartType_K is the entity that expresses the type of detailed elements of parts and material units of tunnel component elements, and includes flanges, overhangs, stiffeners, bracings, webs, ribs, and shoes.

EXPRESS Specification:

```
ENTITY IfcTunnelElementPartType_K
   SUBTYPE OF(IfcElementComponentType);
     PredefinedType : IfcTunnelElementPartTypeEnum_K;
  END_ENTITY;
```

Inheritance Graph:

```
ENTITY IfcTunnelElementPartType_K
 ENTITY IfcRoot
  GlobalId              :IfcGloballyUniqueId;
  OwnerHistory          :OPTIONAL IfcOwnerHistory;
  Name                  :OPTIONAL IfcLabel;
  Description           :OPTIONAL IfcText;
 ENTITY IfcObjectDefinition
 INVERSE
  HasAssignments        :SET OF IfcRelAssigns FOR RelatedObjects;
  Nests                 :SET [0:1] OF IfcRelNests FOR RelatedObjects;
  IsNestedBy            :SET OF IfcRelNests FOR RelatingObject;
  HasContext            :SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
  IsDecomposedBy        :SET OF IfcRelAggregates FOR RelatingObject;
  Decomposes            :SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
  HasAssociations       :SET OF IfcRelAssociates FOR RelatedObjects;
 ENTITY IfcTypeObject
  ApplicableOccurrence:OPTIONAL IfcIdentifier;
  HasPropertySets       :OPTIONAL SET [1:?] OF IfcPropertySetDefinition;
 INVERSE
  Types                 :SET [0:1] OF IfcRelDefinesByType FOR RelatingType;
 ENTITY IfcTypeProduct
  RepresentationMaps    :OPTIONAL LIST [1:?] OF UNIQUE IfcRepresentationMap;
  Tag                   :OPTIONAL IfcLabel;
 INVERSE
  ReferencedBy          :SET OF IfcRelAssignsToProduct FOR RelatingProduct;
 ENTITY IfcElementType
 ENTITY IfcElementComponentType
 ENTITY IfcTunnelElementPartType_K
 PredefinedType         :IfcTunnelElementPartTypeEnum_K;
 END_ENTITY;
```

10.3.11 IfcGroundReinforcingElement_K

Description

IfcGroundReinforcingElement_K is the entity that expresses the ground reinforcement materials used in civil engineering work.

Common Use Definitions

Object Typing

Object types, applied in this entity, are expressed in the following entity type.

| Type |
| --- |
| IfcGroundReinforcingElementType_K |

Table — IfcGroundReinforcingElementType_K Object Typing

EXPRESS Specification:

```
ENTITY IfcGroundReinforcingElement_K
   SUBTYPE OF(IfcReinforcingElement);
     PredefinedType : OPTIONAL IfcGroundReinforcingElementyTypeEnum_K;
  END_ENTITY;
```

EXPRESS-G diagram
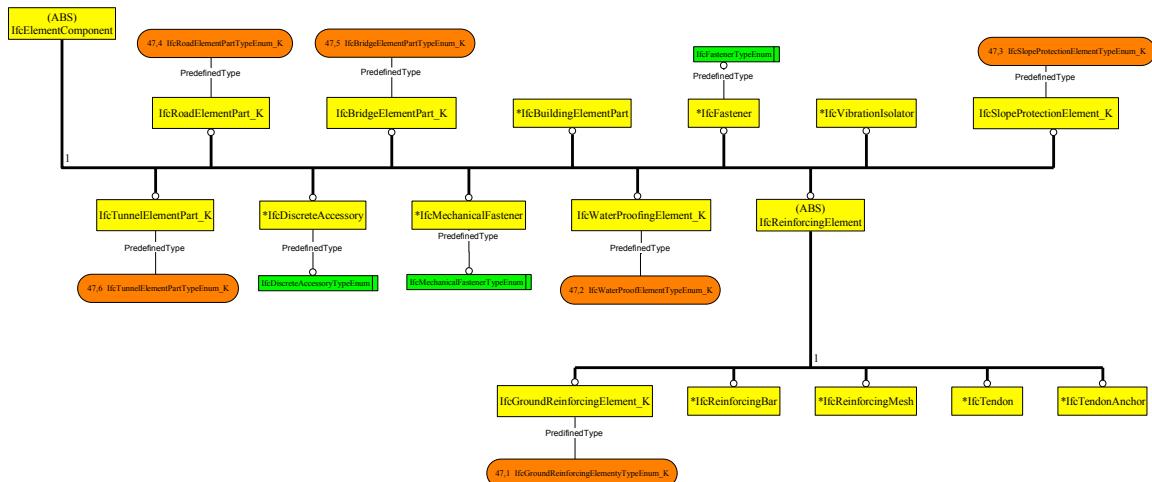
Inheritance Graph:

```
ENTITY IfcGroundReinforcingElement_K
 ENTITY IfcRoot
  GlobalId              :IfcGloballyUniqueId;
  OwnerHistory          :OPTIONAL IfcOwnerHistory;
  Name                  :OPTIONAL IfcLabel;
  Description           :OPTIONAL IfcText;
 ENTITY IfcObjectDefinition
 INVERSE
  HasAssignments        :SET OF IfcRelAssigns FOR RelatedObjects;
  Nests                 :SET [0:1] OF IfcRelNests FOR RelatedObjects;
  IsNestedBy            :SET OF IfcRelNests FOR RelatingObject;
  HasContext            :SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
  IsDecomposedBy        :SET OF IfcRelAggregates FOR RelatingObject;
  Decomposes            :SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
  HasAssociations       :SET OF IfcRelAssociates FOR RelatedObjects;
 ENTITY IfcObject
  ObjectType            :OPTIONAL IfcLabel;
 INVERSE
  IsDeclaredBy          :SET [0:1] OF IfcRelDefinesByObject FOR RelatedObjects;
```

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```
  Declares            :SET OF IfcRelDefinesByObject FOR RelatingObject;
  IsTypedBy           :SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
  IsDefinedBy         :SET OF IfcRelDefinesByProperties FOR RelatedObjects;
 ENTITY IfcProduct
  ObjectPlacement     :OPTIONAL IfcObjectPlacement;
  Representation      :OPTIONAL IfcProductRepresentation;
 INVERSE
  ReferencedBy        :SET OF IfcRelAssignsToProduct FOR RelatingProduct;
 ENTITY IfcElement
  Tag                 :OPTIONAL IfcIdentifier;
 INVERSE
  FillsVoids             :SET [0:1] OF IfcRelFillsElement FOR RelatedBuildingElement;
  ConnectedTo            :SET OF IfcRelConnectsElements FOR RelatingElement;
  IsInterferedByElements :SET OF IfcRelInterferesElements FOR RelatedElement;
  InterferesElements     :SET OF IfcRelInterferesElements FOR RelatingElement;
  HasProjections         :SET OF IfcRelProjectsElement FOR RelatingElement;
  ReferencedInStructures :SET OF IfcRelReferencedInSpatialStructure FOR RelatedElements;
  HasOpenings            :SET OF IfcRelVoidsElement FOR RelatingBuildingElement;
  IsConnectionRealization:SET OF IfcRelConnectsWithRealizingElements FOR RealizingElements;
  ProvidesBoundaries     :SET OF IfcRelSpaceBoundary FOR RelatedBuildingElement;
  ConnectedFrom          :SET OF IfcRelConnectsElements FOR RelatedElement;
  ContainedInStructure   :SET [0:1] OF IfcRelContainedInSpatialStructure FOR RelatedElements;
 ENTITY IfcElementComponent
 ENTITY IfcGroundReinforcingElement_K
PredefinedType            :OPTIONAL IfcGroundReinforcingElementTypeEnum_K;
END_ENTITY;
```

10.3.12 IfcGroundReinforcingElementType_K

Description

IfcGroundReinforcingElementType_K is the entity that expresses the type of ground reinforcement material used in civil engineering work, and includes earth anchors, lock bolts, lock anchors, shotcrete, and steel ribs.

EXPRESS Specification:

```
  ENTITY IfcGroundReinforcingElementType_K
    SUBTYPE OF(IfcElementComponentType);
      PredefinedType : IfcGroundReinforcingElementyTypeEnum_K;
  END_ENTITY;
```

▣ EXPRESS-G diagram
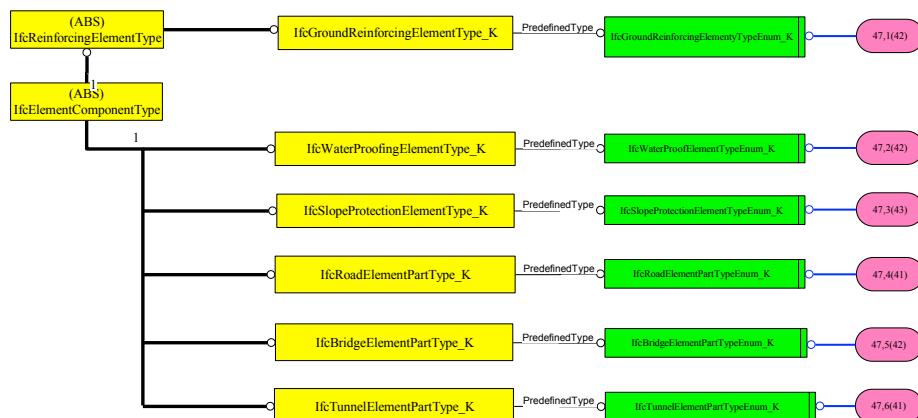
Inheritance Graph:

```
ENTITY IfcGroundReinforcingElementType_K
 ENTITY IfcRoot
```

```
 GlobalId              :IfcGloballyUniqueId;
 OwnerHistory          :OPTIONAL IfcOwnerHistory;
 Name                  :OPTIONAL IfcLabel;
 Description           :OPTIONAL IfcText;
ENTITY IfcObjectDefinition
INVERSE
 HasAssignments        :SET OF IfcRelAssigns FOR RelatedObjects;
 Nests                 :SET [0:1] OF IfcRelNests FOR RelatedObjects;
 IsNestedBy            :SET OF IfcRelNests FOR RelatingObject;
 HasContext            :SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
 IsDecomposedBy        :SET OF IfcRelAggregates FOR RelatingObject;
 Decomposes            :SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
 HasAssociations       :SET OF IfcRelAssociates FOR RelatedObjects;
ENTITY IfcTypeObject
 ApplicableOccurrence:OPTIONAL IfcIdentifier;
 HasPropertySets       :OPTIONAL SET [1:?] OF IfcPropertySetDefinition;
INVERSE
 Types                 :SET [0:1] OF IfcRelDefinesByType FOR RelatingType;
ENTITY IfcTypeProduct
 RepresentationMaps    :OPTIONAL LIST [1:?] OF UNIQUE IfcRepresentationMap;
 Tag                   :OPTIONAL IfcLabel;
INVERSE
 ReferencedBy          :SET OF IfcRelAssignsToProduct FOR RelatingProduct;
ENTITY IfcElementType
ENTITY IfcElementComponentType
ENTITY IfcGroundReinforcingElementType_K
PredefinedType        :IfcGroundReinforcingElementTypeEnum_K;
END_ENTITY;
```