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4		Identify IfcRoad Extension Schedule	4 days	Tue 15-09-01	Fri 15-09-04
5		Define the entire IfcRoad Schema V1.0	3 days	Mon 15-09-07	Wed 15-09-09
6		Confiure Pset Outline with PSD-XML for IfcRoad Convereter	3 days	Thu 15-09-10	Mon 15-09-14
7		Define Information Delivery Manual for IfcRoad	12 days	Thu 15-09-10	Fri 15-09-25
8		Confiure MVD outlines	4 days	Tue 15-09-29	Fri 15-10-02
9		**Final IfcRoad Schema based on IFC4**	**5 days**	**Mon 15-09-07**	**Fri 15-09-11**
10		Review of Final IfcRoad Schema V1.0	5 days	Mon 15-09-07	Fri 15-09-11
11		**Complete Pset for IfcRoad**	**14 days**	**Tue 15-09-01**	**Fri 15-09-18**
12		Completion of Final Pset for Road	5 days	Mon 15-09-07	Fri 15-09-11
13		Completion of Earthwork, Drainage, Subsidiary etc	5 days	Mon 15-09-14	Fri 15-09-18
14		Conversion of Pset template to PSD-XML	12 days	Tue 15-09-01	Wed 15-09-16
15		Final review of Pset for IfcRoad	2 days	Thu 15-09-17	Fri 15-09-18
16		**Develop IDM with Use case**	**9 days**	**Wed 15-09-09**	**Mon 15-09-21**
17		Define Use case (Quantity Takeoff) for using IfcRoad	2 days	Wed 15-09-09	Thu 15-09-10
18		Identify a BIM process of corresponding use case	2 days	Thu 15-09-10	Fri 15-09-11
19		Configure Process Map of IDM for IfcRoad	2 days	Fri 15-09-11	Mon 15-09-14
20		Analyze Information and Data requirements for each process unit	2 days	Mon 15-09-14	Tue 15-09-15
21		Configure ER (Exchange Requirements) Template for the use case	2 days	Tue 15-09-15	Wed 15-09-16
22		Review of Final IDM for IfcRoad	3 days	Thu 15-09-17	Mon 15-09-21
23		**Apply Case Study for Real on-going Road Construction Projects**	**4 days**	**Fri 15-09-11**	**Wed 15-09-16**
24		Define Case Study Outline and Process	2 days	Fri 15-09-11	Sat 15-09-12
25		Configure Case Study Implementation Contexts	3 days	Mon 15-09-14	Wed 15-09-16
26		**Develop HTML version of IfcRoad Specifications**	**16 days**	**Thu 15-09-17**	**Thu 15-10-08**
27		Identify IfcDocTools	5 days	Thu 15-09-17	Wed 15-09-23
28		Prepare HTML version of IfcRoad Spec. (with only Road part)	9 days	Thu 15-09-24	Tue 15-10-06
29		Review of HTML version of IfcRoad Spec.	3 days	Tue 15-10-06	Thu 15-10-08
30		**Expert Meeting**	**0 days**	**Mon 15-09-28**	**Mon 15-09-28**
31		Technical review by professionals	0 days	Mon 15-09-28	Mon 15-09-28
32		**Develop MVD for IfcRoad by MSG of bSI**	**274 days**	**Tue 15-09-29**	**Fri 16-10-14**
33		Define MVD Contexts of IfcRoad	8 days	Tue 15-09-29	Thu 15-10-08
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35		Prepare MVD Diagram for IfcRoad	64 days	Mon 16-01-04	Thu 16-03-31
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39		**bSI in Singapore (InfraRoom Meeting)**	**5 days**	**Mon 15-10-12**	**Fri 15-10-16**
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48		Verifying that the export of information from a software	65 days	Mon 15-11-02	Fri 16-01-29
49		**Final delivery process**	**110 days**	**Mon 16-10-17**	**Fri 17-03-17**
50		Finalize as new IFC4 Extension	55 days	Mon 16-10-17	Fri 16-12-30
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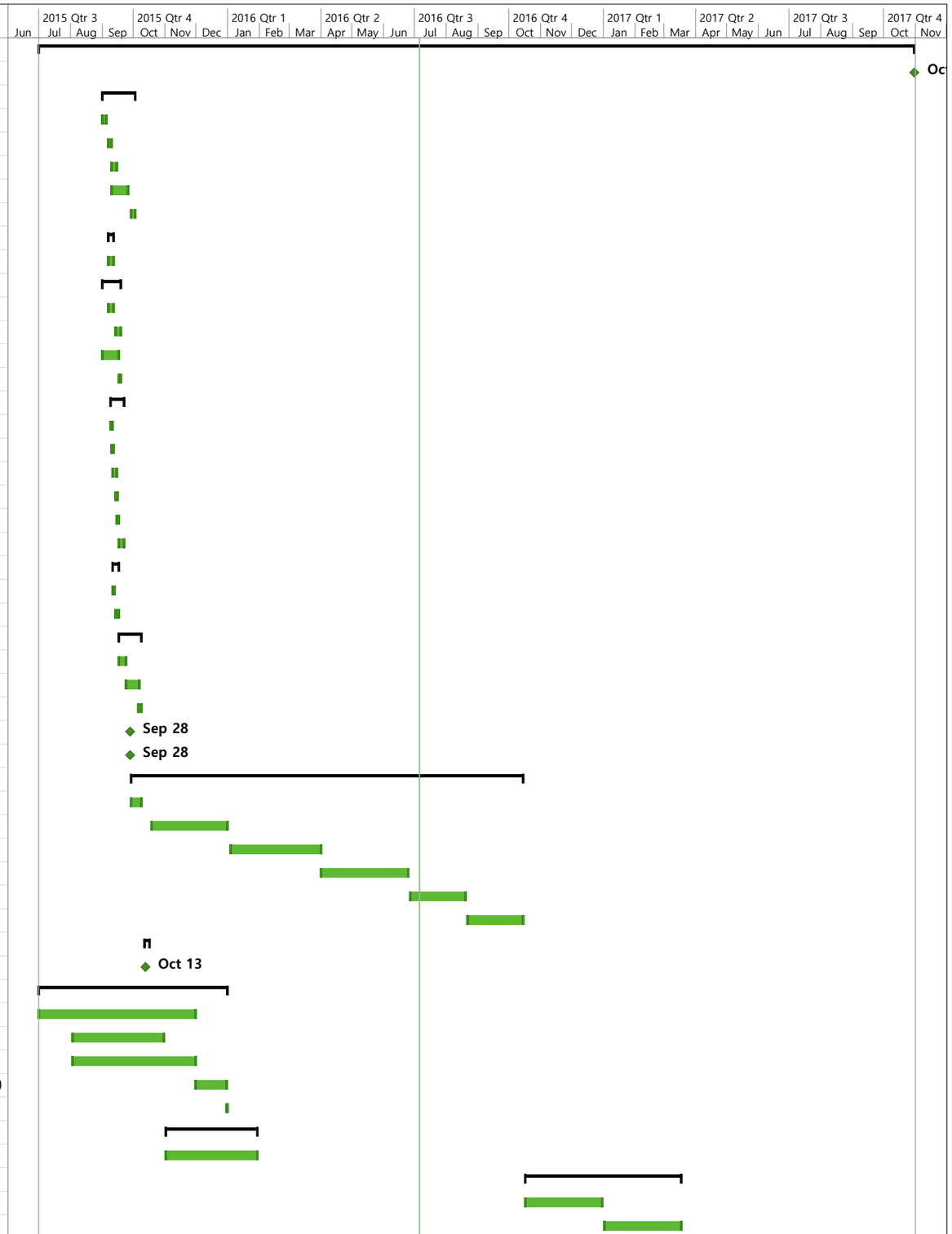


Project: schedule
Date: Wed 16-07-06

Task	Summary	Inactive Milestone	Duration-only	Start-only	External Milestone	Manual Progress
Split	Project Summary	Inactive Summary	Manual Summary Rollup	Finish-only	Deadline	
Milestone	Inactive Task	Manual Task	Manual Summary	External Tasks	Progress	

Chapter 2
IfcRoad Development History

Feb. 22 2016

Dr. Hyounseok Moon
Korea Institute of Civil Engineering and Building Technology

Contents

1. Outlines of Infra BIM Projects

IfcRoad Development Outline

Project Title	Development of Information Model Standard and Verification Technique for Infra BIM
Duration	Jan. 1, 2012 to Dec. 31, 2016 (5 years) – Current in 4th year
Cost	Approximate $ 3,000,000

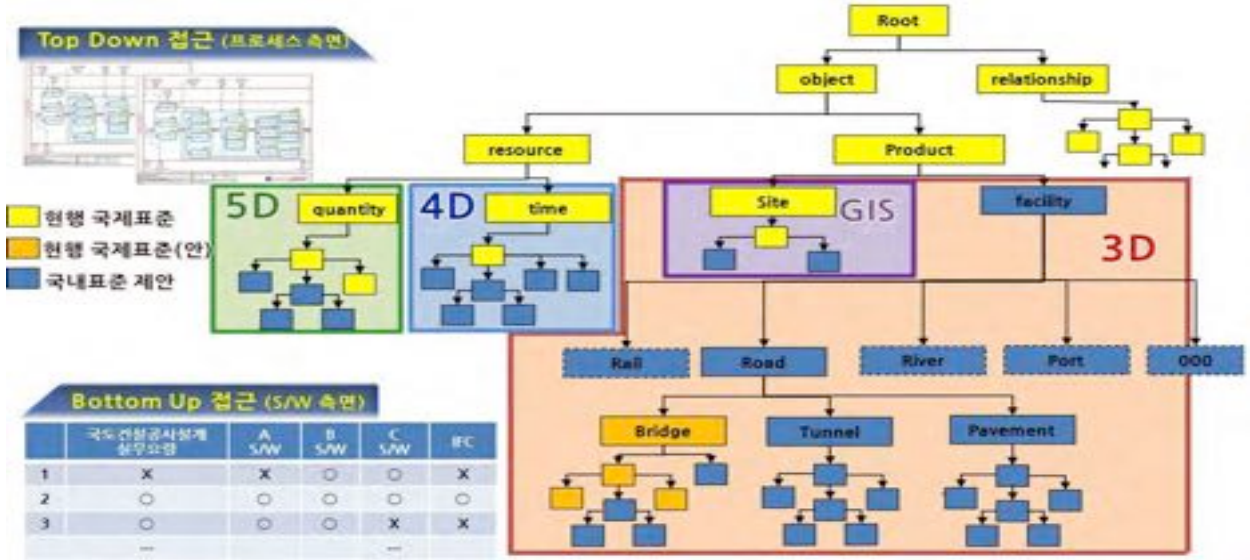
1. Outlines of Infra BIM Projects

Overall Research Objectives

Vision Leading BIM Application for Public SOC Projects and Establishing Application Base

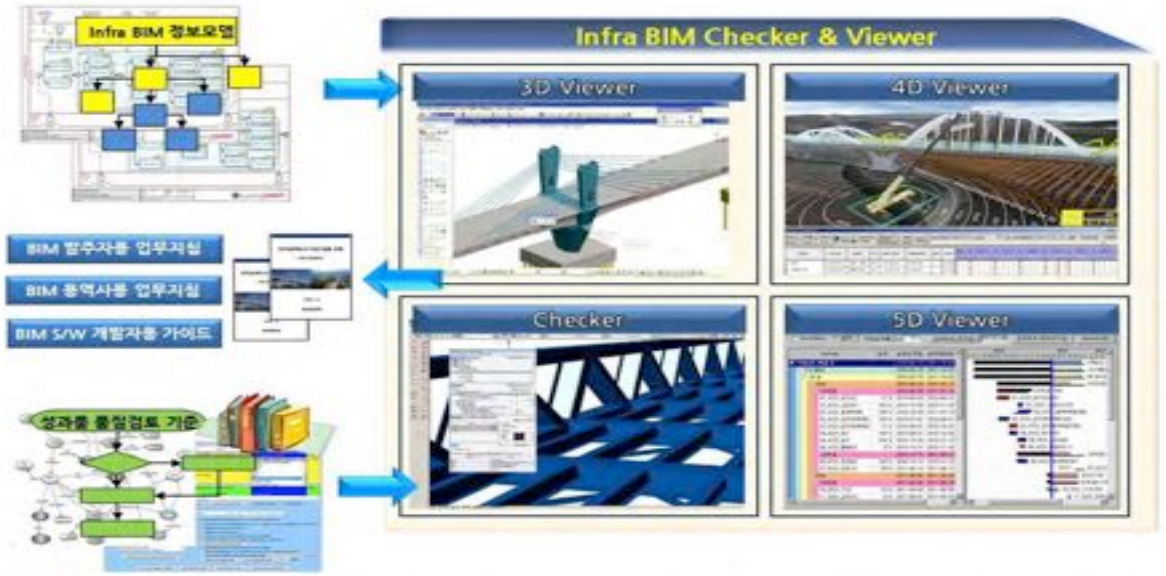
Development of Preparation and Delivery Standards for Infra BIM

Objective1 Development of Draft IFC Standard for Infra BIM



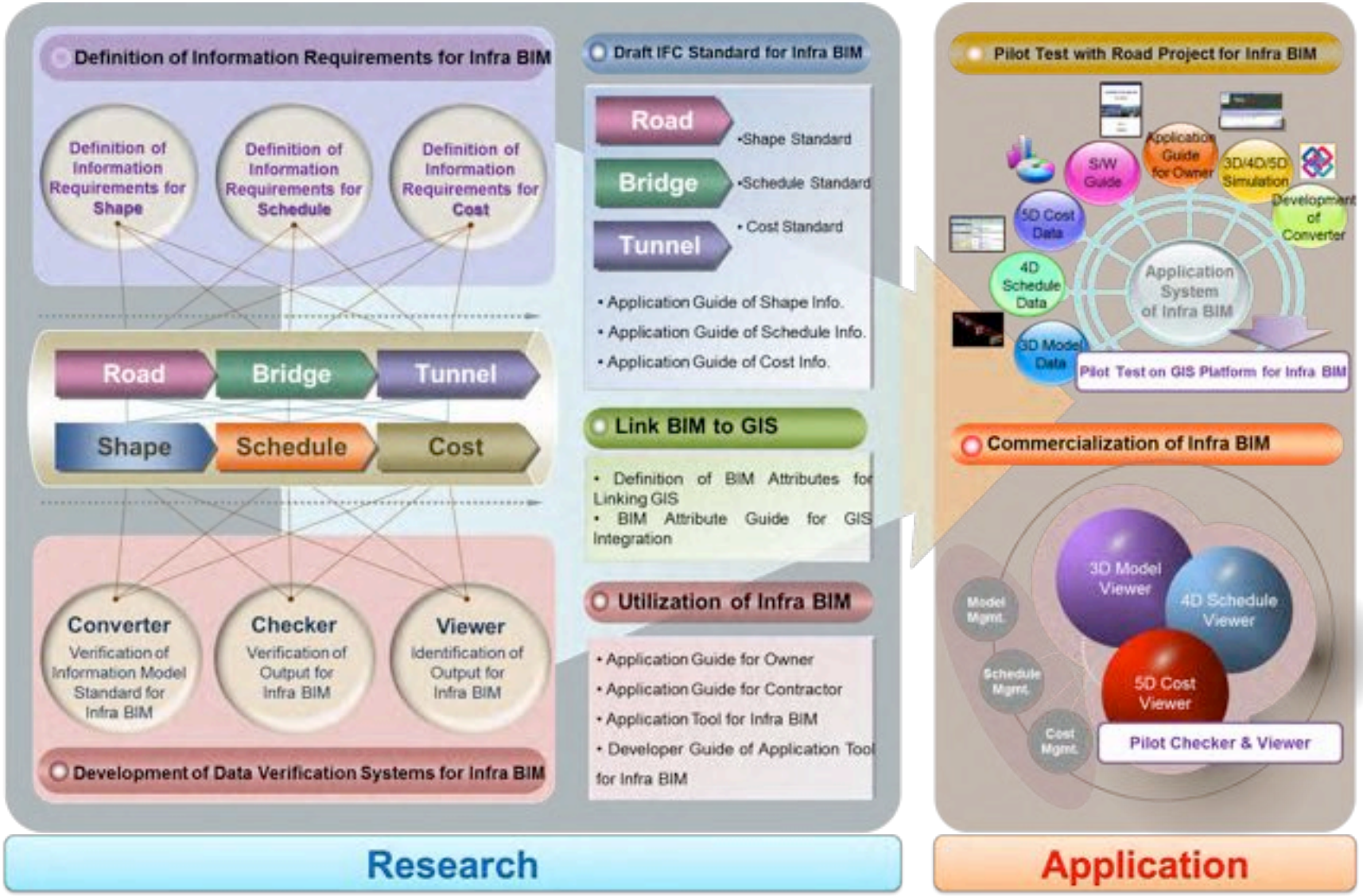
		A S/W	B S/W	C S/W	IFC
1	X	X	○	○	X
2	○	○	○	○	○
3	○	○	○	X	X
	…			…	

Objective2 Verification of Deliverables and Development of Utilization System for Infra BIM



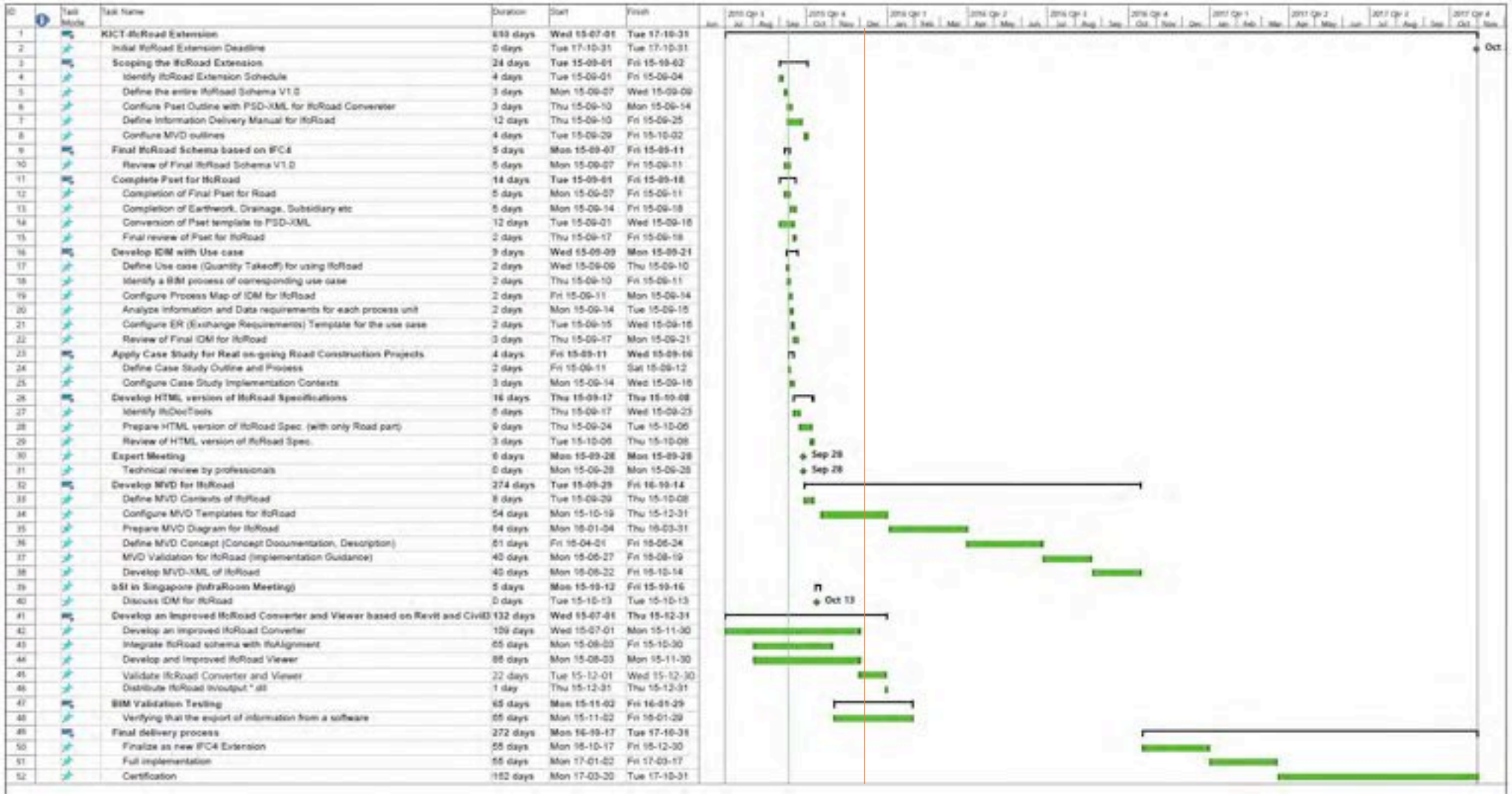
1. Outlines of Infra BIM Projects

Entire Research Contents



2. IfcRoad Development Schedule

Planned Schedule for IfcRoad Completion



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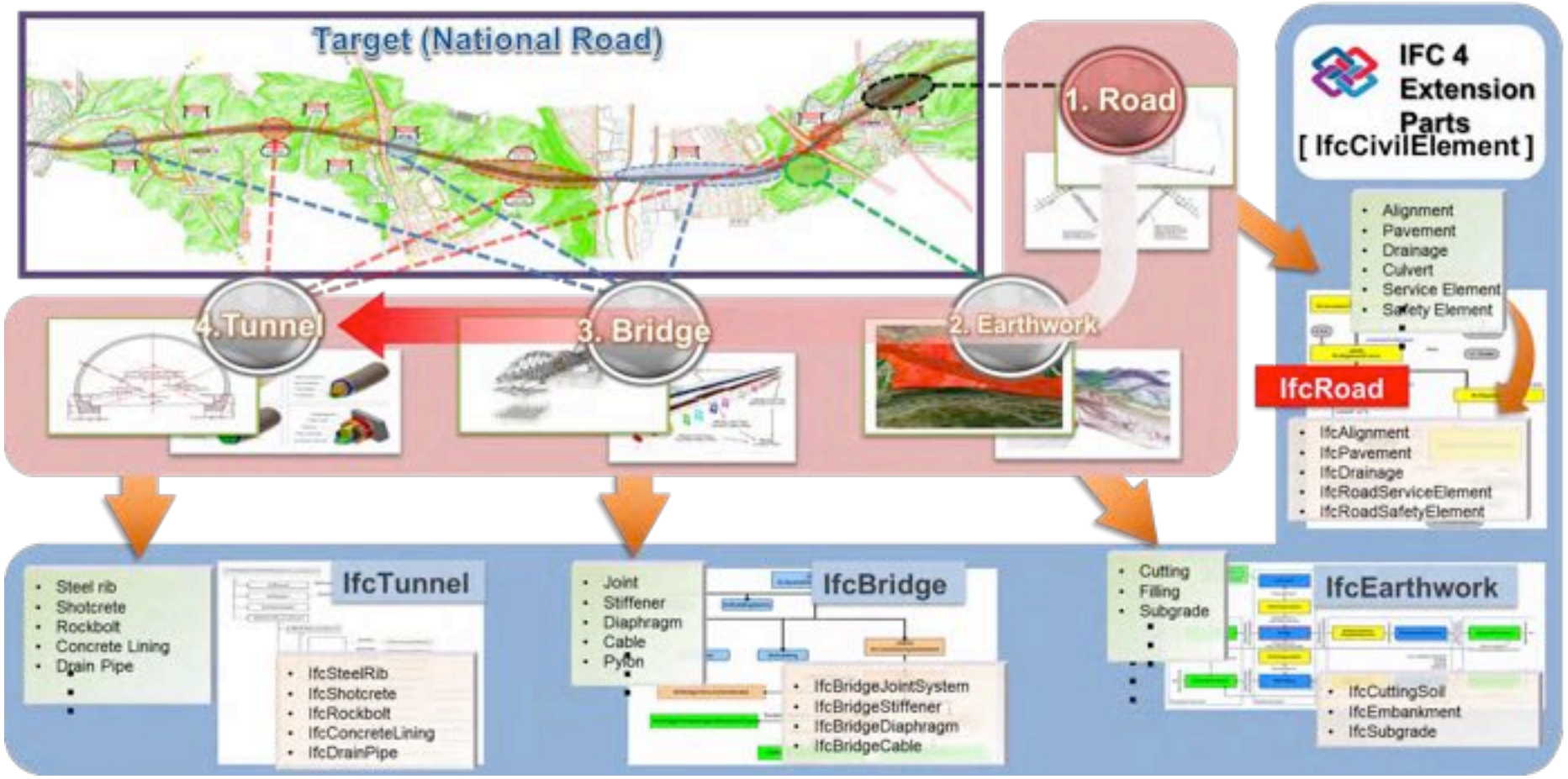
50		Finalize as new IFC4 Extension	65 days	Mon 16-10-17	Fri 16-12-30
51		Full implementation	65 days	Mon 17-01-02	Fri 17-03-17
52		Certification	152 days	Mon 17-03-20	Tue 17-10-31

We are here now

3. IfcRoad Extensions

IfcRoad Extension Scope

The focus of IfcRoad extensions is to develop a complete exchange standard, which supports 3D road design data with alignments, partial terrain layers, and subsidiary facilities between different BIM software in civil engineering. Based on the official IFC4, Road-IFC will be consistently linked with IFC4 structure by Express-G (ISO 10303-11) representation maintaining the IFC4 structure without any change.

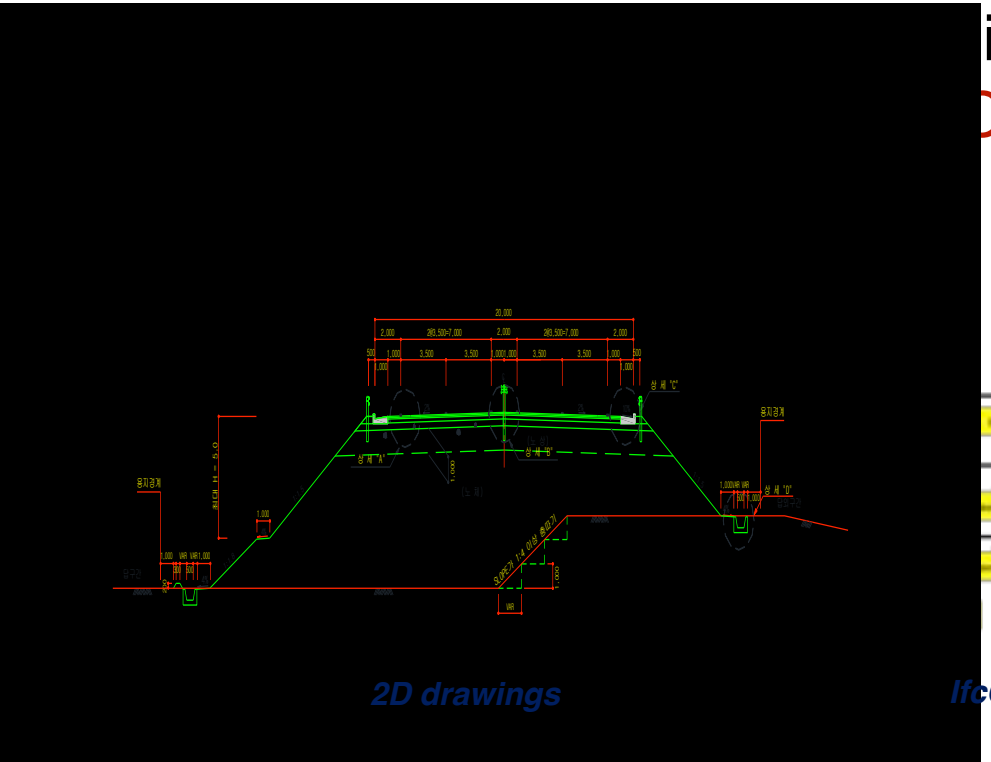


3. IfcRoad Extensions

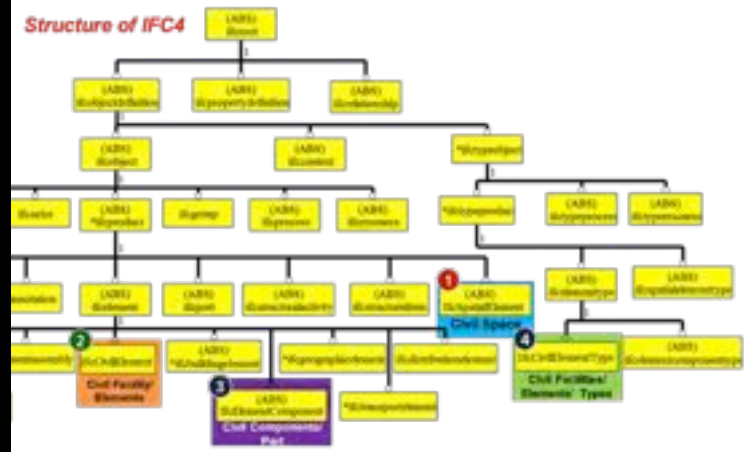
Development Necessity of IfcRoad

1. Most designers is still designing and delivering 2D drawings for civil projects.
2. There are no standardized common exchange format internationally for ensuring data interoperability of road project. (Currently, Korea and V-Con)
3. International efforts and needs for GIS integration of IfcRoad to apply Infra BIM.
4. International needs for integrating life cycle data of civil facilities into IfcRoad.

in moving forward to ISO16739 revision (IFC5)
C4 (IfcCivilElement & IfcCivilElementType).



2D drawings



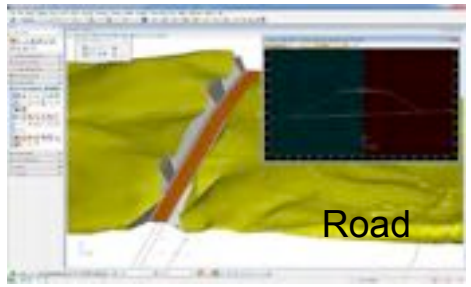
IfcCivilElement/ IfcCivilElementType in IFC4

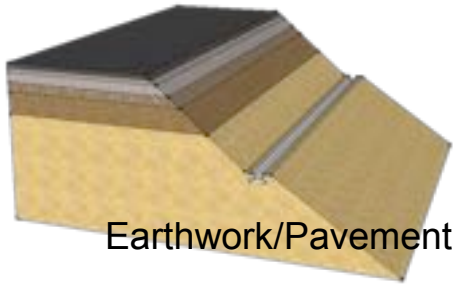
GIS integration of IFC

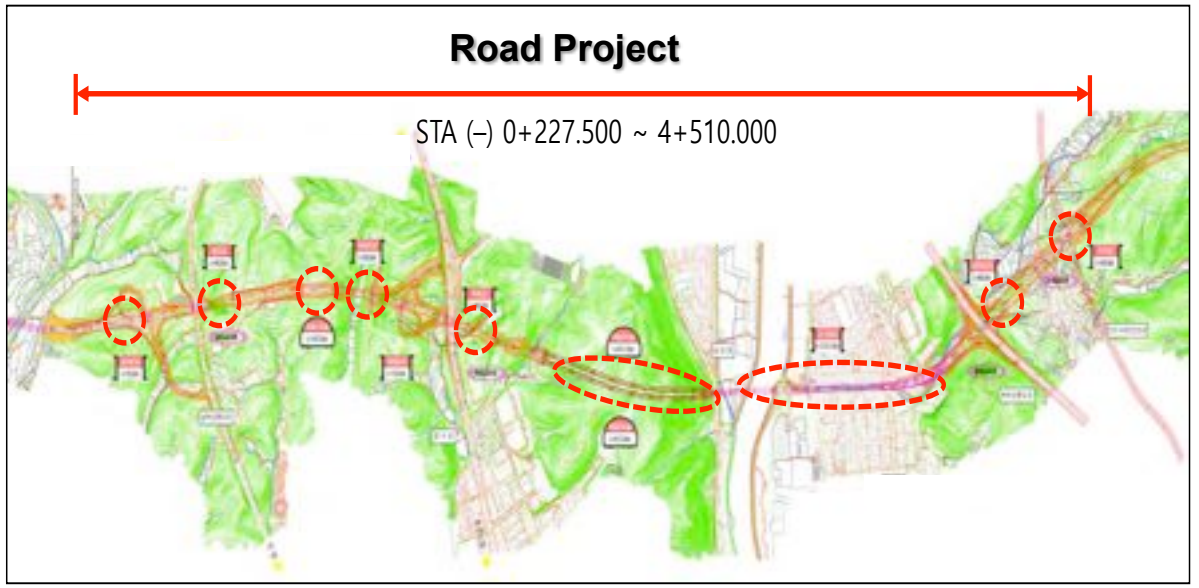
3. IfcRoad Extensions

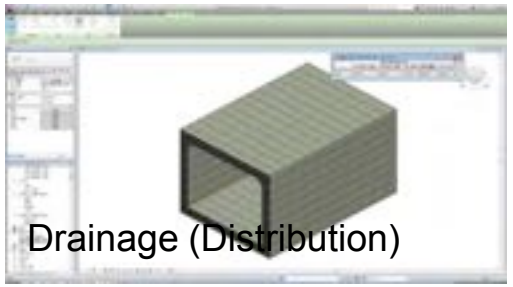
Target, Scope and View Perspective of IfcRoad Extension

Target









Phase

Plan → Basic Design → **Detailed Design** → Construction → Maintenance

Delivering 3D Models to Government

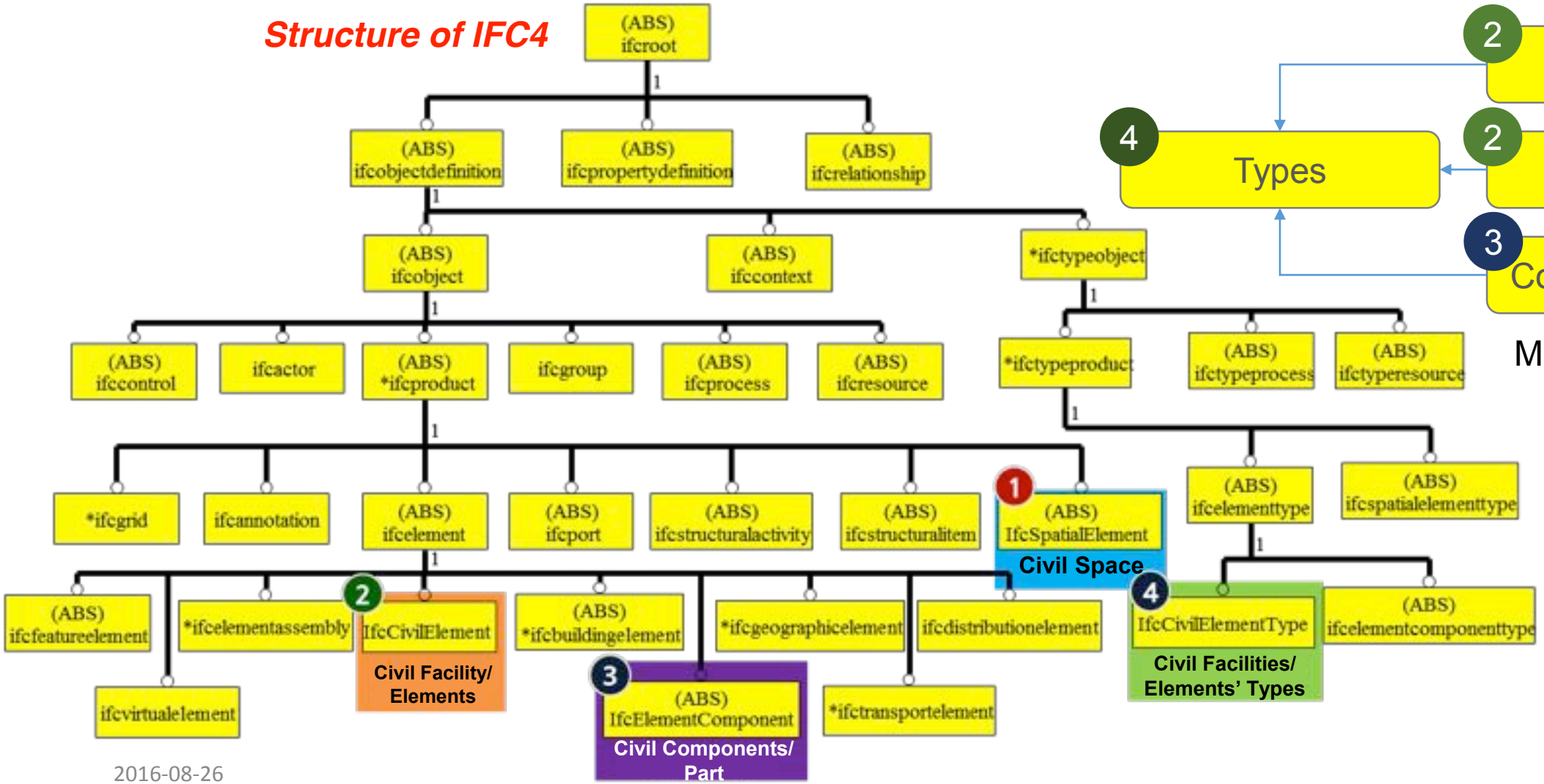
View

Object Shape Representation of Civil Elements, Components and Basic Attributes

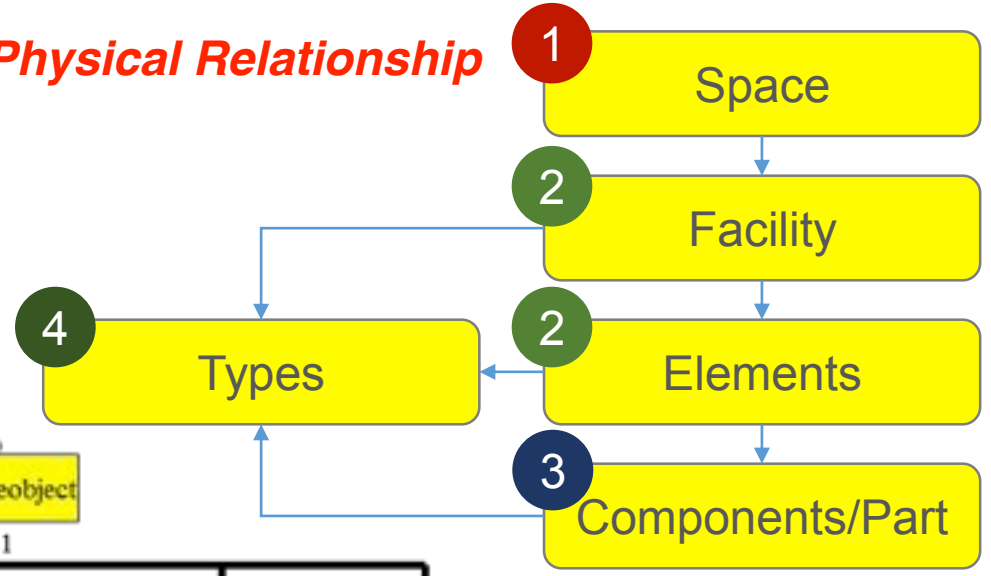
3. IfcRoad Extensions

Extension Scope to IFC4 Entity for Road

Structure of IFC4

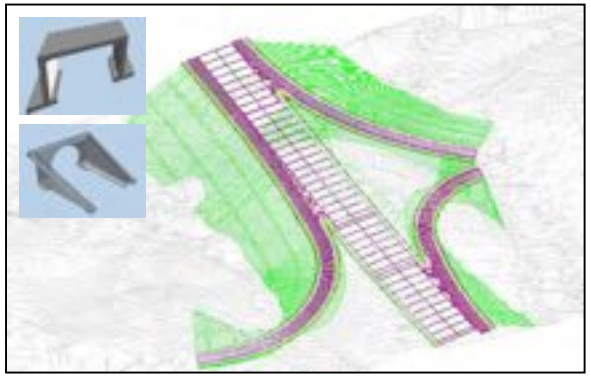
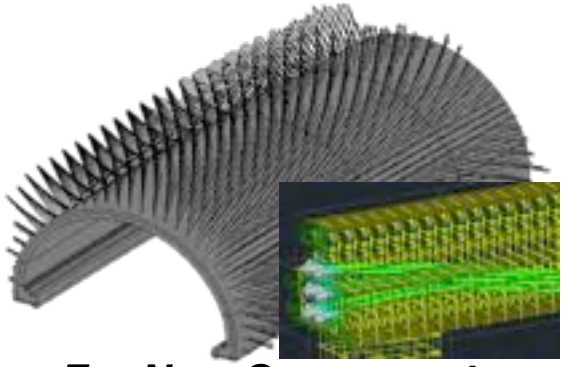


Physical Relationship

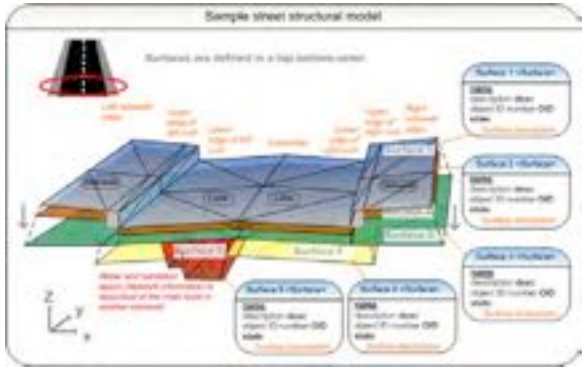
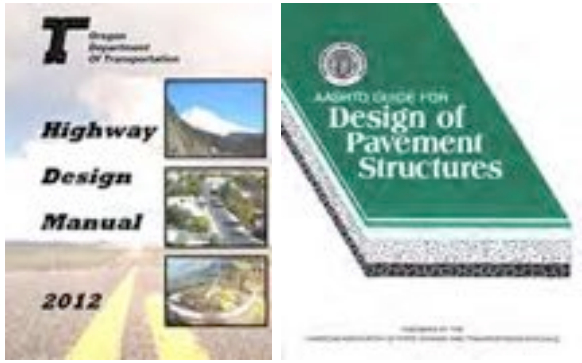
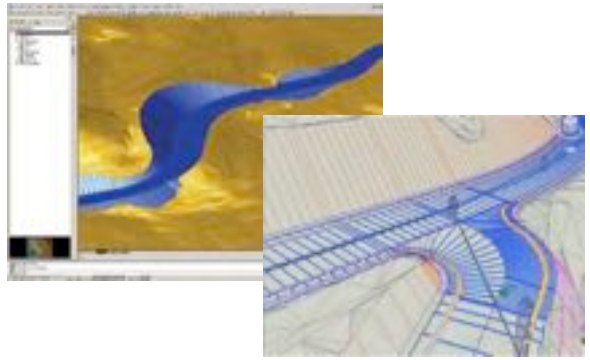


3. IfcRoad Extensions

Extension Scope to IFC4 Entity for Road

Space/ Physical Facility/ Element	Pavement/ Subsidiary Facility	Components/ Parts	Drainage Facility
			
For New Civil Facilities	*For Common Elements*	*For New Components in Civil Facilities*	*For New Types to Architecture Distribution*

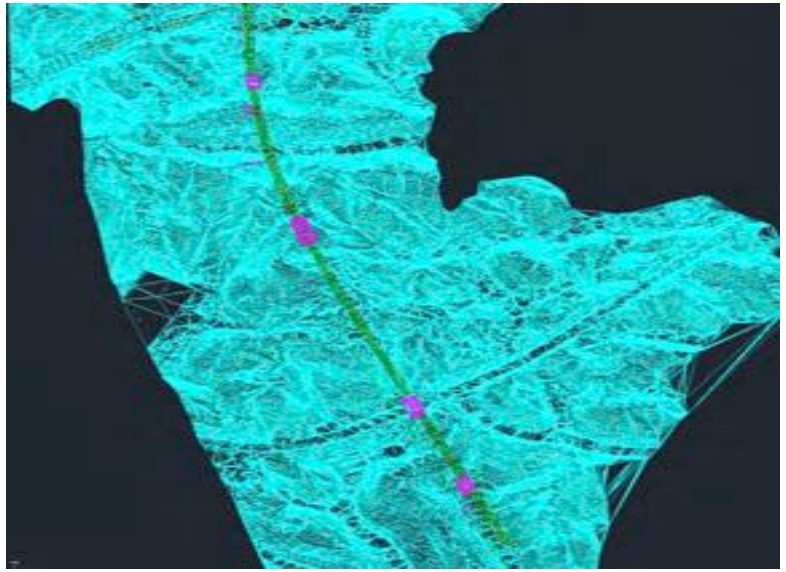
Definition Criteria of Schema Structure

			
Reference Models (LandXML, JHDM etc.)	*Road Design Guidance*	*Standardized 2D Drawings*	*3D Modeling S/W (Autodesk, Bentley)*

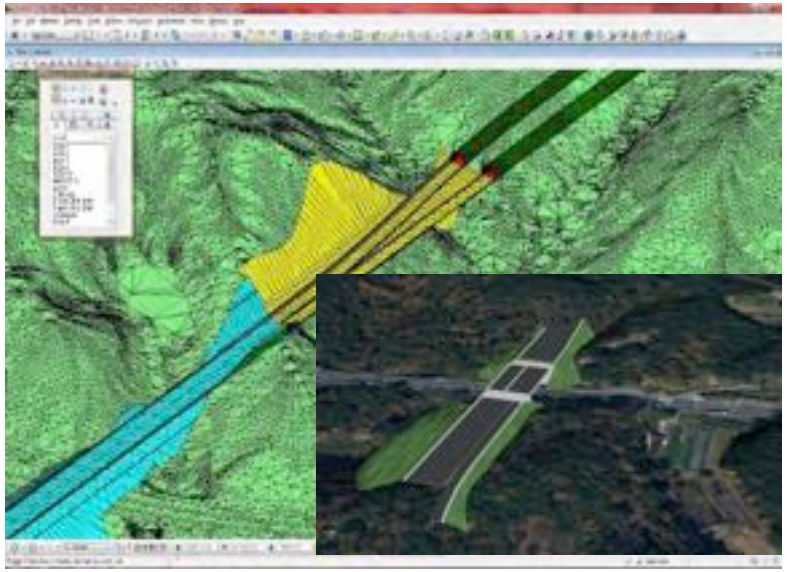
3. IfcRoad Extensions

Spatial Extension for IfcRoad (3 Spatial Concepts)

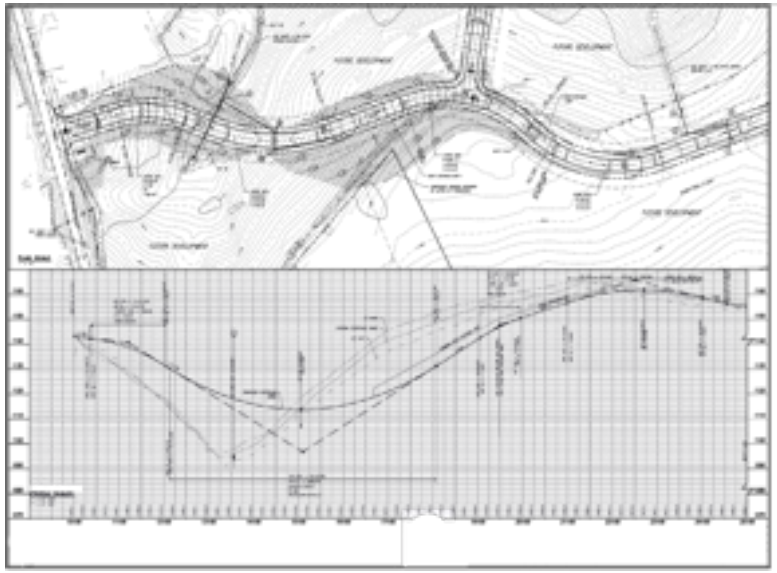
a. Topographical Space (Site)	b. Structural Space (Structure)	c. Line Reference Space



Original/ Planned Earthwork



Road project



Horizontal/ Vertical/ Sectioned Space

- Spatial Structure Hierarchy

ifcSite⊃ifcCur.S.A_K⊃CurvilinearNodeSpace_K⊃**IfcVerticalSubspace_K**⊃ifcSpace

a. Site ***b. Structural Space*** ***c. Reference Space***

3. IfcRoad Extensions

Structures and its Elements Extension for IfcRoad (4 Stages)

Why do we need this?

Need to classify and compose Spatial Group with Road Entities, and specify their relationships

Need to identify and extract standardized road entities

Need to identify and extract standardized road entities and their attributes

Need to define standardized terminology of entire entities with attributes toward bsDD

Processes

Classification

Analysis of Common WBS in Road Projects

[Identification of Hierarchical Structure]

Categorization 1

Analysis of Current Reference Model for Road Projects

[Identification of Facility Elements]

Categorization 2

Analysis of Design Data for Road Facilities

[Identification of Detailed Facility Elements with Parts/Components]

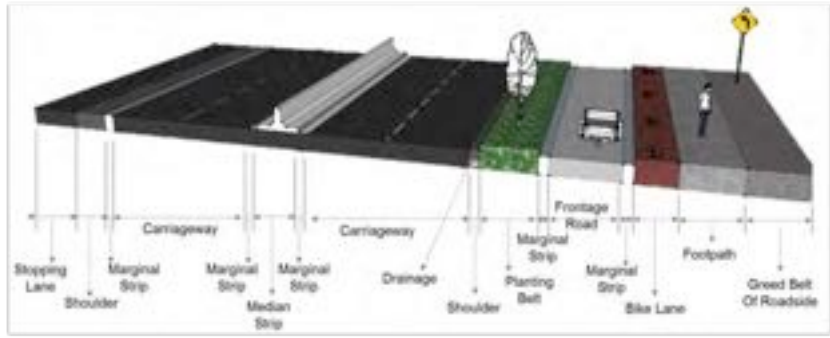
Normalization

Configurations of Entity and Attribute for Road

[Definition of Detailed Attributes and Resource Layer-Technical Terminology for Road]

Referenced Data

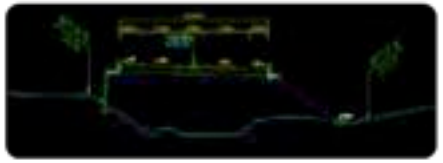
Structures and its Elements for IfcRoad Composition



The Standardized 3D Cross-Section Drawings for Road Segment

Road Design Handbook and Standard etc.

Existing 3D Shape Model

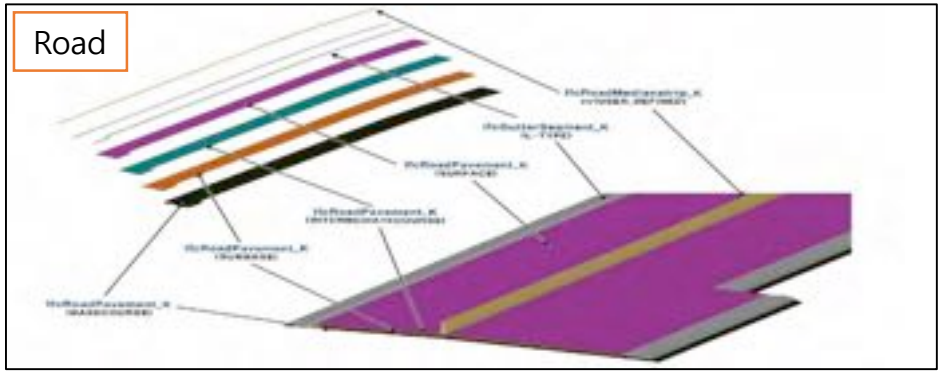


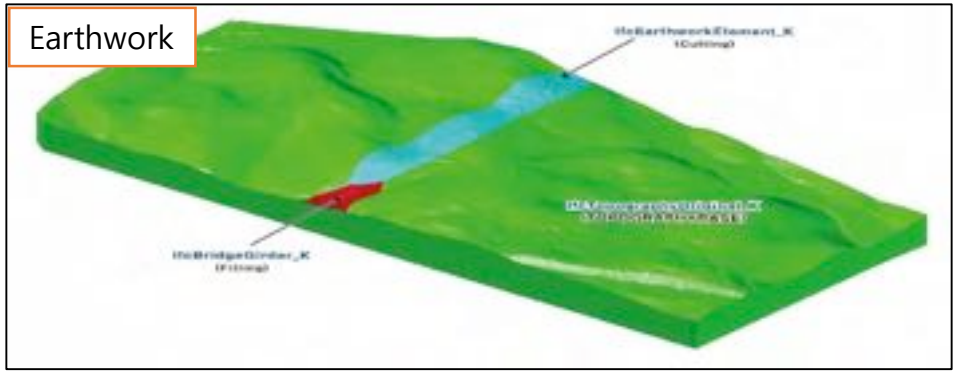
Standardized 2D Cross-Section Drawings for Road

3. IfcRoad Extensions

IfcRoad history since 2012

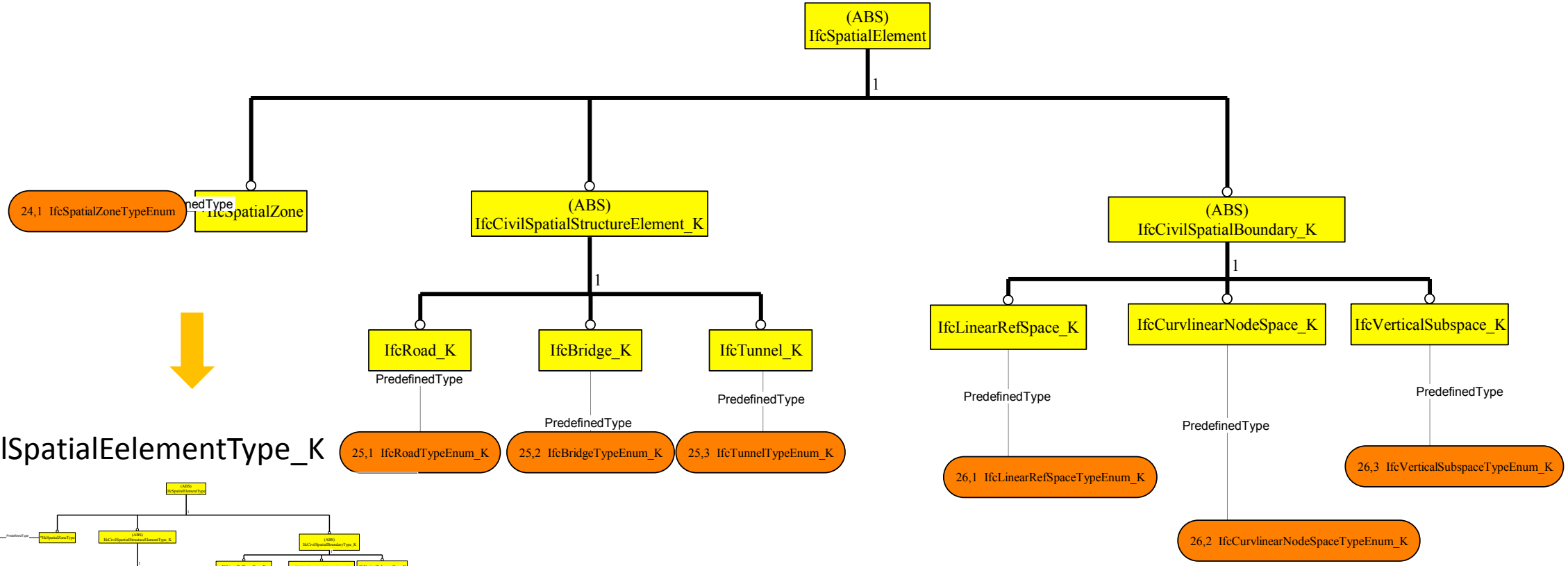
- The IfcRoad Ver.1.0 was completed in Sept. 30 2015 based on **IFC4 ADD1** (The IfcRoad is incorporated with a new converter and viewer software.)
- In addition to this, we have configured **property and quantity sets** for each IFC entity in a PSD-XML type.
- To secure practical usability of IfcRoad in the high level, preparation of IDM including use cases was strongly required, so that was developed.
- Performed consulting processes by external expert group; IFC experts, Road Engineers, Construction Company etc.
- Verifying IfcRoad schema through validation system with converter and viewer (Suitability of IFC conversion, Checking spatial structure and missing entities for each structure)
  - Converting 3D models with any infra objects into IfcRoad schema in commercial software(eg. Autodesk Revit/Civil3D)
  - Identifying the converted 3D model with ifcRoad schema visually in self stand-alone system
- Performed In-depth review of IfcRoad schema by Dr. Thomas Liebich for 5 days in Korea
- Real application of pilot projects with one road projects under construction in Korea



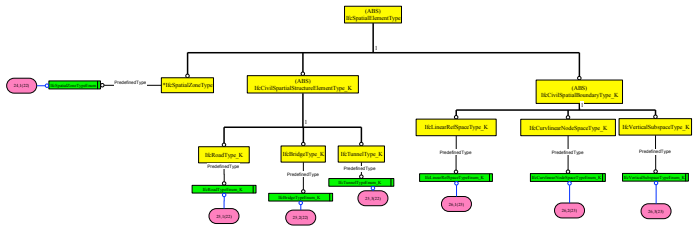


4. IfcRoad Data Schema

IfcCivilSpatialElement_K

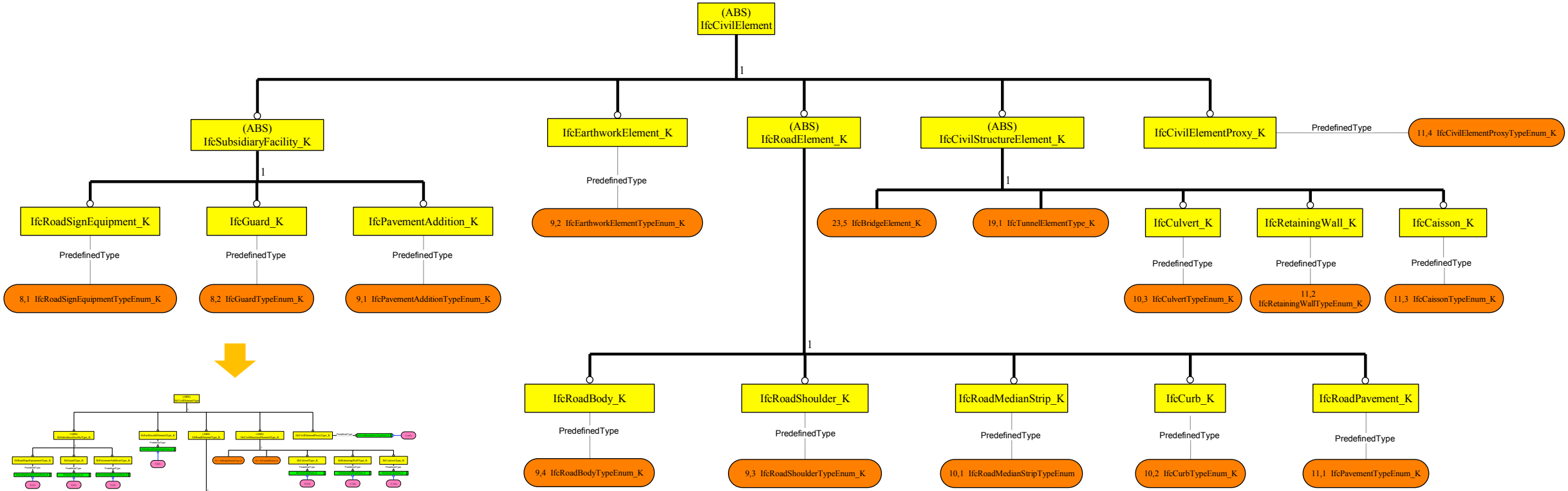


IfcCivilSpatialEelementType_K



4. IfcRoad Data Schema

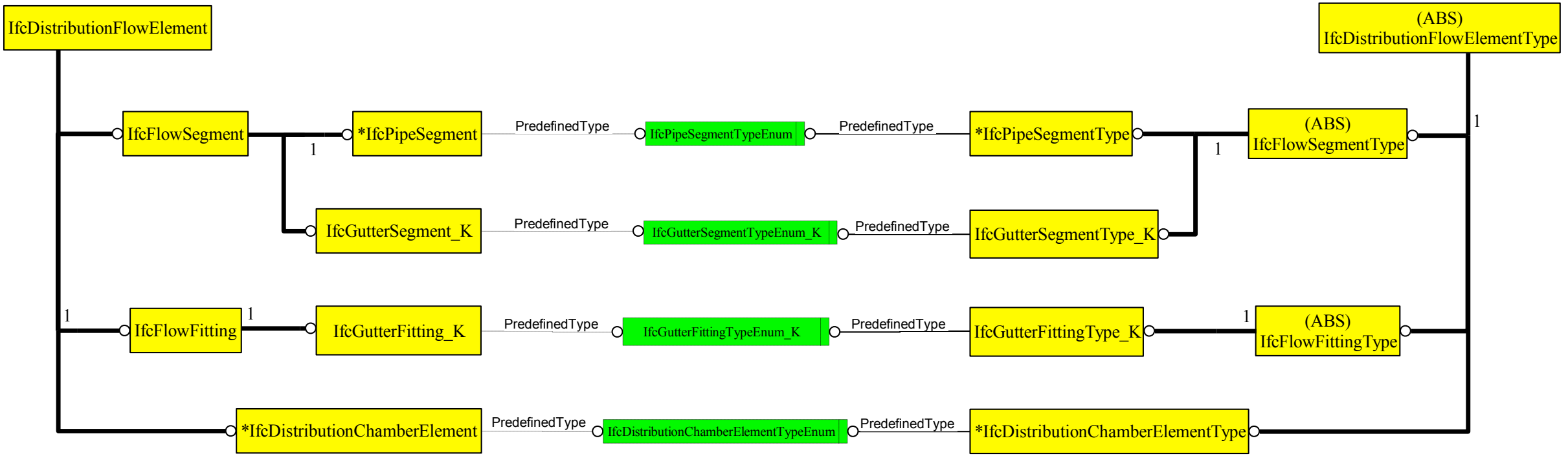
- ***IfcRoadElement_K, IfcEarthworkElemet_K, IfcSubsidiaryFacility_K, IfcCivilStructureElement_K, IfcCivilElementProxy_K***



IfcRoadElementType_K

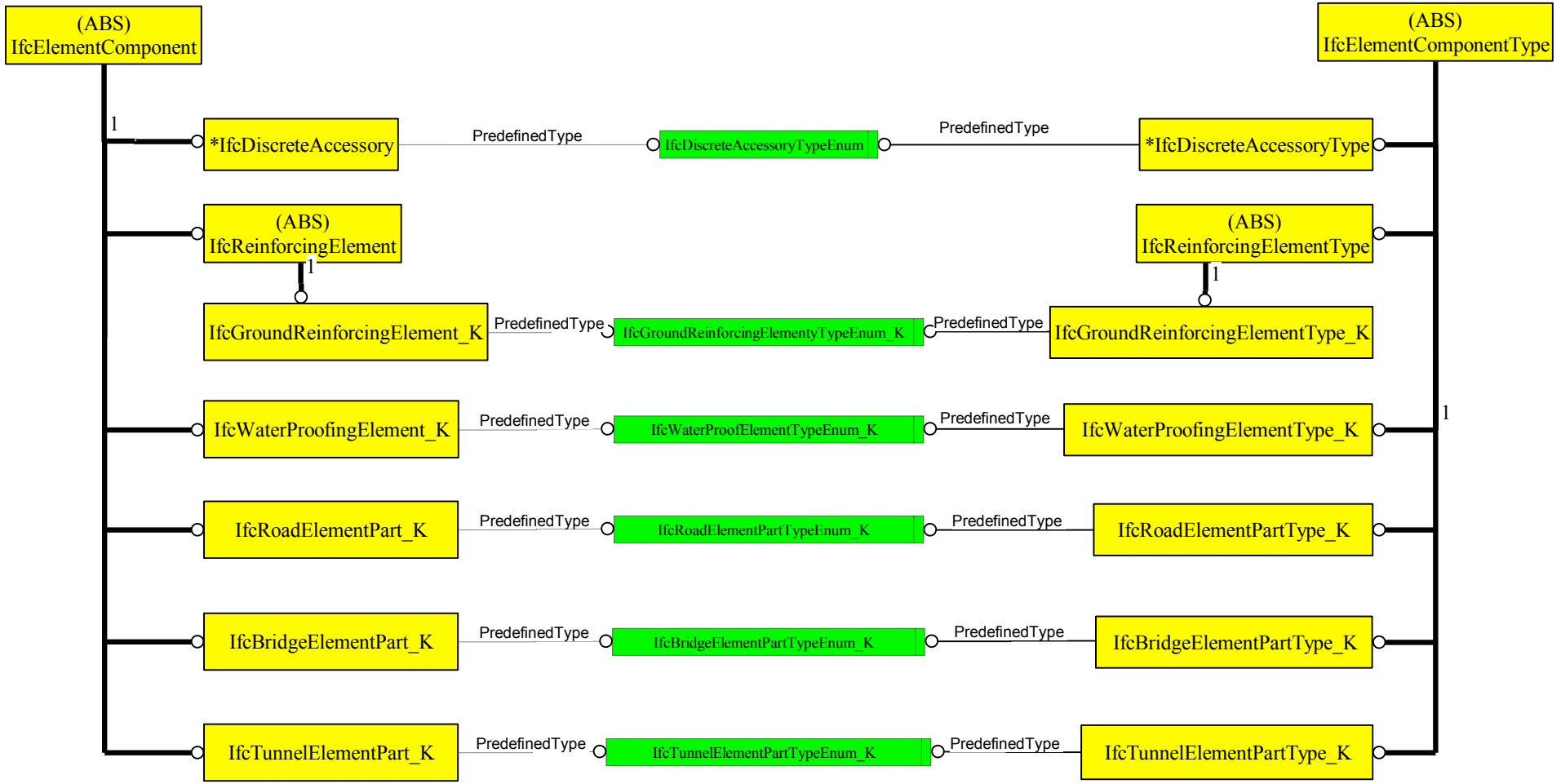
4. IfcRoad Data Schema

Road Drainage in IfcGutterSegment_K, IfcGutterFitting_K



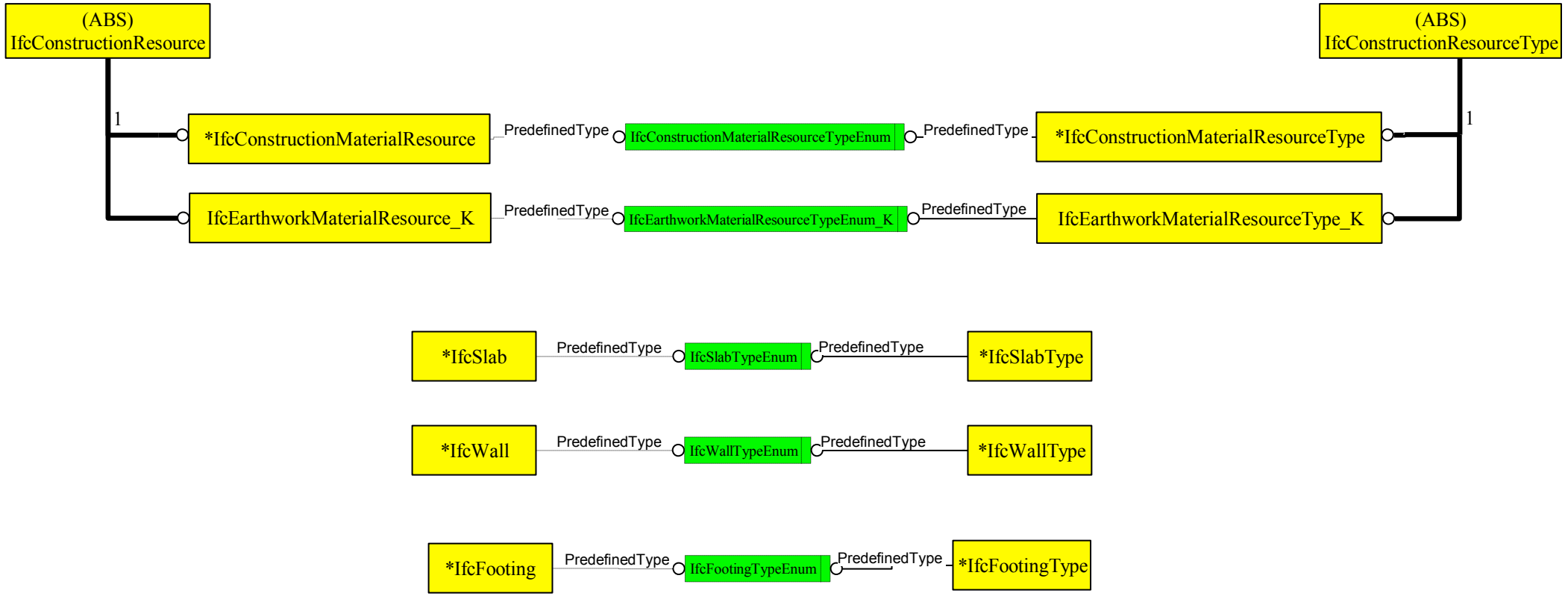
4. IfcRoad Data Schema

IfcElementComponent



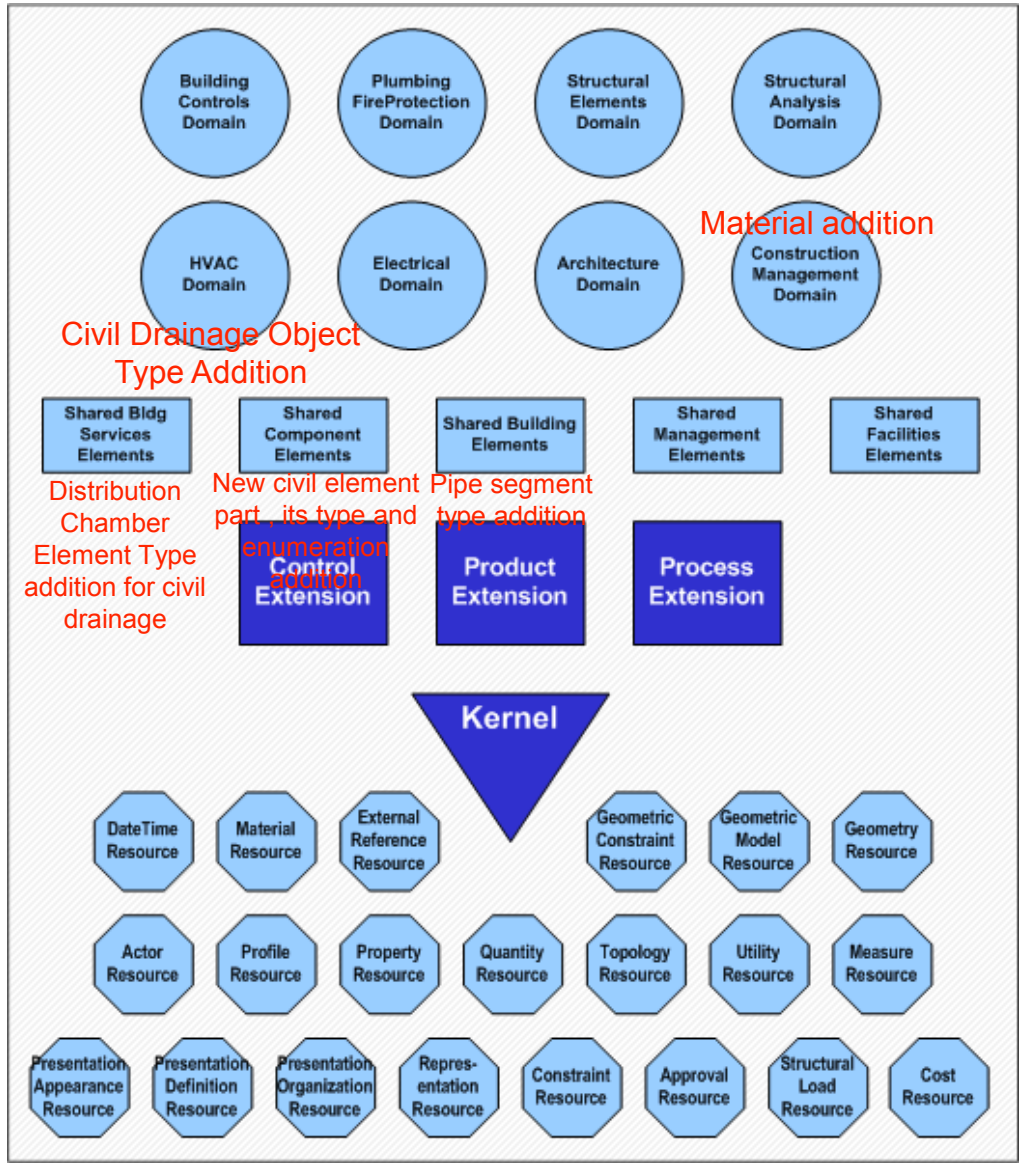
4. IfcRoad Data Schema

Civil Materials and Others

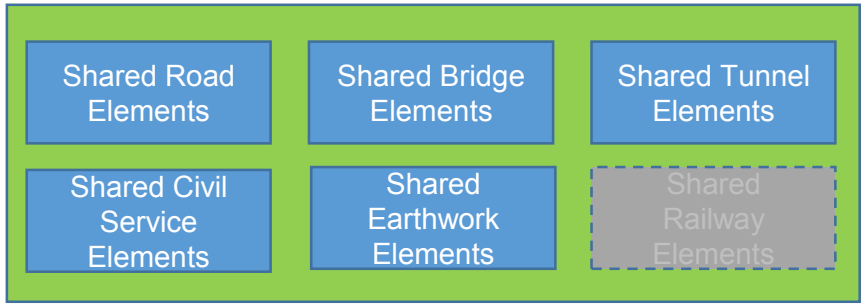


4. IfcRoad Data Schema

IFC4 Architecture Extension



Shared Layer Extension related to road facilities



Product Extension — IfcCivilSpatialElement (Entity, Type)

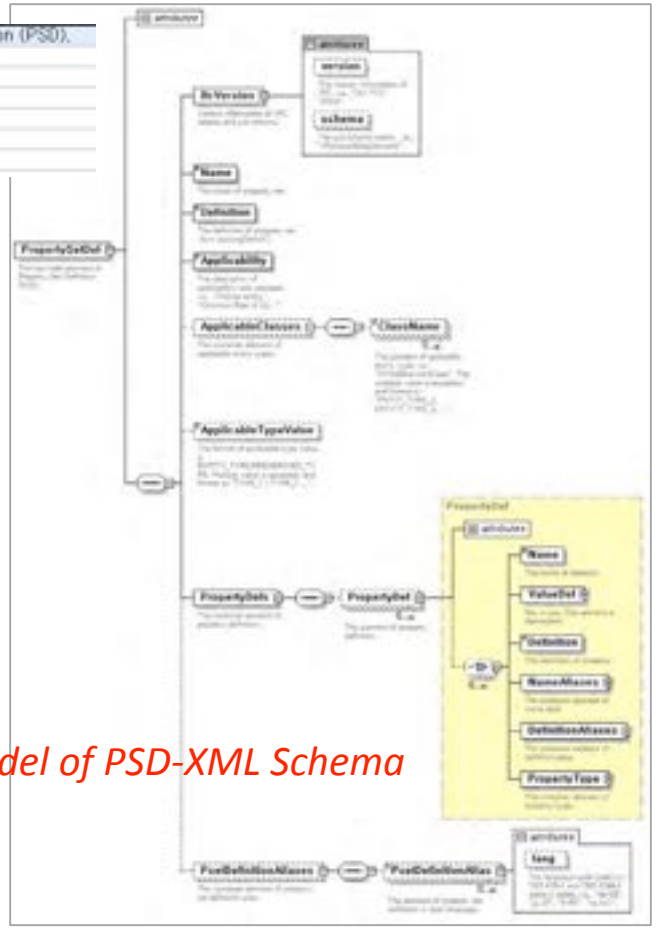
5. Pset & Qset for IfcRoad

PropertySets (Pset) with PSD-XML for IfcRoad Entities

- The Pset was developed in order to support external parameters and attribute for any use cases.
- The Pset was configured in PSD-XML format (buidingSMART guideline) using Altova XMLSpy 2015 trial version.
- The Pset was also incorporated into a converter and viewer, and that can support external PSD-XML typed Psets.

element	PropertySetDef	ann: The top node element of Property Set Definition (PSD).
complexType	PropertyDef	ann: The element of property definition.
complexType	PropertyType	ann: The element of property type.
complexType	DataType	ann: The element of data type.
complexType	UnitType	ann: The element of unit type.
complexType	ReferenceSelect	ann: The element of reference select.
complexType	Values	ann: The element of values.

XML Schema Structure of PSD_IFC4



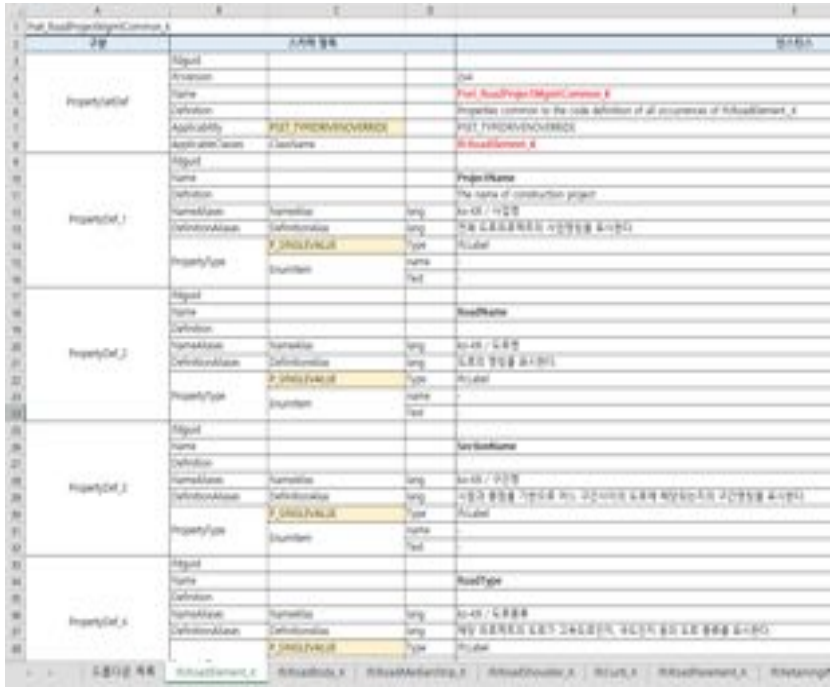
XMLSpy Contents Model of PSD-XML Schema Structure

An example of PsetBeamCommon for IfcBeam

5. Pset & Qset for IfcRoad

PropertySets (Pset) Configuration of IfcRoad

- Psets for IfcRoadElement_K, IfcCaisson_K, IfcCulvert_K, IfcRetWall_K



PropertySet Template

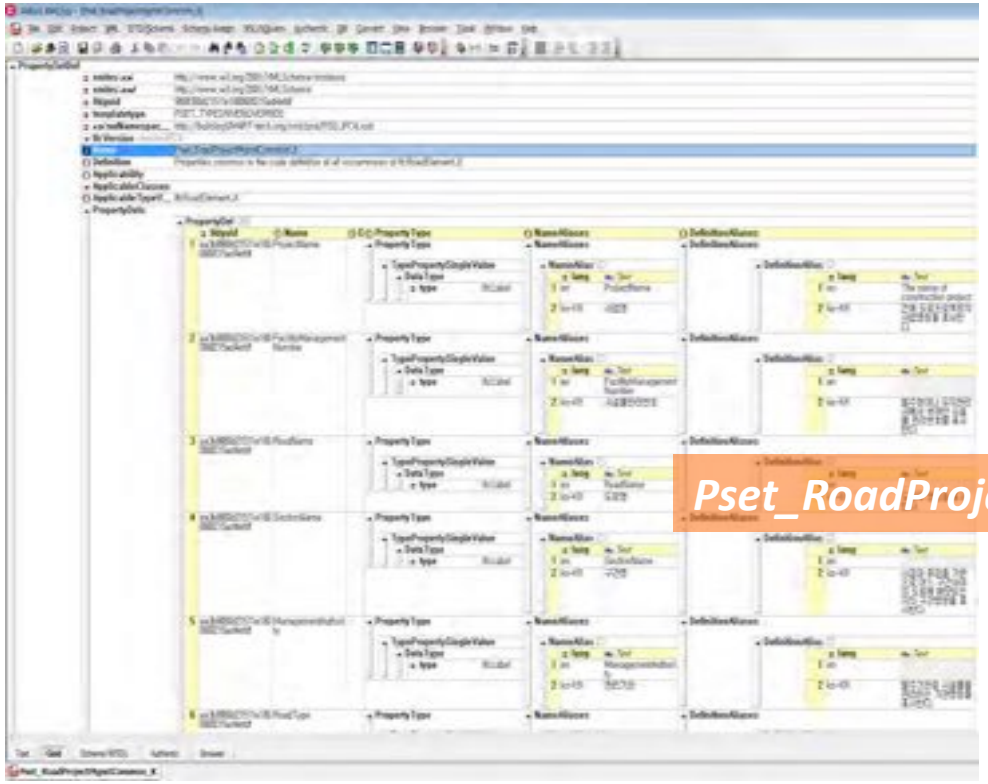
Pset_CaissonCommon_K	2015-09-04 오후...	XML 문서	7KB
Pset_CulvertCommon_K	2015-09-04 오후...	XML 문서	9KB
Pset_RetWallCommon_K	2015-09-04 오후...	XML 문서	5KB
Pset_RoadAlignmentDesignCommon_K	2015-09-07 오전...	XML 문서	11KB
Pset_RoadBodyDesignParameter_K	2015-09-07 오전...	XML 문서	16KB
Pset_RoadCurbCodeCommon_K	2015-09-07 오전...	XML 문서	3KB
Pset_RoadElementDesignParameters_K	2015-09-07 오전...	XML 문서	10KB
Pset_RoadMedianstripDesignCommo...	2015-09-07 오전...	XML 문서	9KB
Pset_RoadMedianstripManagement_K	2015-09-07 오전...	XML 문서	4KB
Pset_RoadPavementCommon_K	2015-09-07 오전...	XML 문서	7KB
Pset_RoadProjectMgmtCommon_K	2015-09-07 오전...	XML 문서	14KB
Pset_RoadShoulderCommon_K	2015-09-07 오전...	XML 문서	6KB

List up of prepared PSD-XML file of Psets for Road Elements

5. Pset & Qset for IfcRoad

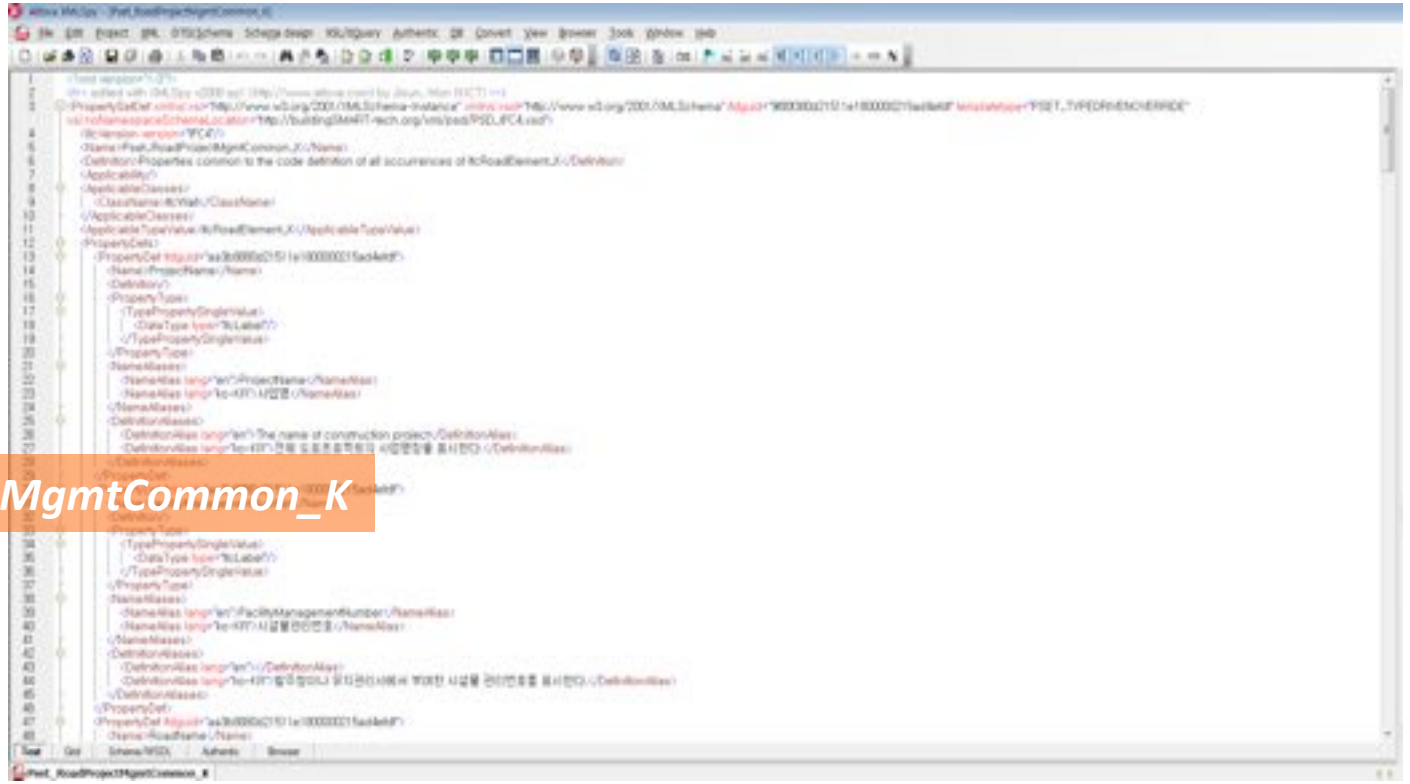
A PropertySet Sample

- **Pset_RoadProjectMgmtCommon_K for IfcRoadElement_K**



PropertySet Contents Input

Pset_RoadProjectMgmtCommon_K

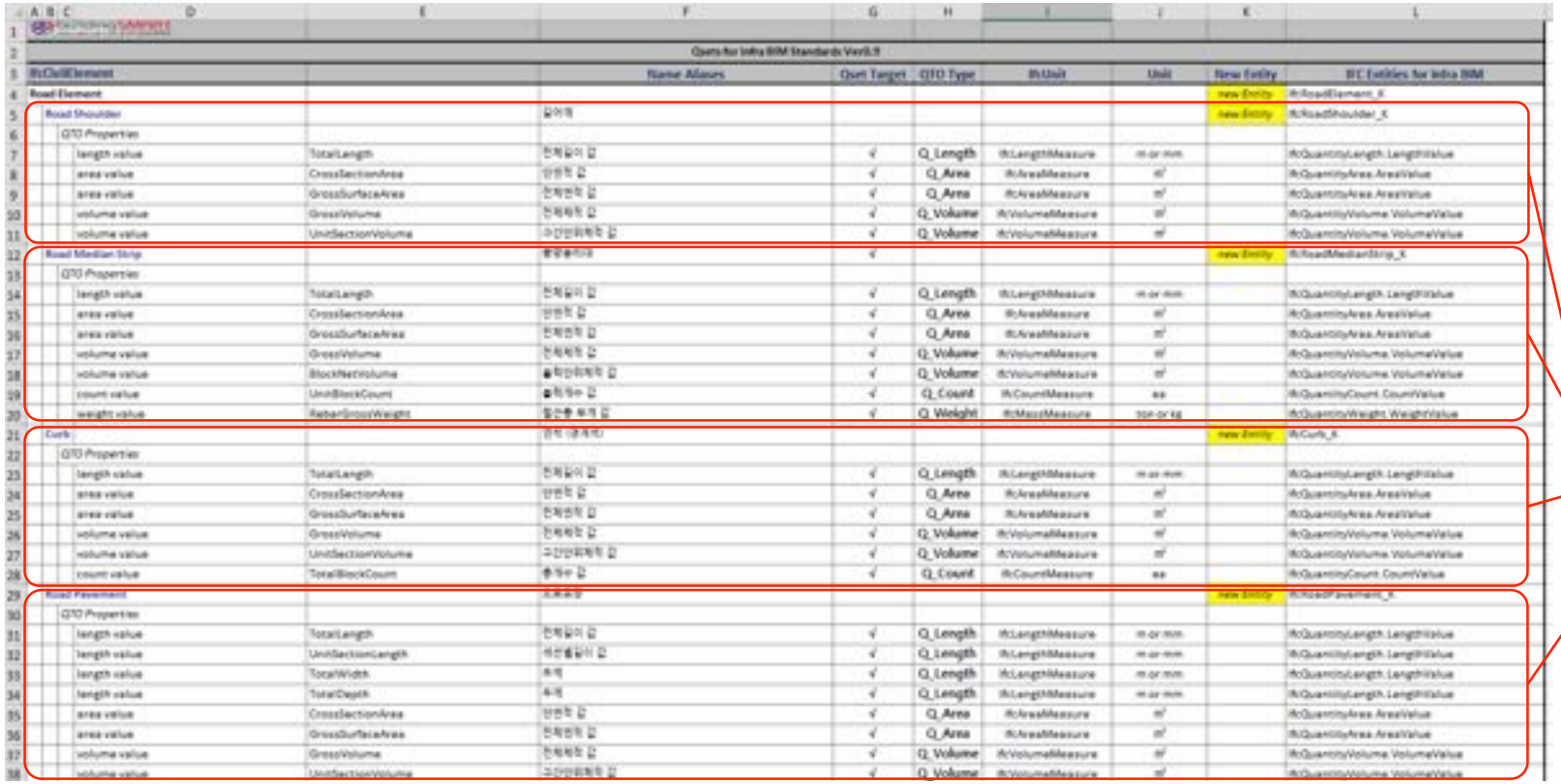


A PropertySet Sample with XML

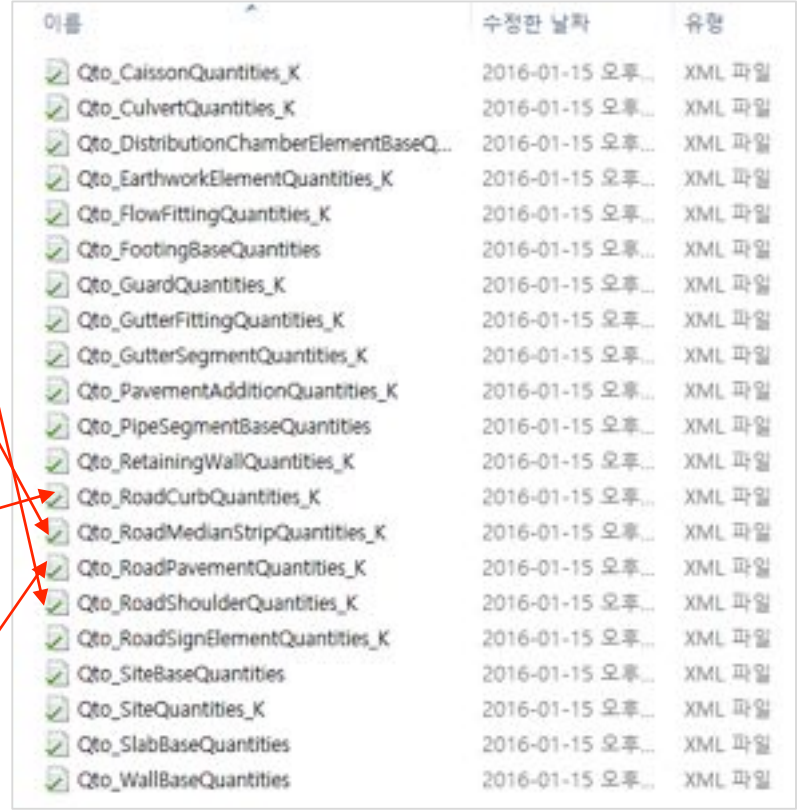
5. Pset & Qset for IfcRoad

QuantitySet(Qset) for IfcRoad

- Qsets were made to support IDM QTO Process and based the exchange requirements from the IDM document
- Incorporated into a converter and viewer like Pset



QuantitySet Template in Exchange Requirements from IDM QTO Process



List up of Qsets for Road Elements

6. IDM with Use Case (QTO)

IDM overview for IfcRoad (1/2)

- IDM Development History
  - IDM V0.8 for IfcRoad for Internal Review : Feb. 10 2015 – Jul. 12 2015 (Distributed)
  - IDM V0.9 for IfcRoad QTO for external distribution : Jul. 13 2015 – Sept.22 (Distributed)
    - > Review of QTO process with stakeholders for Road Projects
    - > Preparation of BIM-based QTO process for Road Projects
    - > In-depth Analysis of exchange data for transferring IfcRoad schema for QTO between stakeholders
    - > Preparation of BIM-based QTO process map, Exchange Requirements (ER), and Functional Parts (FP) for road projects
    - > Entire Documentation of IDM for QTO

- Reference Data
  - bSI IDM Template (http://iug.buildingsmart.org/idms/template)
  - bSI's Official IDM Document (http://iug.buildingsmart.org/idms/information-delivery-manuals)
    - > "IDM for Geographical Referencing"
    - > "IDM for Building Programming (draft)"
  - GSA's AECOO-1 IDM for QTO

- Point of View
  - Focusing on QTO for Road in Detailed Design Stage
  - Exchange Data in ER were described in the perspective of the entities of IfcRoad schema
  - Of many use cases including asset management, design change etc., only QTO for road projects are selected.

6. IDM with Use Case (QTO)

IDM overview for IfcRoad (2/2)

- ‘Road design to QTO’ scenario is dealing with information exchange process using road element includes road space, road facilities, earthwork, drainage facilities, and subsidiary facilities.
- The quantity take-off process is executed based on calculation and estimation of physical feature of the road projects.

- In Scope
  - From preparation task of BIM model for QTO to approval task in detailed design phase
  - Automate takeoff from object parameters
  - Only the object properties required for QTO information exchange

- Out of Scope
  - Manual takeoff for modeled objects
  - Virtual takeoff for non-modeled objects
  - The object properties not related to QTO (ex. specification, management properties)


Korea Institute of Civil Engineering and Building Technology

buildingSMART alliance

Date: 09/22/15

Version: 0.9

Category: Engineering Report

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

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KICT

6. IDM with Use Case (QTO)

IDM Documentation Structure

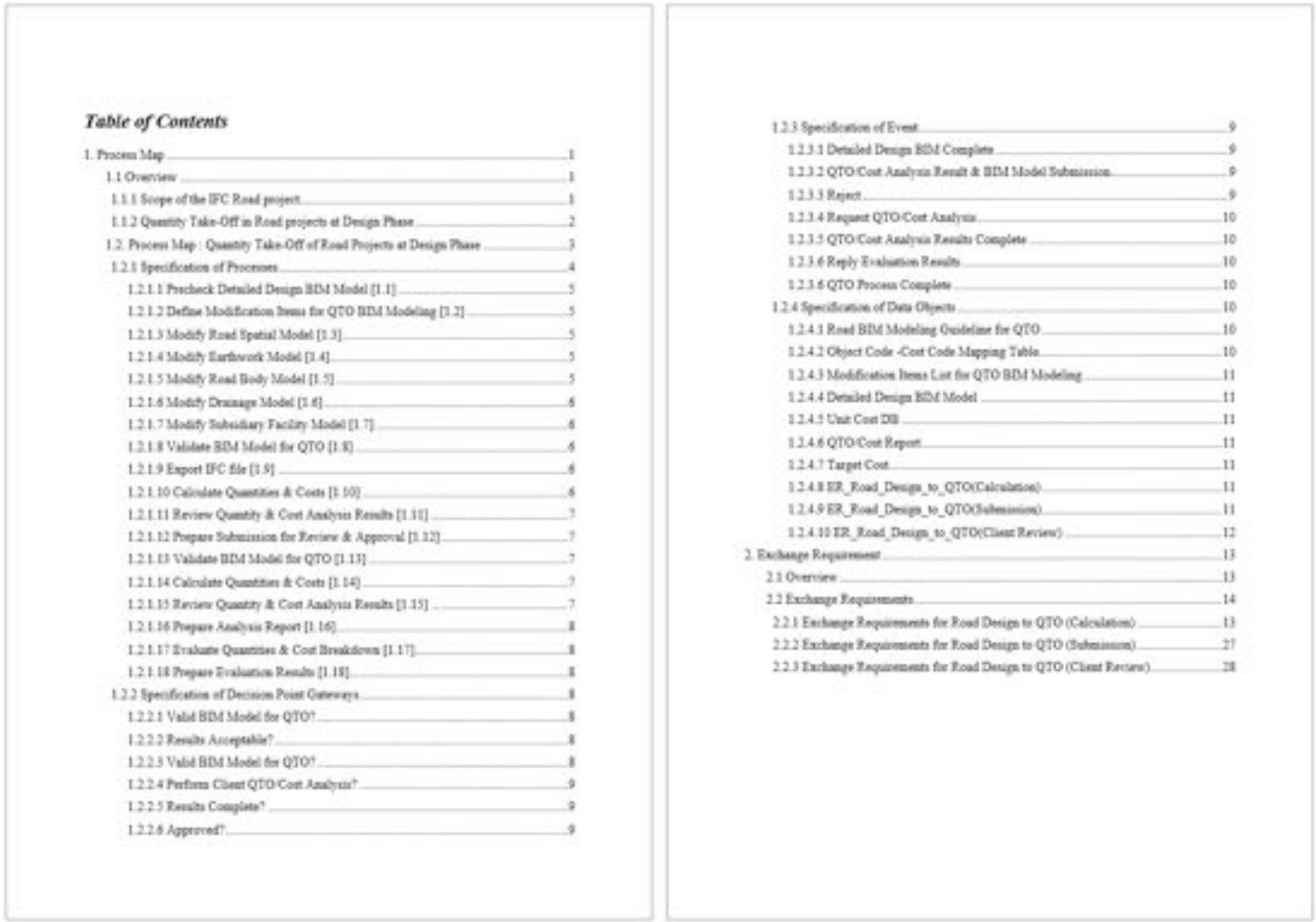


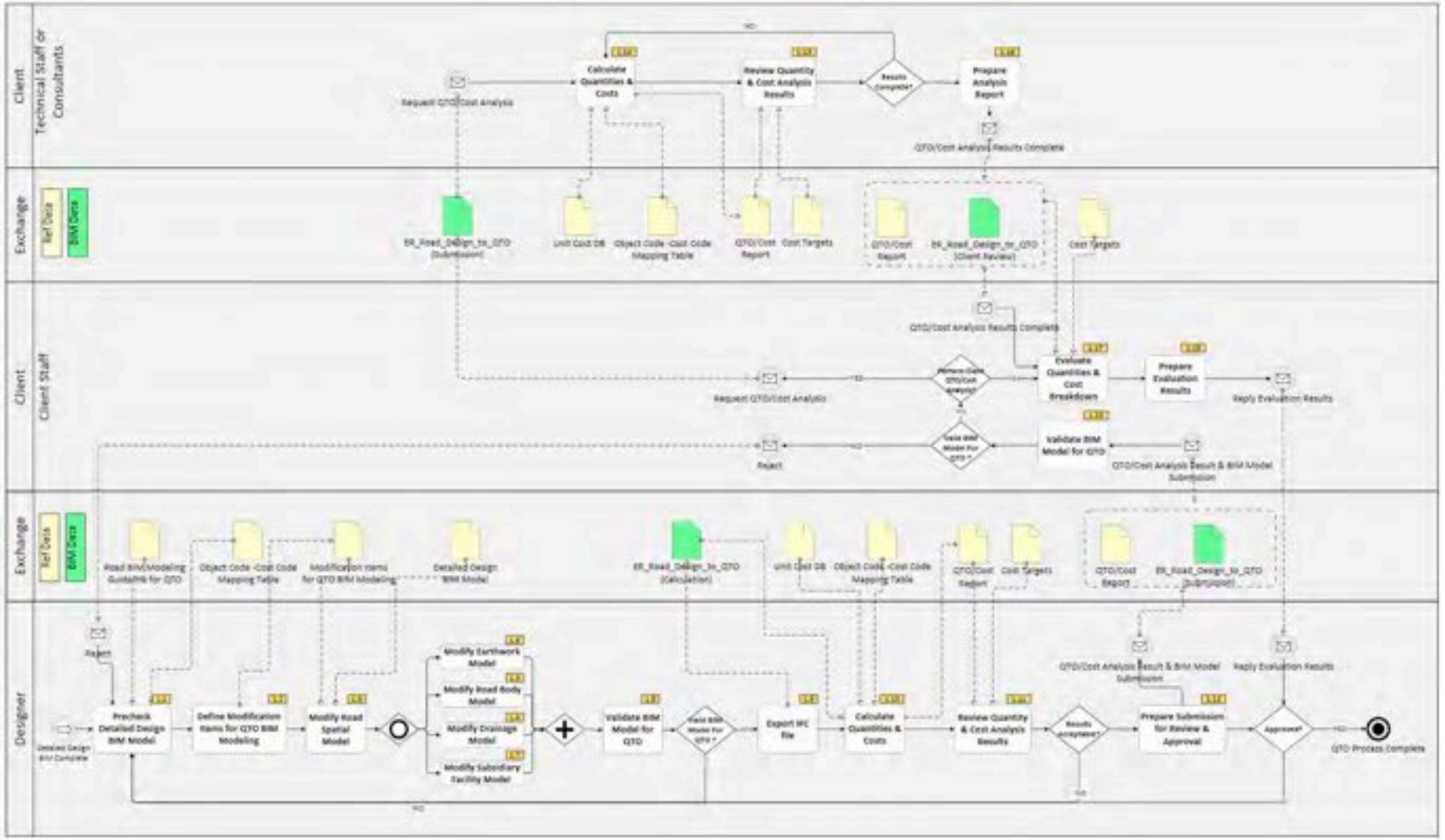
Table of Contents

6. IDM with Use Case (QTO)

Process Map (PM) : Road Design to Quantity take-off

- **Precondition of PM**

- BPMN Diagram
- The Reference data differ between countries.
- The range of QTO is divided by road spatial boundary.
- The quantities is calculated through object parameter based functions in BIM software.



6. IDM with Use Case (QTO)

Exchange Requirements table : Road Design to Quantity take-off

- Exchange Requirements : 12 Element Groups, 27 Elements
- Mapping to IFC Definitions : IfcRoad (22 New Entities) / Ifc4 (8 Entities)

Functional parts

The items included in the QTO report

The calculation results by BIM S/W

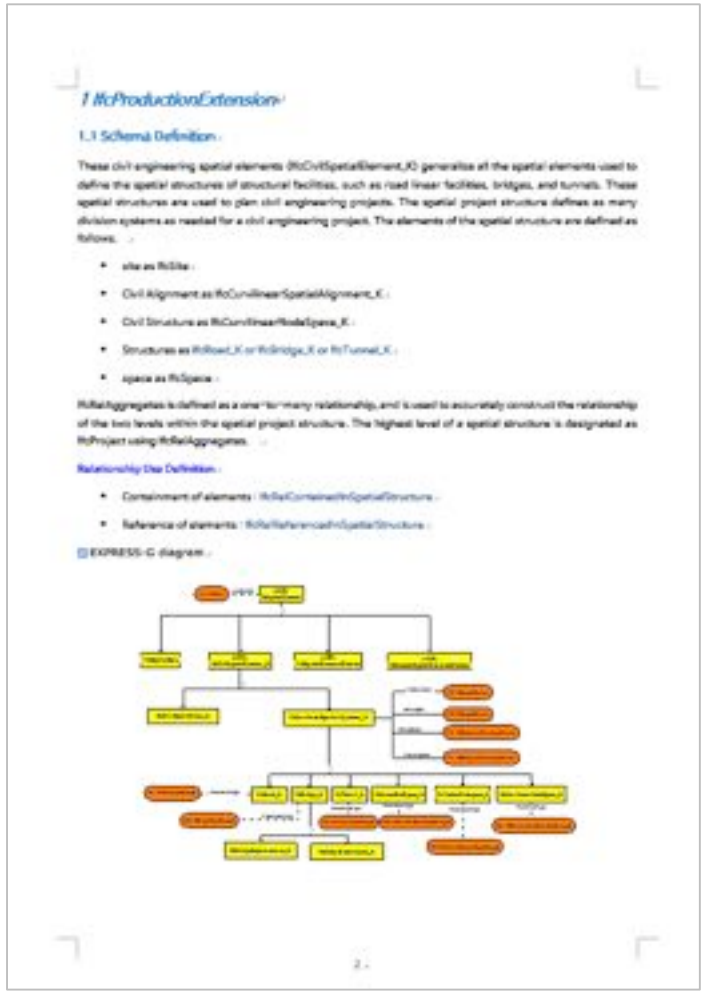
ER mapping to IfcRoad schema

ER mapping to Ifc4 add1 schema

buildingSMART	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
QTO Properties							
material	재료	√		IfcLabel			IfcMaterialDefinition.Name
construction type	유형	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	길이 값	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	면적 값	√		IfcAreaMeasure	m^2		IfcQuantityArea.AreaValue
volume value	체적 값	√		IfcVolumeMeasure	m^3		IfcQuantityVolume.VolumeValue
count value	개수 값	√		IfcCountMeasure	ea		IfcQuantityCount.CountValue
weight value	무게 값	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
time value	시간 값	√		IfcTimeMeasure	seconds or days		IfcQuantityTime.TimeValue
Subsidiary Facility						new Entity	IfcSubsidiaryFacility_K
Road Sign Element	도로시작시설					new Entity	IfcRoadSignElement_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	이름	√		IfcLabel			IfcCivilElement.Name
object type	객체 타입		√	IfcLabel			IfcCivilElementType.ElementType
description	설명		√	IfcText			IfcCivilElement.Description
classification code	분류코드	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	재료	√		IfcLabel			IfcMaterialDefinition.Name
construction type	유형	√		IfcLabel			IfcElementType / IfcPropertySetDefinition
length value	길이 값	√		IfcLengthMeasure	m or mm		IfcQuantityLength.LengthValue
area value	면적 값	√		IfcAreaMeasure	m^2		IfcQuantityArea.AreaValue
volume value	체적 값	√		IfcVolumeMeasure	m^3		IfcQuantityVolume.VolumeValue
count value	개수 값	√		IfcCountMeasure	ea		IfcQuantityCount.CountValue
weight value	무게 값	√		IfcMassMeasure	kg or g		IfcQuantityWeight.WeightValue
time value	시간 값	√		IfcTimeMeasure	seconds or days		IfcQuantityTime.TimeValue
Guard	도로보호시설					new Entity	IfcGuard_K
General Properties							
global ID	Software Identify	√		IfcGloballyUniqueId			IfcCivilElement.GlobalID
name	이름	√		IfcLabel			IfcCivilElement.Name
object type	객체 타입		√	IfcLabel			IfcCivilElementType.ElementType
description	설명		√	IfcText			IfcCivilElement.Description
classification code	분류코드	√		IfcIdentifier			IfcClassification.ReferenceTokens
QTO Properties							
material	재료	√		IfcLabel			IfcMaterialDefinition.Name

7. IfcRoad Documentation

IfcRoad Specifications



1 IfcProductExtension

1.1 Schema Definition

These civil engineering spatial elements (IfcCivilSpatialElement_K) generalize all the spatial elements used to define the spatial structures of structural facilities, such as road linear facilities, bridges, and tunnels. These spatial structures are used to plan civil engineering projects. The spatial project structure defines as many division systems as needed for a civil engineering project. The elements of the spatial structure are defined as follows.

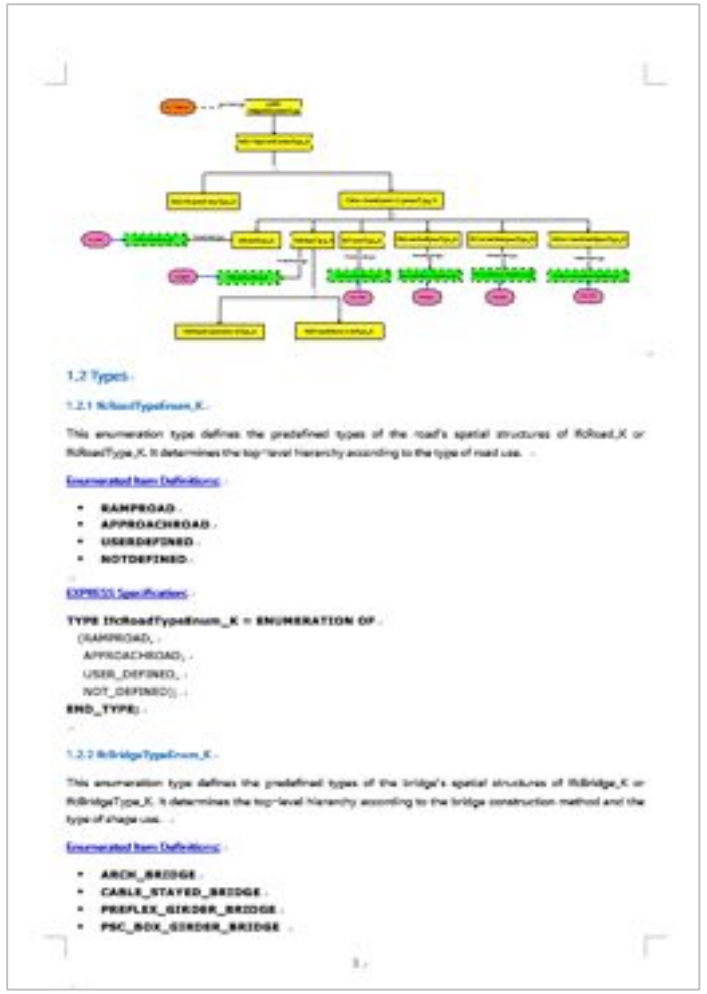
- site as IfcSite
- Civil Alignment as IfcCurvilinearSpatialAlignment_K
- Civil Structure as IfcCurvilinearRodaSpace_K
- Structures as IfcRoad_K or IfcBridge_K or IfcTunnel_K
- space as IfcSpace

IfcRelAggregates is defined as a one-to-many relationship, and is used to accurately construct the relationship of the two levels within the spatial project structure. The highest level of a spatial structure is designated as IfcProject using IfcRelAggregates.

Relationship Use Definition

- Containment of elements : IfcRelContainedInSpatialStructure
- Reference of elements : IfcRelReferencedInSpatialStructure

EXPRESS-G diagram



1.2 Types

1.2.1 IfcRoadTypeEnum_K

This enumeration type defines the predefined types of the road's spatial structures of IfcRoad_K or IfcRoadType_K. It determines the top-level hierarchy according to the type of road use.

Enumerated Item Definitions

- RAMPROAD
- APPROACHROAD
- USERDEFINED
- NOTDEFINED

EXPRESS Specifications

```
TYPE IfcRoadTypeEnum_K = ENUMERATION OF
  (RAMPROAD,
   APPROACHROAD,
   USER_DEFINED,
   NOT_DEFINED);
END_TYPE;
```

1.2.2 IfcBridgeTypeEnum_K

This enumeration type defines the predefined types of the bridge's spatial structures of IfcBridge_K or IfcBridgeType_K. It determines the top-level hierarchy according to the bridge construction method and the type of shape use.

Enumerated Item Definitions

- ARCH_BRIDGE
- CABLE_STAYED_BRIDGE
- PREFLEX_GIRDER_BRIDGE
- PSC_BOX_GIRDER_BRIDGE

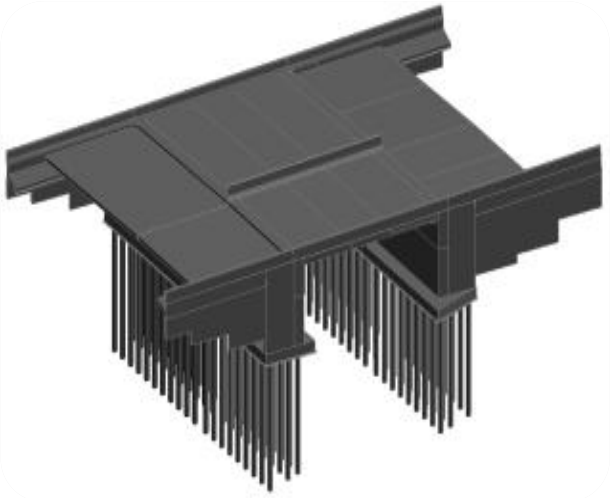
2.4.30 Pset_CulvertCommon

PSET_TYPEDRIVENOVERRIDE / IfcCulvert_K

- CulvertID
  - P_SINGLEVALUE / IfcIdentifier
- ManagementAuthority
  - P_SINGLEVALUE / IfcLabel
- FacilityManagementNumber
  - P_SINGLEVALUE / IfcCountMeasure
- CulvertType
  - P_ENUMERATEDVALUE / IfcLabel / PEnum_CulvertType: ONEWAYWATERWAYCULVERT, TWOWAYWATERWAYCULVERT, THREEWAYWATERWAYCULVERT, ONEWAYPASSAGEWAYCULVERT, TWOWAYPASSAGEWAYCULVERT, ONEWAYSIDEWEIRWATERWAYCULVERT, TWOWAYSIDEWEIRWATERWAYCULVERT, THREEWAYSIDEWEIRWATERWAYCULVERT, ONEWAYSIDEWEIRPASSAGEWAYCULVERT, TWOWAYSIDEWEIRPASSAGEWAYCULVERT, STONEFILLEDCULVERTTYPE1, STONEFILLEDCULVERTTYPE2, STONEFILLEDCULVERTTYPE3, STONEFILLEDCULVERTTYPE4, STONEFILLEDCULVERTTYPES, COMMONDUCT, CLOSED_CONDUIT, NOTDEFINED, USERDEFINED
- CulvertFoundationType
  - P_ENUMERATEDVALUE / IfcLabel / PEnum_CulvertFoundationType: BASE_FOOTING, FITMOUTH_FOOTING, CAISSON_FOUNDATION, PSC_PILE_FOUNDATION, RC_PILE_FOUNDATION, SLURRY_WALL_FOUNDATION, SPREAD_FOUNDATION, STEEL_PILE_FOUNDATION, STEEL_SHEET_PILE_FOUNDATION, USERDEFINED, NOTDEFINED
- CulvertWingWallType
  - P_SINGLEVALUE / IfcLabel
- HasCulvertWingWall
  - P_SINGLEVALUE / IfcBoolean
- CulvertUtilizationType
  - P_SINGLEVALUE / IfcLabel
- CulvertDesignStandard
  - P_SINGLEVALUE / IfcLabel
- CulvertMaterial
  - P_ENUMERATEDVALUE / IfcLabel / PEnum_CulvertMaterialType: AGGREGATES, CONCRETE, DRYWALL, FUEL, GYPSUM, MASONRY, PLASTIC, WOOD, ASPHALT_k, NOTDEFINED, USERDEFINED
- CulvertSpanLength
  - P_SINGLEVALUE / IfcPositiveLengthMeasure
- CulvertSize
  - P_SINGLEVALUE / IfcLabel
- CulvertCrossSectionArea
  - P_SINGLEVALUE / IfcAreaMeasure
- ThicknessOfCulvertCoverConcrete
  - P_SINGLEVALUE / IfcPositiveLengthMeasure
- GrossVolumeOfCulvert
  - P_SINGLEVALUE / IfcVolumeMeasure
- Others
  - P_SINGLEVALUE / IfcLabel

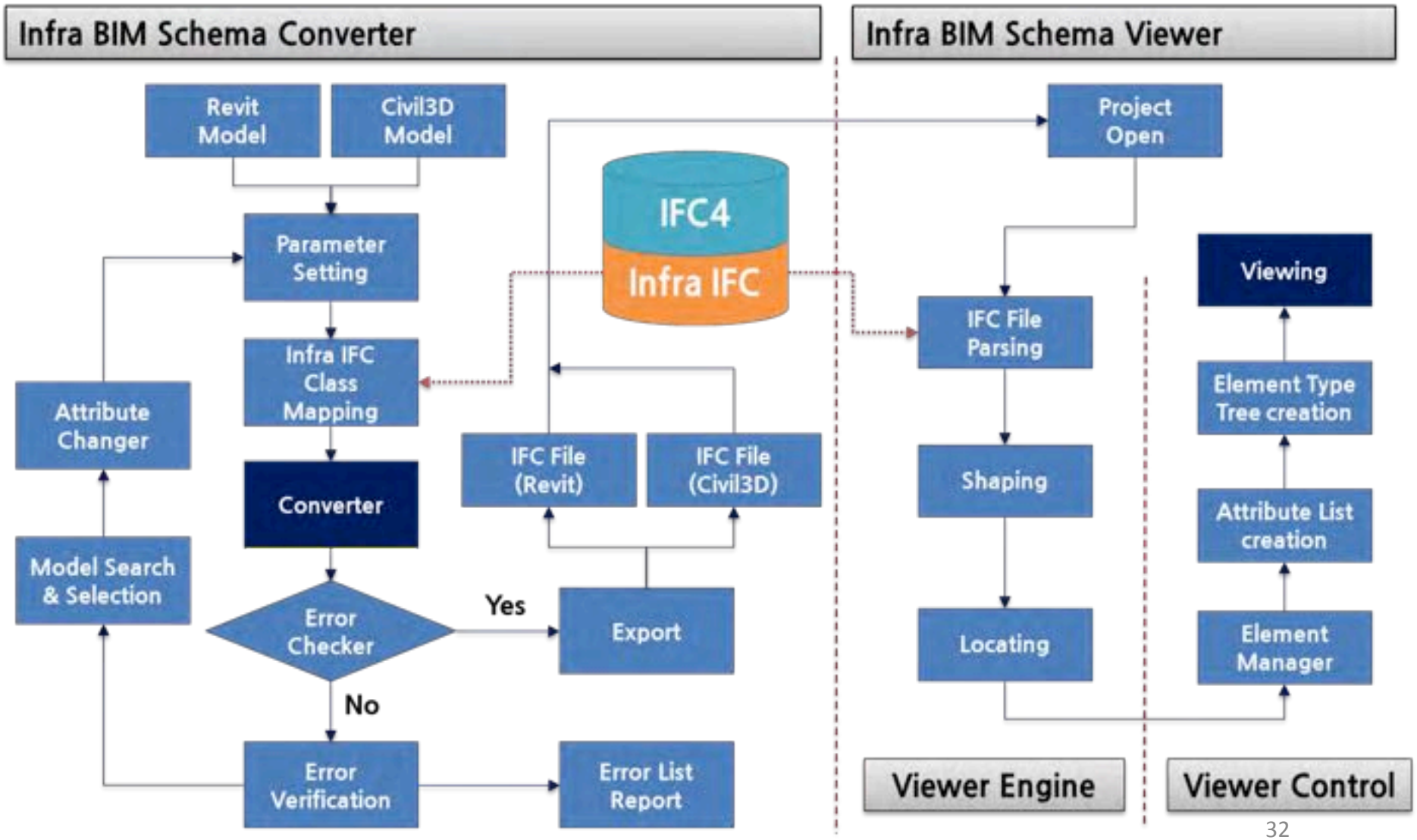
8. IfcRoad Verification

IfcRoad Converter and Viewer



Autodesk Revit API for Road, Bridge, Tunnel etc.

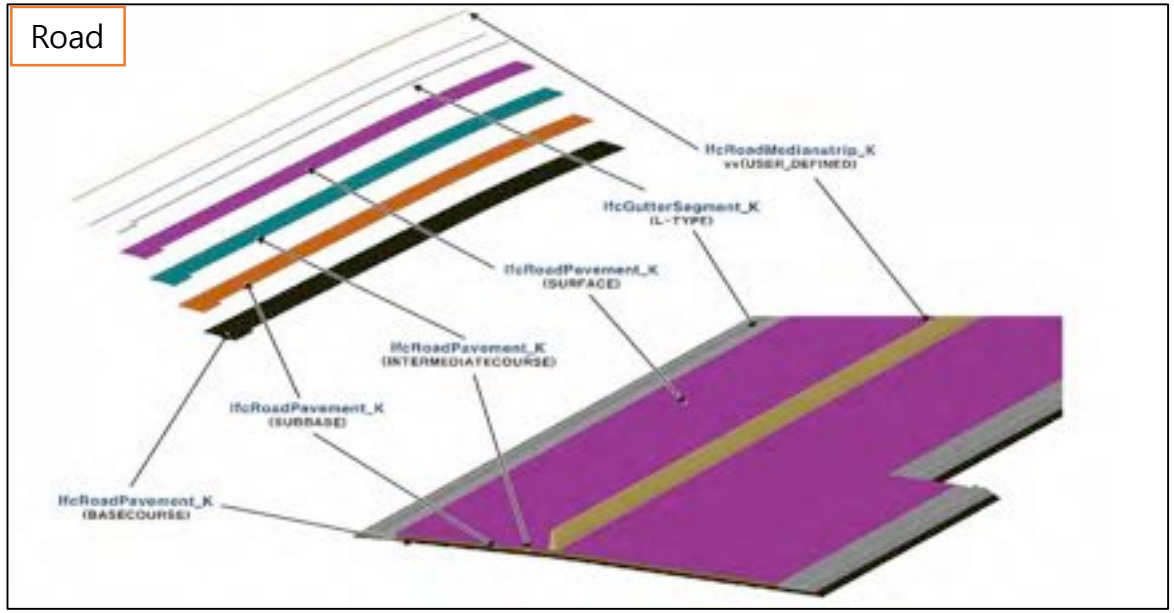
Autodesk Civil3D API



8. IfcRoad Verification

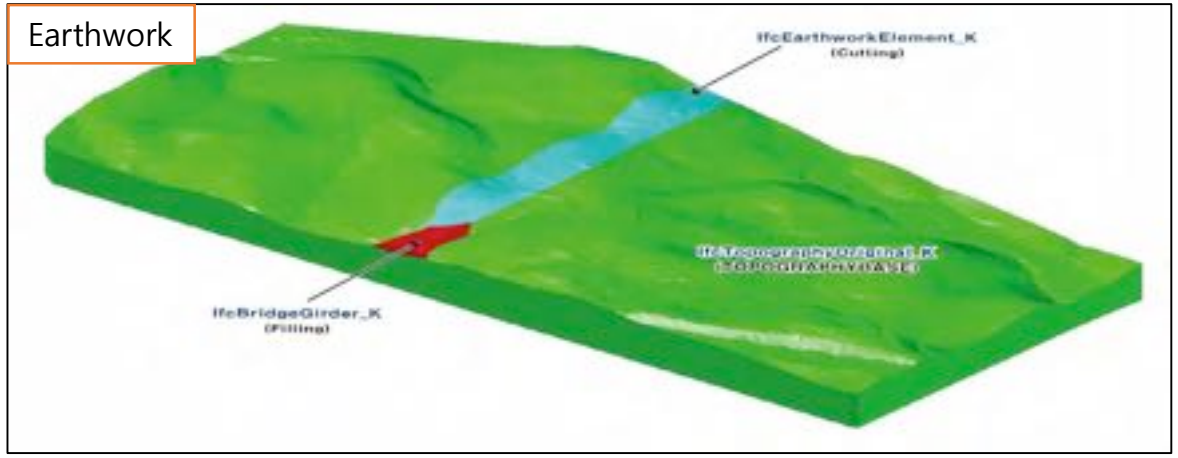
Road and Earthwork

Road



NO	명칭	Civil 3D 레이어	IFC	건기연 스키마	Type	비고
1	중앙분리대	Surface		IfcRoadMedianstrip_K	USER_DEFINED	
2	측구	Gutter		IfcGutterSegment_K	L-TYPE	
3	포장	Pave1		IfcRoadPavement_K	SURFACE	
4	포장	Pave2		IfcRoadPavement_K	INTERMEDIATECOURSE	
5	포장	Pave3		IfcRoadPavement_K	SUBBASE	
6	포장	Pave4		IfcRoadPavement_K	BASECOURSE	

Earthwork

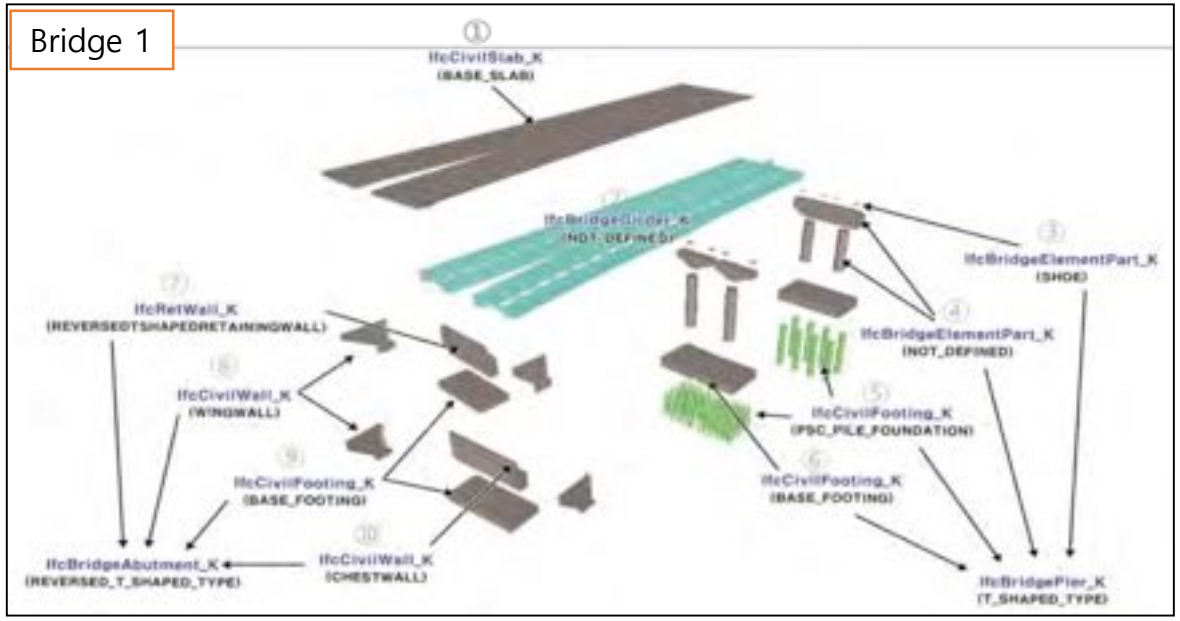


NO	명칭	Civil 3D 레이어	IFC	건기연 스키마	Type	비고
1	원지형	Surface		IfcTopographyOriginal_K	TOPOGRAPHYBASE	
2	성토	Filling		IfcEarthworkElement_K	FILLING	
3	절토	Cutting		IfcEarthworkElement_K	CUTTING	

8. IfcRoad Verification

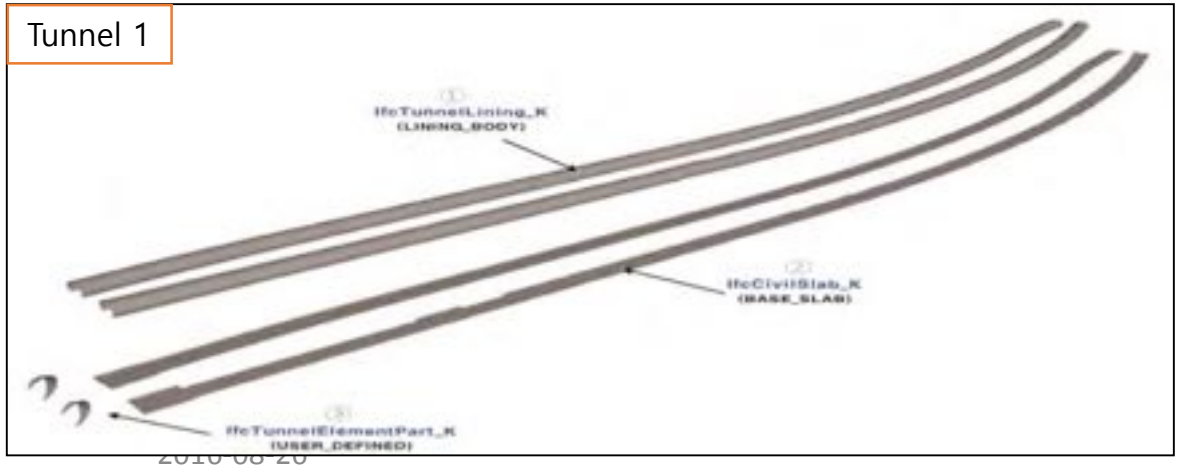
Bridge and Tunnel

Bridge 1



NO	명칭	Revit 패밀리명	IFC	건기연 스키마		Type	비고
1	슬래브	바닥	IfcSlab		IfcCivilSlab_K	BASE_SLAB	
2	스텝박스거더	구조프레임	IfcBuildingElementProxy		IfcBridgeGirder_K	NOT_DEFINED	
3	교좌장치	받침	IfcFooting	IfcBridgePier_K (NOT_DEFINED)	IfcBridgeElementpark_K	SHEO	교각
4	코핑	구조기둥_콘크리트 컬럼	IfcColumn		IfcBridgeElementpark_K	NOT_DEFINED	
4	기둥	콘크리트원형기둥	IfcColumn		IfcBridgeElementpark_K	NOT_DEFINED	
5	교각파일기초	일반모델	IfcBuildingElementProxy		IfcCivilFooting_K	PSC_PILE_FOUNDATION	
6	교각기초	교각기초_구조기초	IfcFooting		IfcCivilFooting_K	BASE_FOOTING	
6	교각기초	버팀콘크리트_구조기초	IfcFooting		IfcCivilFooting_K	BASE_FOOTING	
7	벽체	교대상부_구조기초	IfcFooting	IfcCivilWall_K (REVERSED_T_SHAPED_TYPE)	IfcRetWall_K	REVERSEDTSHAPEDRETAININGWALL	교대 (옹벽, 구체 구분이 되어 있지 않고 모델이 교대상부/하부로 구축됨)
8	날개벽	교대상부 우측/좌측 날개	IfcFooting		IfcCivilWall_K	WINGWALL	
9	교대기초	교대바닥_구조기초	IfcFooting		IfcCivilFooting_K	BASE_FOOTING	
9	교대기초	교대받침_구조기초	IfcFooting		IfcCivilFooting_K	BASE_FOOTING	
10	흉벽	-	-		IfcCivilWall_K	CHESTWALL	

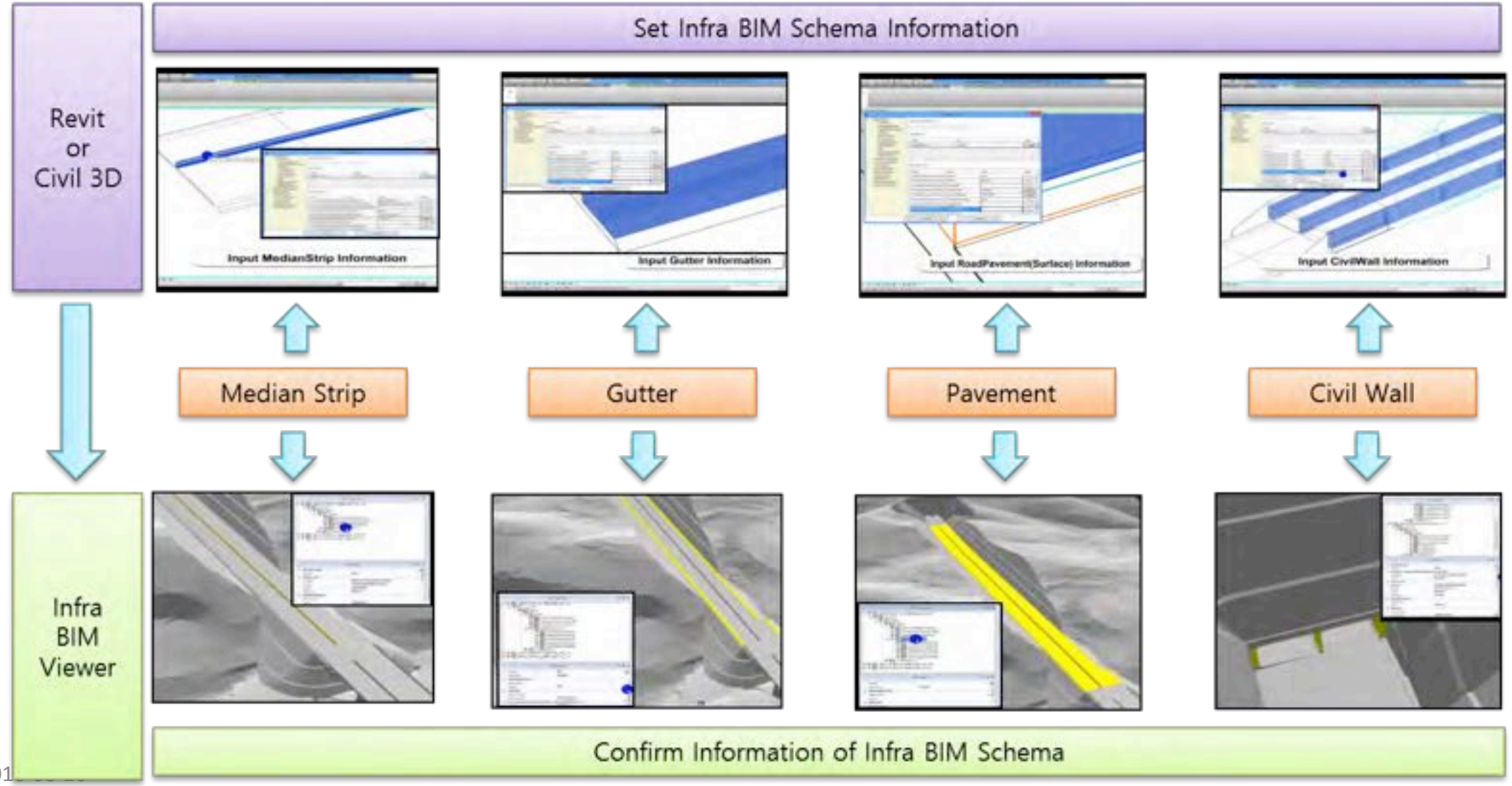
Tunnel 1



NO	명칭	Revit 패밀리명	IFC	건기연 스키마		Type	비고
1	라이닝콘크리트	일반모델	IfcBuildingElementProxy		IfcTunnelLining_K	LINING_BODY	
2	슬래브	바닥	IfcSlab		IfcCivilSlab_K	BASE_SLAB	
2	경문바닥	바닥	IfcBuildingElementProxy		IfcCivilSlab_K	BASE_SLAB	
3	터널경문	일반모델	IfcWall		IfcTunnelElementPart_K	USER_DEFINED	
3	터널경문	벽	IfcBuildingElementProxy		IfcTunnelElementPart_K	USER_DEFINED	

8. IfcRoad Verification

IfcRoad Conversion and Visualization

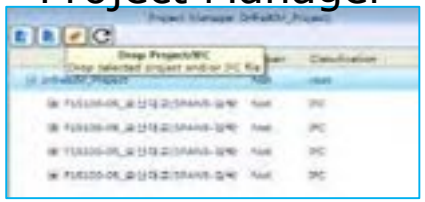


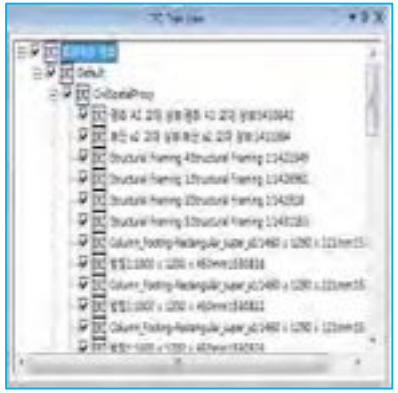
8. IfcRoad Verification

IfcRoad Viewer

- IFC File Open
- Project Manager
  - Project Create(New Project)
  - Add / Delete IFC to Project
  - Delete Project
- TreeView
- Properties
- Model View
- Capture Window
- Model view
- View Object
- View Mode
- Measure
- Section View
- Decomposition
- User View
- Mini Map

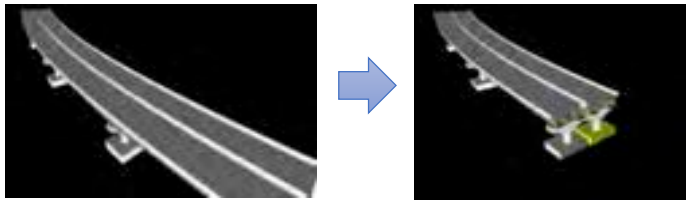
Project Manager





Tree View

Properties



Section View

Decompositio

User View

8. IfcRoad Verification

IfcRoad Converter and Viewer

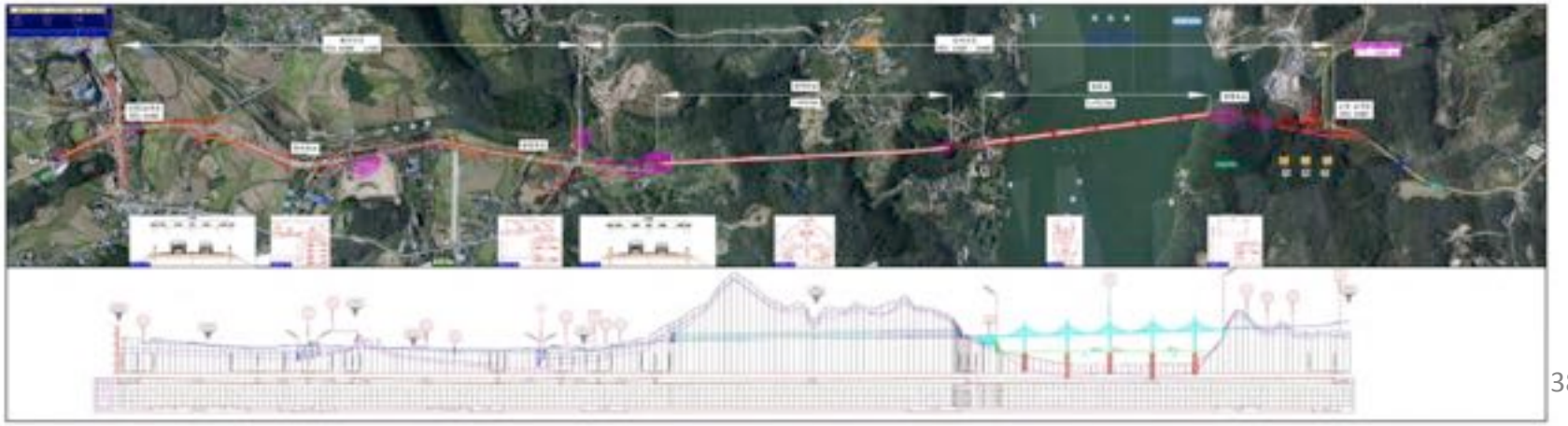
9. Case Study for a Real Road Project with IfcRoad

Case Study Outline

- Aim : For verifying IfcRoad schema applicability into real road projects in terms of delivering BIM design model, and sharing the final results for BIM-based QTO processes
- Case Study Duration : July. 1 2015 - November 30 2015 (about 5 months)
- Case Study Budget : about 120,000 dollar (3D shop modelling, IfcRoad Adoption in Delivering, Economical Evaluation)
- Target Modeling : Road, Earthwork, Bridge, Tunnel, Subsidiary Facilities with component/part, rebar

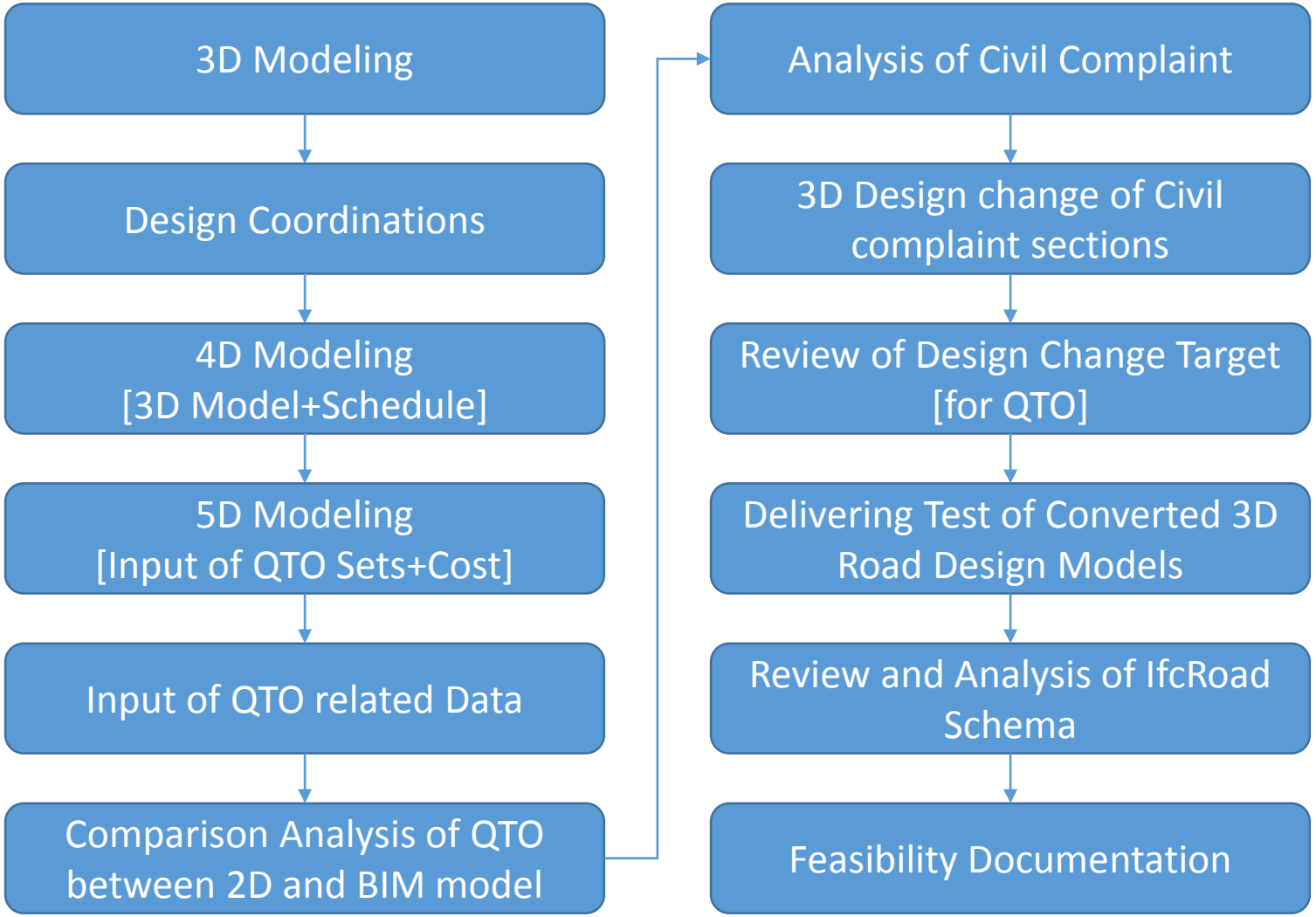
Road Project Overview

- Road Project Name : Seolak-Cheongpyeong Road Construction Project (Gyeonggi province, Gapyeong)
- Road Facilities : Road Body, Earthwork (Filling / Cutting), ED type bridge (Cheongpyeong Bridge, 720m), NATM type Tunnel (Seolak Tunnel, 924m), entire subsidiary facilities, and Road drainage facilities etc.
- Total Length : 3.9km, Width : 10.5m - 11.5m (2 lane)
- Utilization business with BIM : Civil complaint, Design change, QTO, Schedule management / Constructivity



9. Case Study for a Real Road Project with IfcRoad

Case Study Process

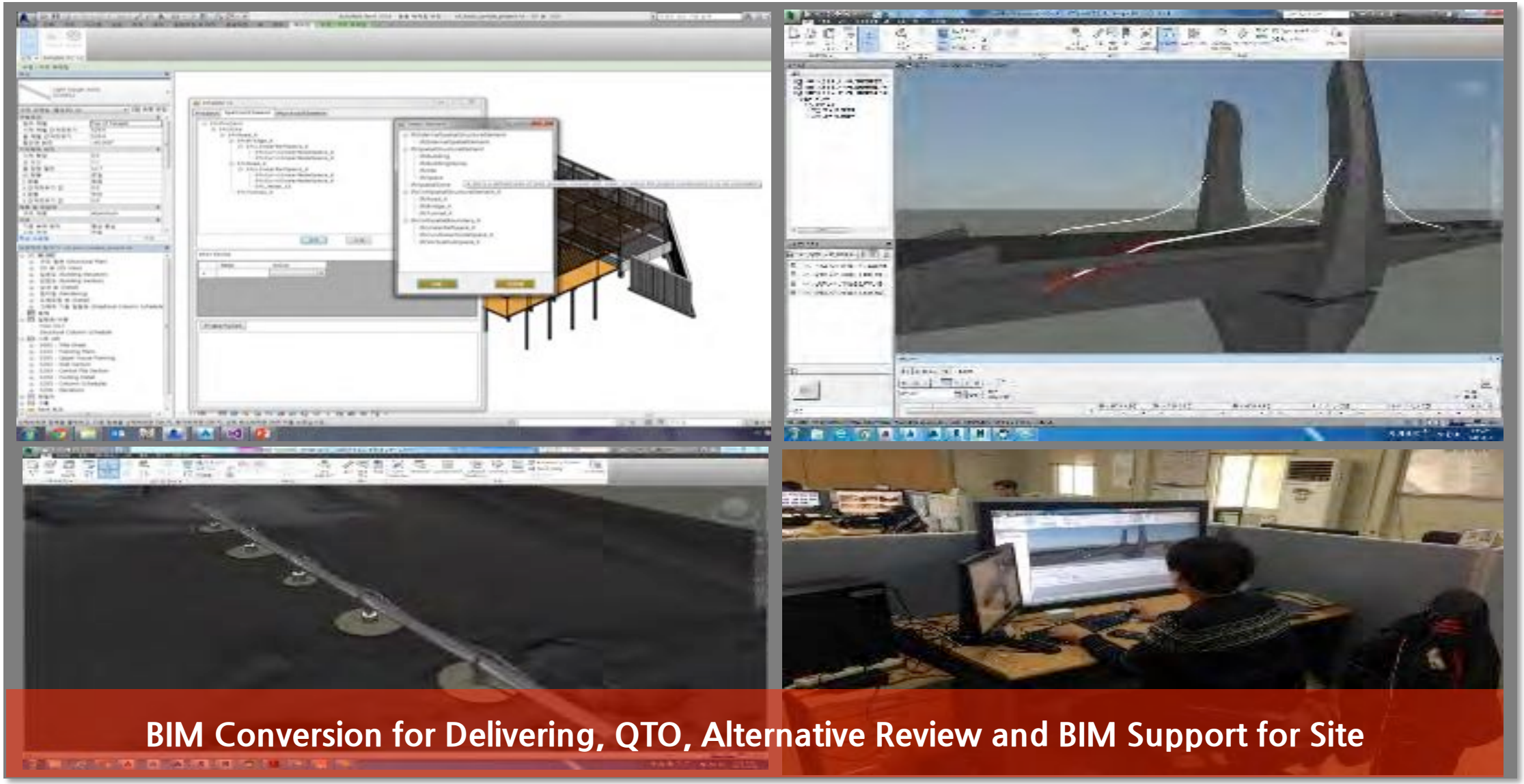


9. Case Study for a Real Road Project with IfcRoad

Application of Case Study with IfcRoad

- 3D Modeling : 3D Shop Drawing with component/ parts and rebar (Model Coordination)
- 4D Modeling : using planned construction schedule
- 5D Modeling : Quantity Takeoff
- IfcRoad Conversion and Delivering Test : Verification of a new Converter and Viewer based on an improved IfcRoad schema (Geometrical shape representation test in commercial software which include Revit and Civil3D, Conversion error checking, Delivery process analysis etc.)
- Economical Evaluation (Infra BIM feasibility report) for road project delivery by government agency
- Benefit analysis Target Business : Civil complaint, Design change, QTO, Schedule management/Constructability analysis

9. Case Study for a Real Road Project with IfcRoad

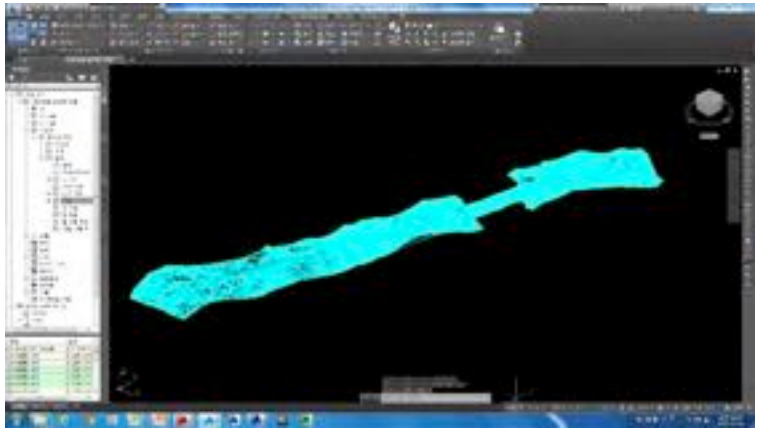


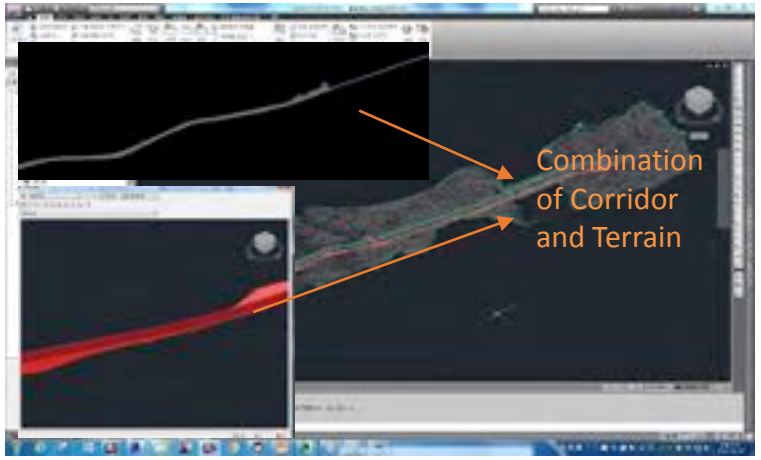
BIM Conversion for Delivering, QTO, Alternative Review and BIM Support for Site

9. Case Study for a Real Road Project with IfcRoad

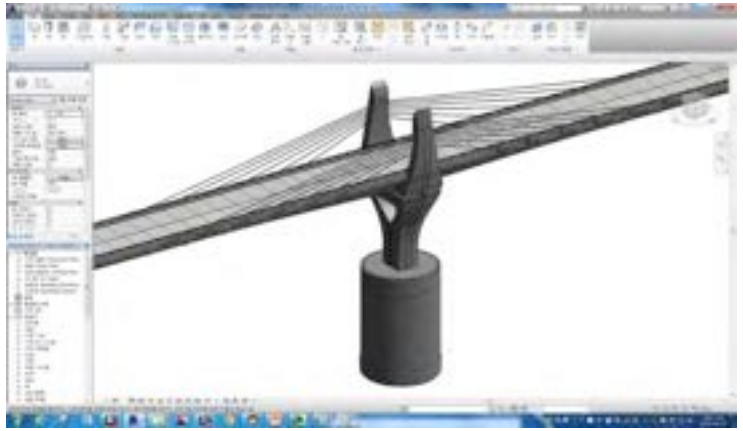
3D modeling sample for the road project

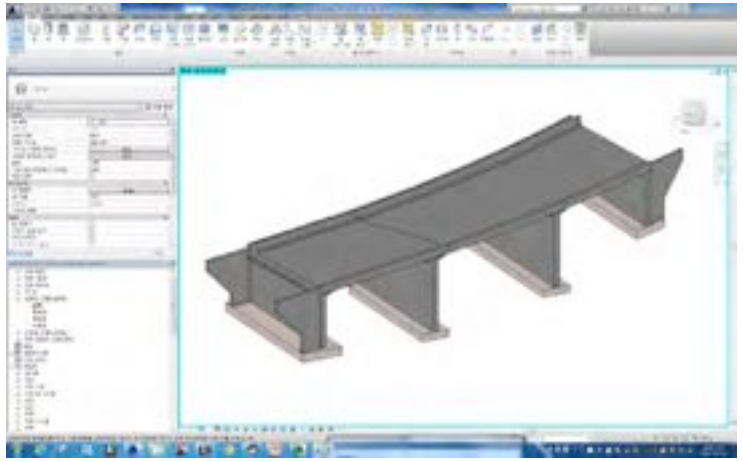
Road and Terrain model



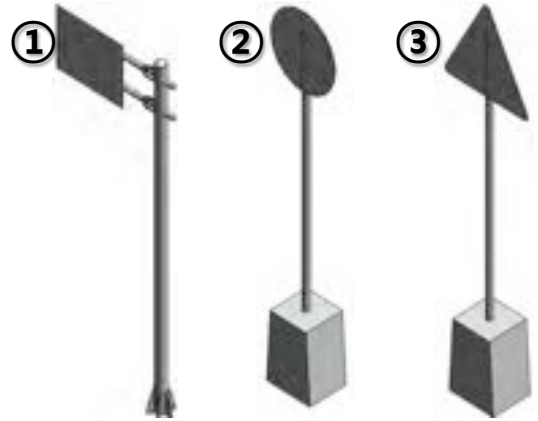


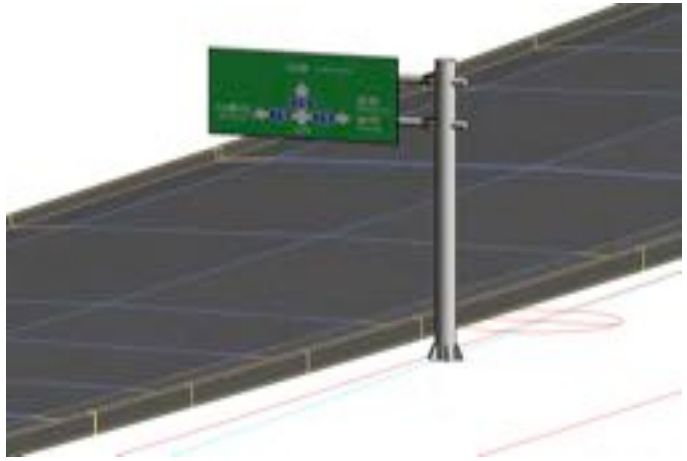
Structures





BIM Library

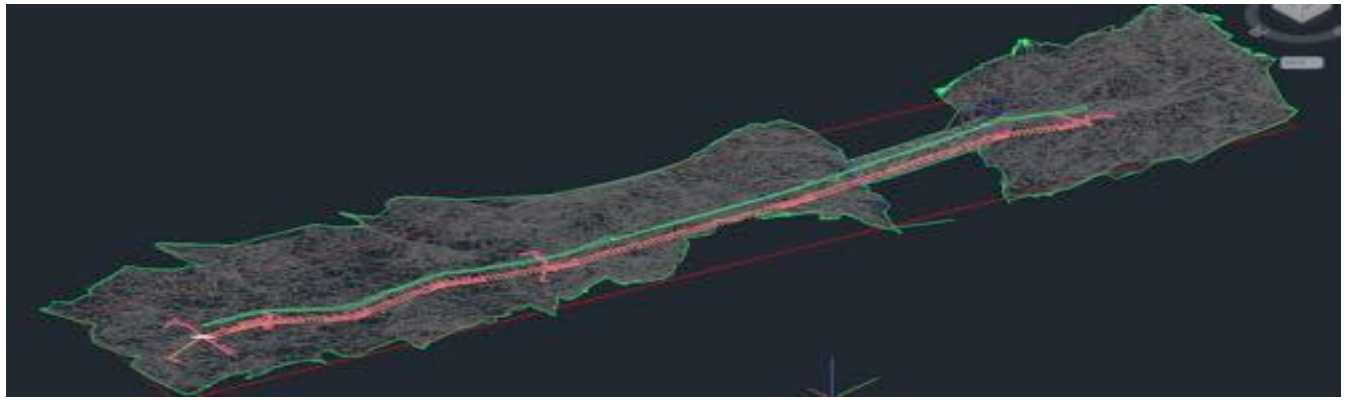




9. Case Study for a Real Road Project with IfcRoad

BIM Model : Terrain and Road (Corridor)

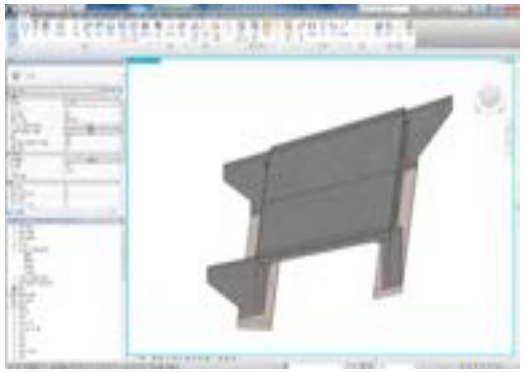
Original + Planned Terrain & Road Corridor (by Alignment)



BIM Model : Bridge

Bridge 1

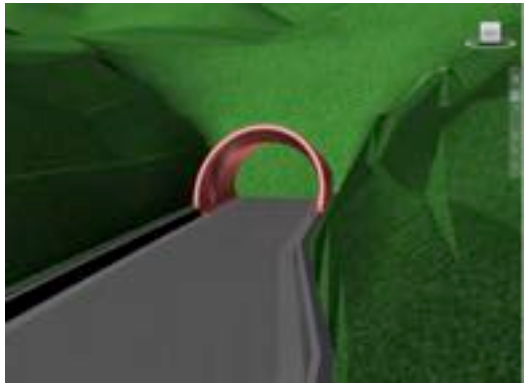
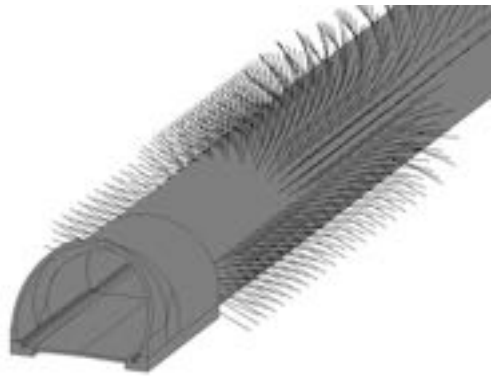
Bridge 2



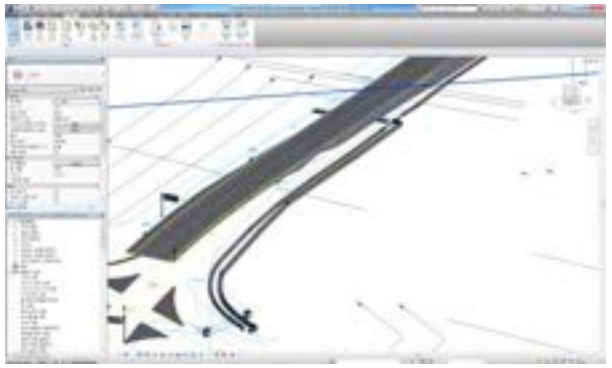
Bridge 3 (ED Bridge)

9. Case Study for a Real Road Project with IfcRoad

BIM Model : Tunnel

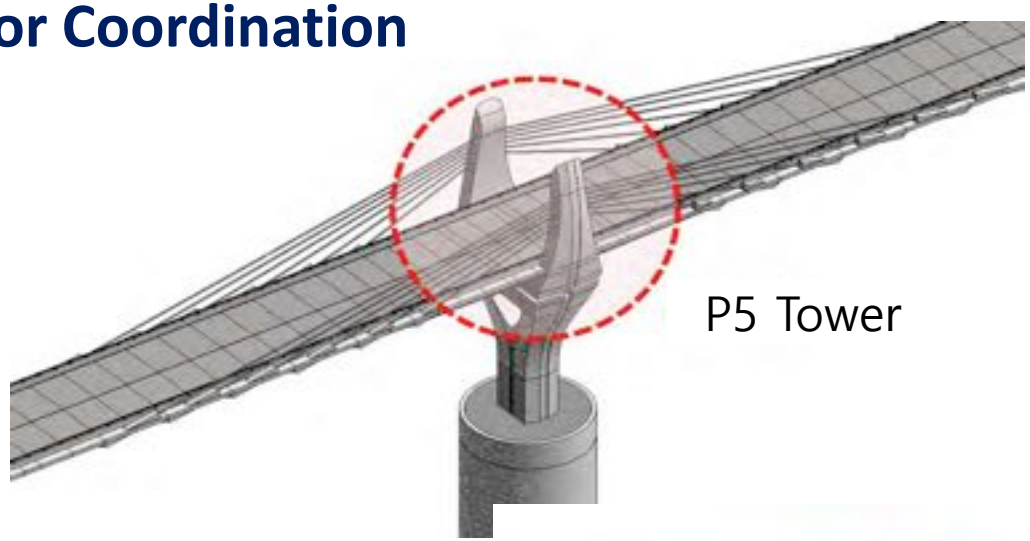
Tunnel Office	Tunnel 1
	 

BIM Model : Extra Structure

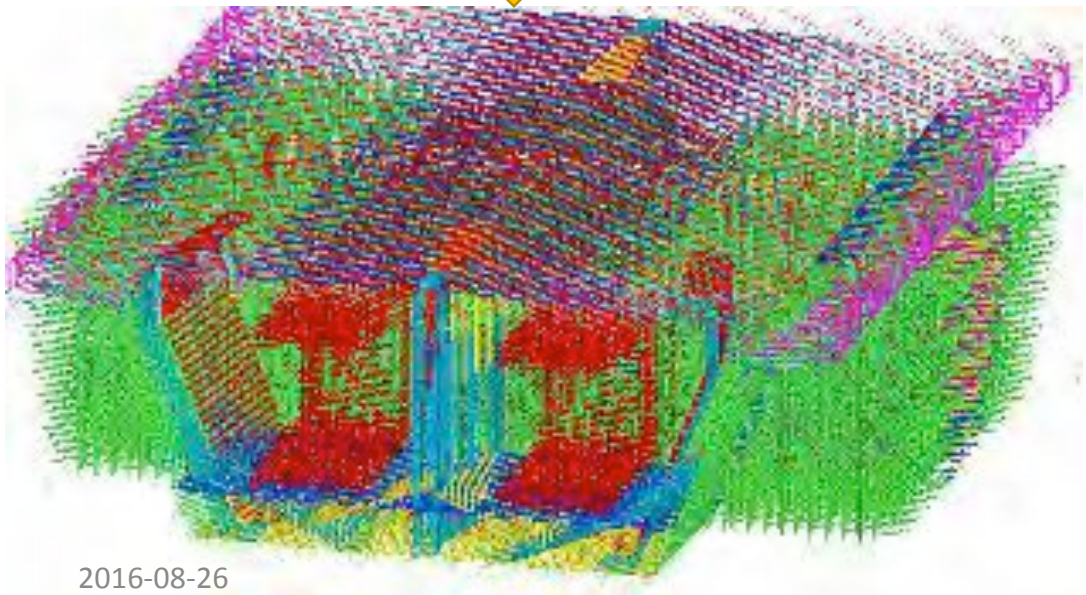
Drainage	Culvert	Eco-Overpass
		

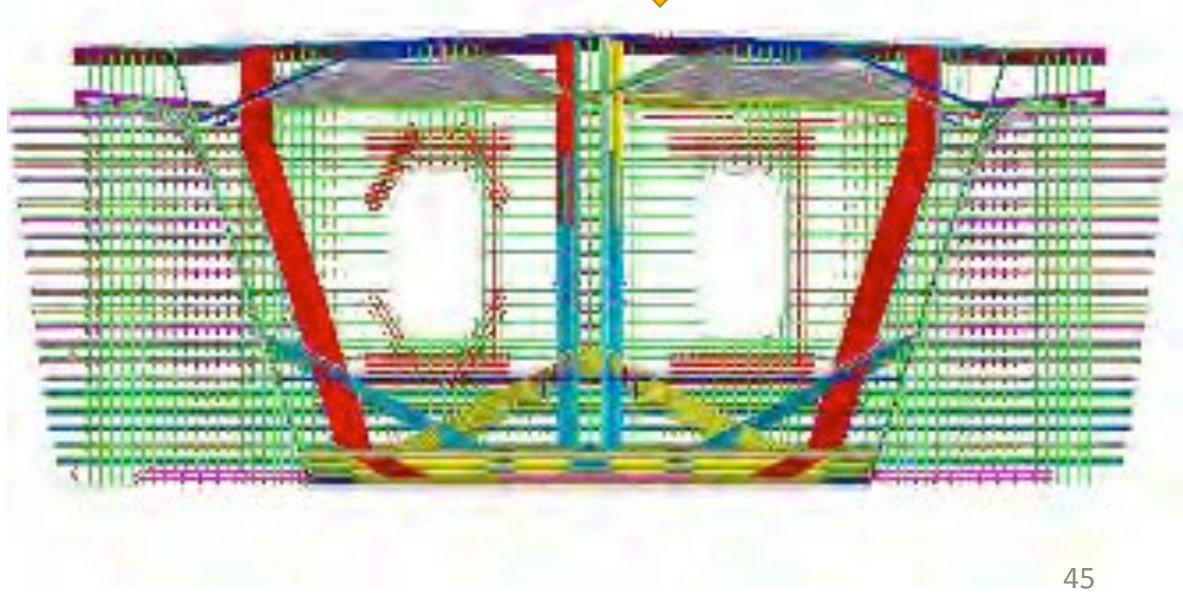
9. Case Study for a Real Road Project with IfcRoad

Shop Drawing (Rebar) for Coordination



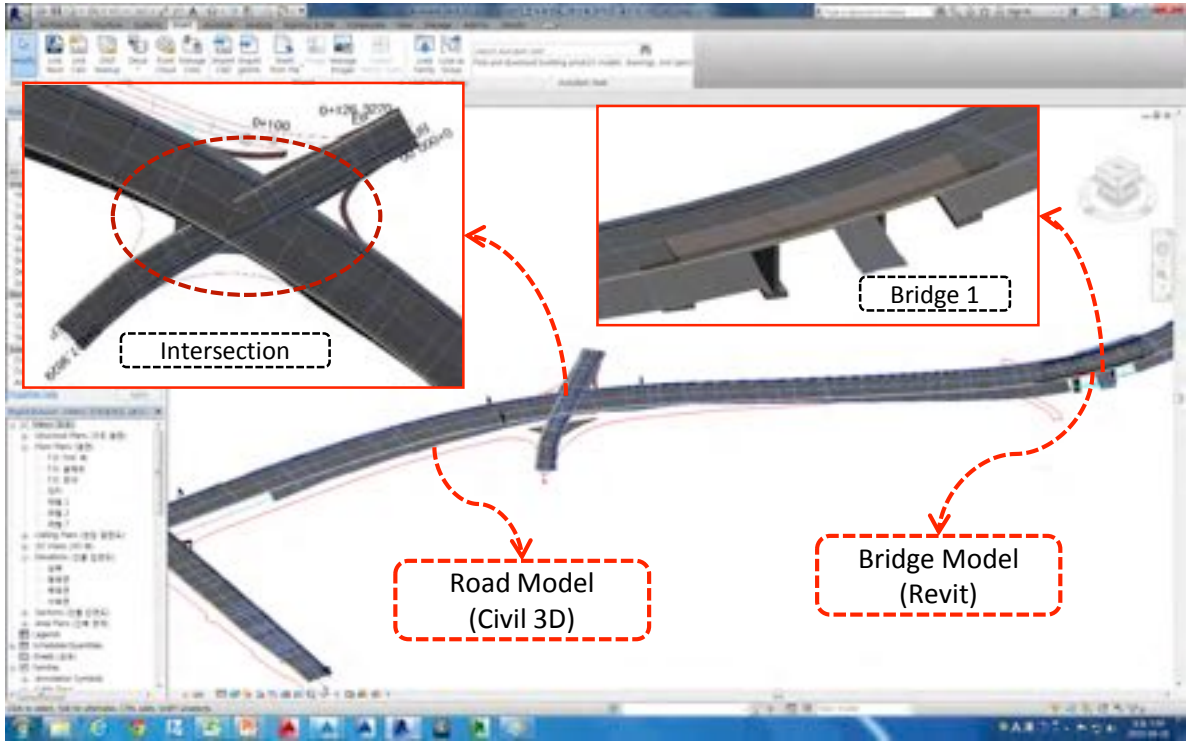
P5 Tower

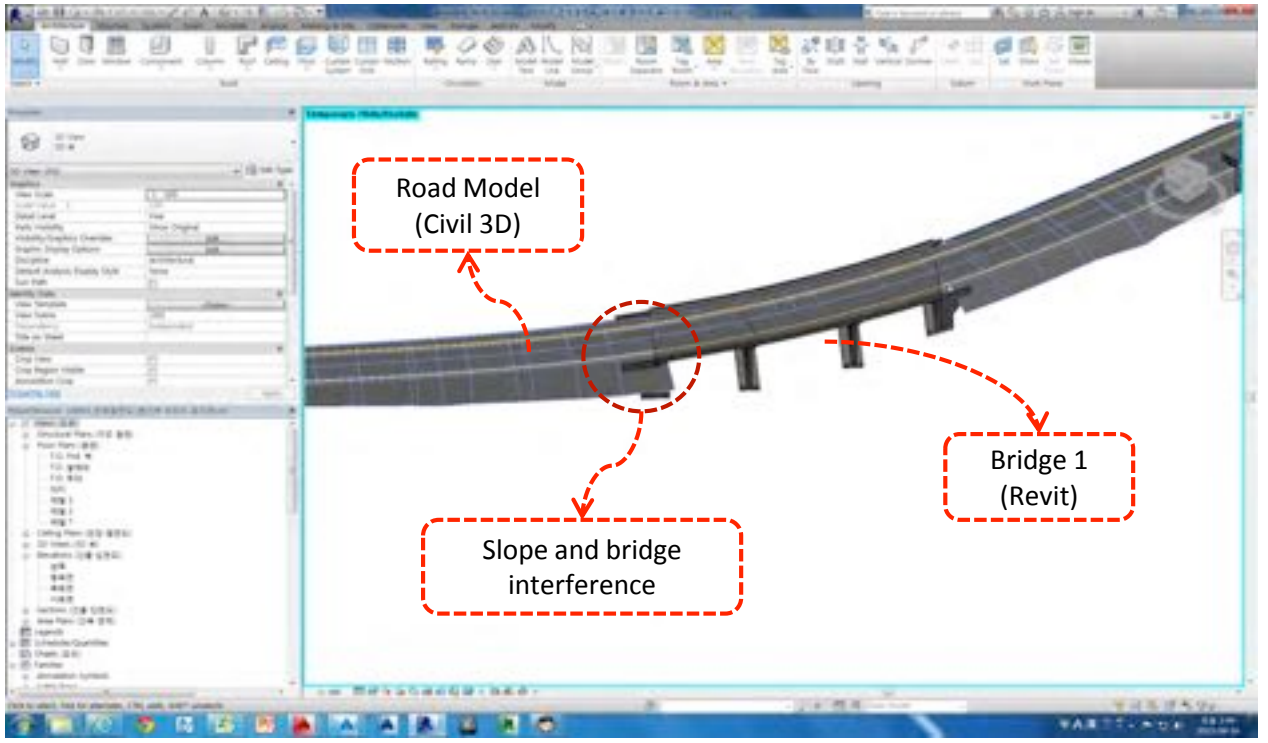




9. Case Study for a Real Road Project with IfcRoad

Design coordination

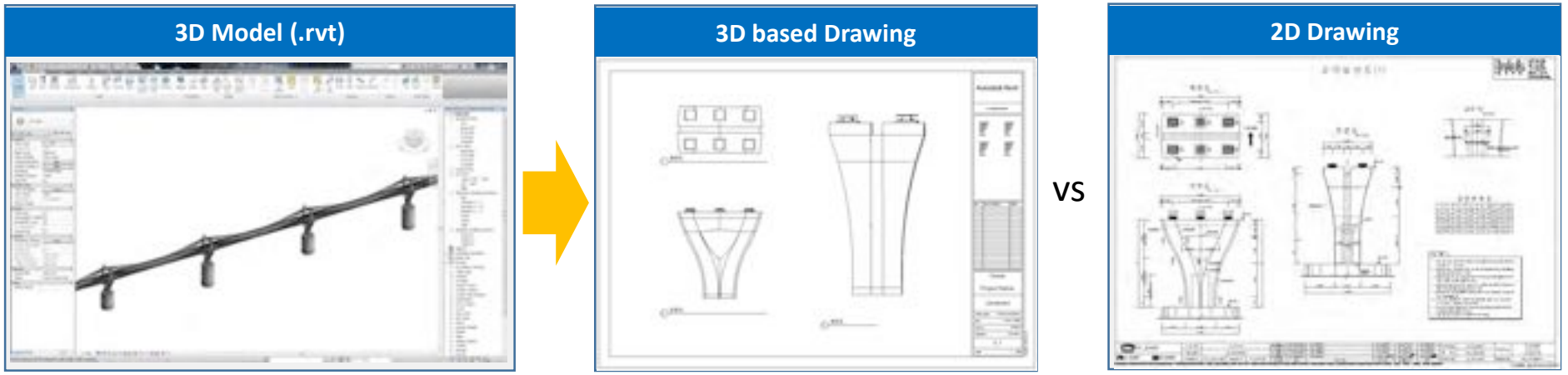




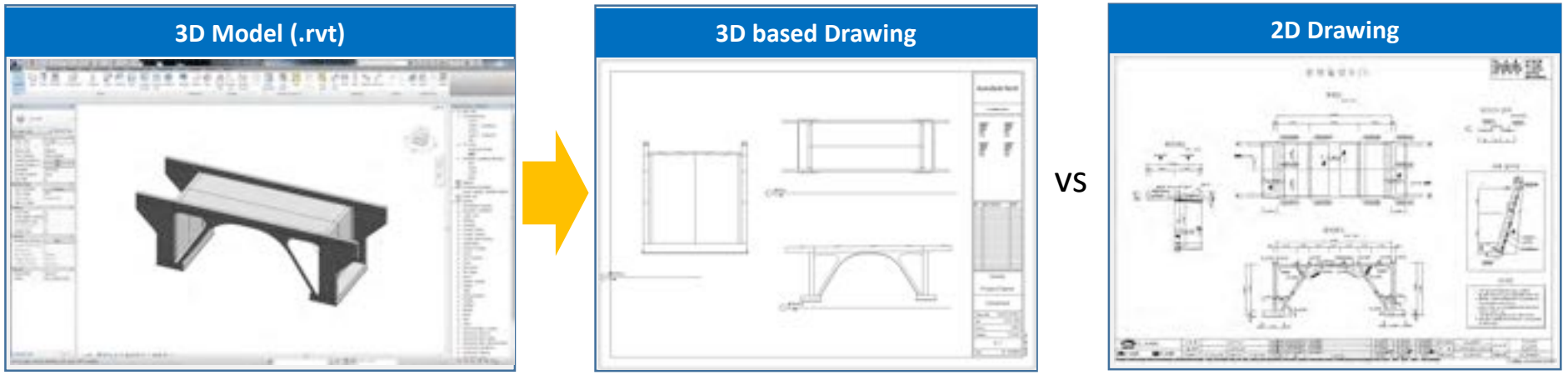
9. Case Study for a Real Road Project with IfcRoad

2D Drawing Extraction and Mutual Comparison

Bridge 1



Bridge 2



9. Case Study for a Real Road Project with IfcRoad

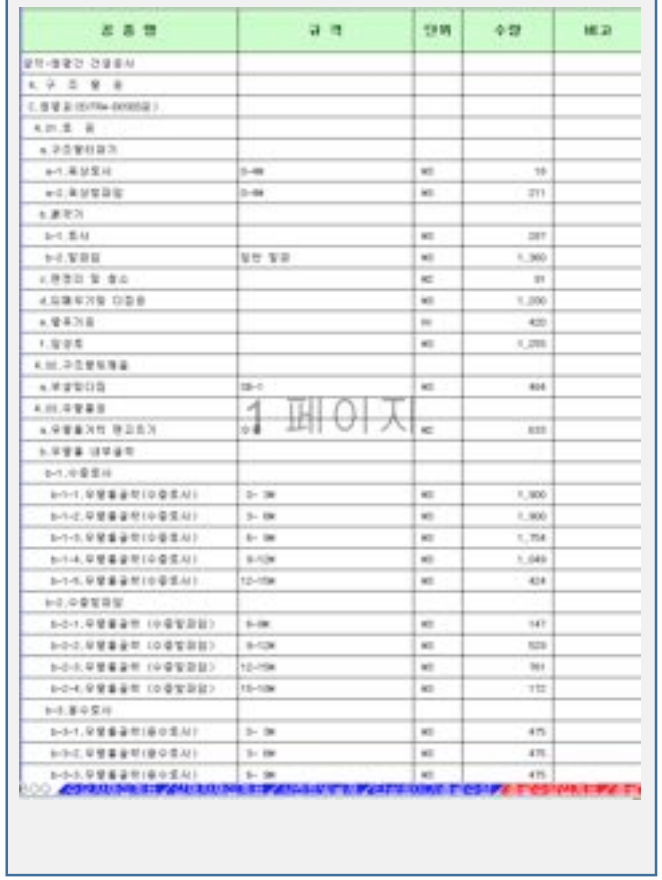
3D based Quantity Takeoff for Road

3D Model (.rvt)

3D Model based QTO statements

VS

2D drawing based QTO statements



Thank you for your attention!!