



TALLINNA
TEHNIKAKÕRGGKOOL
TTK UNIVERSITY OF APPLIED SCIENCES

RoadBIM Seminar
11.09.2013 Tallinn

Ongoing Swedish InfraBIM Activities
Väino Tarandi, KTH & buildingSMART Sweden



Euroopa Liit
Euroopa
Regionaalarengu Fond



Eesti tuleviku heaks

Agenda

- **The Swedish Transport Administration**
 - BIM implementation
 - V-con
- **BIM-examples**
 - Stockholm Bypass
 - Rölfors bridge
- **Conclusions**

**BIM-
implementation in
the Swedish
Transport
Administration**



TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION

The Swedish government has taken a decision.

BIM will contribute to a more effective Sweden.

The Swedish Transport Administration shall take the lead in this.

The **first step** of the implementation shall be completed in January 2015.



January 2015
First Step:

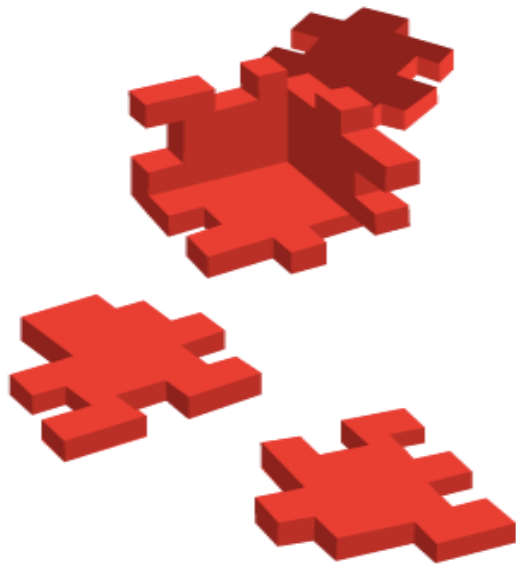
All investments in The
Swedish Transport
Administration shall use
BIM to some extent

Goals for the introduction of BIM in the Swedish Transport Administration

- All investment projects shall use BIM to some extent from 2015
- Streamline Transport Administration operations with about 150 million SEK by 2015
- Transport Administration will be a distinct purchaser of BIM during the design and construction of infrastructure projects

Tactics for the change process

- Management & Control
- Knowledge
- Inspire and convince to change
- Engagement in BIM Alliance Sweden



- Management System
- Standardization
- Business intelligence
- Support to projects
- Communication/Change management

Dialogue with the Board of Directors

Information management strategy

Bim Coordinator manual

Order requirements for infrastructure information models

Dialogues with management teams, project managers and specialists in building projects

Standardization Terminology

Education

Evaluate BIM Building Projects in The Swedish Transport Administration

Measuring benefits

Dialogues with management teams, project managers and specialists in building projects

Change working processes

Adjusting Regulations

Adjusting Management Systems

Identify BIM-levels

BIM-Guidelines

Dedicated BIM Coordinators to support projects

December 2013

March 2014

June 2014

October 2014

Jan 2015

V-Con

Virtual construction
for roads

Mikael Malmkvist
Projektledare utveckling



TRAFIKVERKET



European
Commission

ICT FOR ROADS

BIM – V-Con – PCP

Building Information Modelling Virtual Construction for Roads Pre-Commercial Procurement

"To standardise and implement Building Information Modelling (BIM) technology in the sector of road construction and road management to improve the efficiency and effectiveness of National Road Authorities by improving data exchange in the civil infrastructure sector."

At a Glance

Project acronym:

V-Con – A collaboration programme between Rijkswaterstaat, Trafikverket, CSTB, and TNO. Officially started in October 2012, it aims to break out of a circle of ICT-standstill by defining a first standard, procuring the necessary software and launch a PCP for BIM-server and software tooling.

Project type:

Integrated Project

Programme:

7th EU Framework Programme

Project coordinator:

Benno Koehorst
Rijkswaterstaat (Dutch Agency of the
Ministry of Infrastructure & the
Environment)
benno.koehorst@rws.nl

Project partners:

Trafikverket (National Swedish Road &
Rail Authority)
CSTB (French National Research Institute)
TNO (Dutch National Research Institute)

Start date: Oct 2012

End date: Oct 2016

Total cost: €3.5 million

EU funding: €2.1 million

Project website:

www.rws.nl/v-con

Current situation

In the current situation there is a lack of standardised information exchange and sharing over the civil infrastructure sector. Several developments can be observed, but no comprehensive, generally accepted standard is directly available. Therefore, intention is to develop (part of the) required international open information standard, and procuring the required, compliant software tools. This will stimulate others in the sector to follow.

Within V-Con, a PCP approach has been chosen, challenging the market place to innovate in competition. PCP comprises 3 phases: solution design, prototyping and pre-production testing.

Objectives

This leads to two primary objectives. The first is to establish a draft version of a standardised information and data exchange structure. The second is to procure and test software systems in a PCP that comply with this structure. The results will be embedded in the procurement of two large infra projects, one in the Netherlands and one in Sweden. The result will be a draft version of a standard that will be used in the software that will be procured in the PCP part of the project.

Innovation
Society & Merit

What is V-Con?

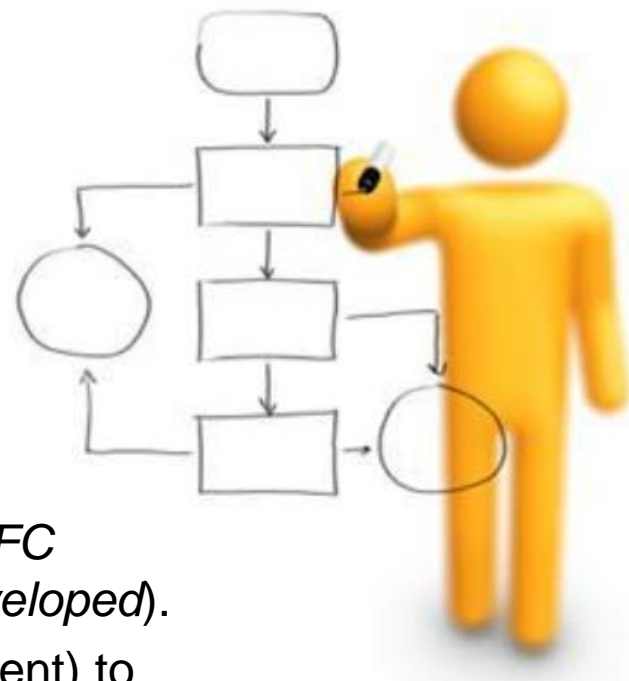
- V-Con, Virtual Construction for Roads

- EU funded project over 4 years
- Involved road administrations:
 - **TRV** (Trafikverket)
 - **RWS** (Rijkswaterstaat)
- Involved research institutes are:
 - **CSTB** (*Centre Scientifique et technique du bâtiment*)
 - **TNO** (*Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek*) a non for profit organization



Purpose with V-Con?

- The project aims to increase the efficiency in infrastructure projects, using BIM
- Goals:
 - Establish a standardized information and data exchange for the elements of the road body (*IFC bridge and some others are already being developed*).
 - Carry out a "PCP" (Pre-Commercial Procurement) to define an interface for a BIM server, which enables information and data exchange.
 - Develop a pre-standard for BIM, which is feasible to implement within TRV and RWS.
 - Hand over a pre-standard to buildingSMART International for continued development, maintenance and ISO-standardization.
 - Build the foundation for a continued development of IFC for infra.



V-Con and IFC

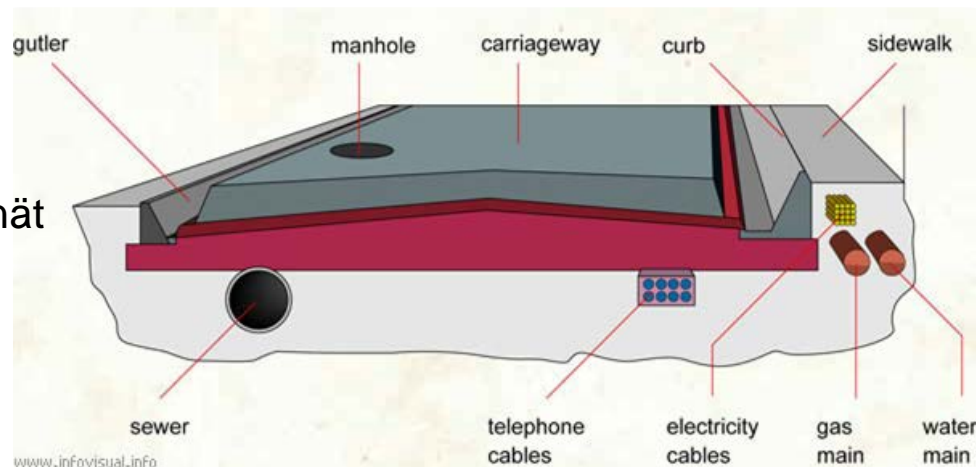
- V-Con builds the foundation for a continued development of IFC for infrastructure.
- V-Con is an important step in the development of BIM for infrastructure, and enables Sweden to participate and influence the standard in a direction which supports the Swedish infrastructure industry.
- What influence on IFC will the project have?
 - Extension of IFC?
 - Improvement of IFC?
 - A completely new standard?
 - Answer – probably an extension of IFC with GML and / or COINS



Basic definitions

Object types in TEiP:

- **Gutler**= DB41c. Ytterslänt
- **Manhole**= H. VA-nät (no sub-division yet)
- **Carriageway**= DB11. Vägbanan
- **Curb**= DB46. Stödmur
- **Sidewalk**= DB12. Gångbana, cykelbana
- **Sewer**= external system or under H. VA-nät (no sub-division yet)
- **Telephone cables**= C2. Befintliga konstruktioner/ Telefonledning
- **Electricity cables**= C2. Befintliga konstruktioner/ Elledning
- **Gas main**= C2. Befintliga konstruktioner/ Gasledning
- **Water main**= C2. Befintliga konstruktioner/ Vattenledning



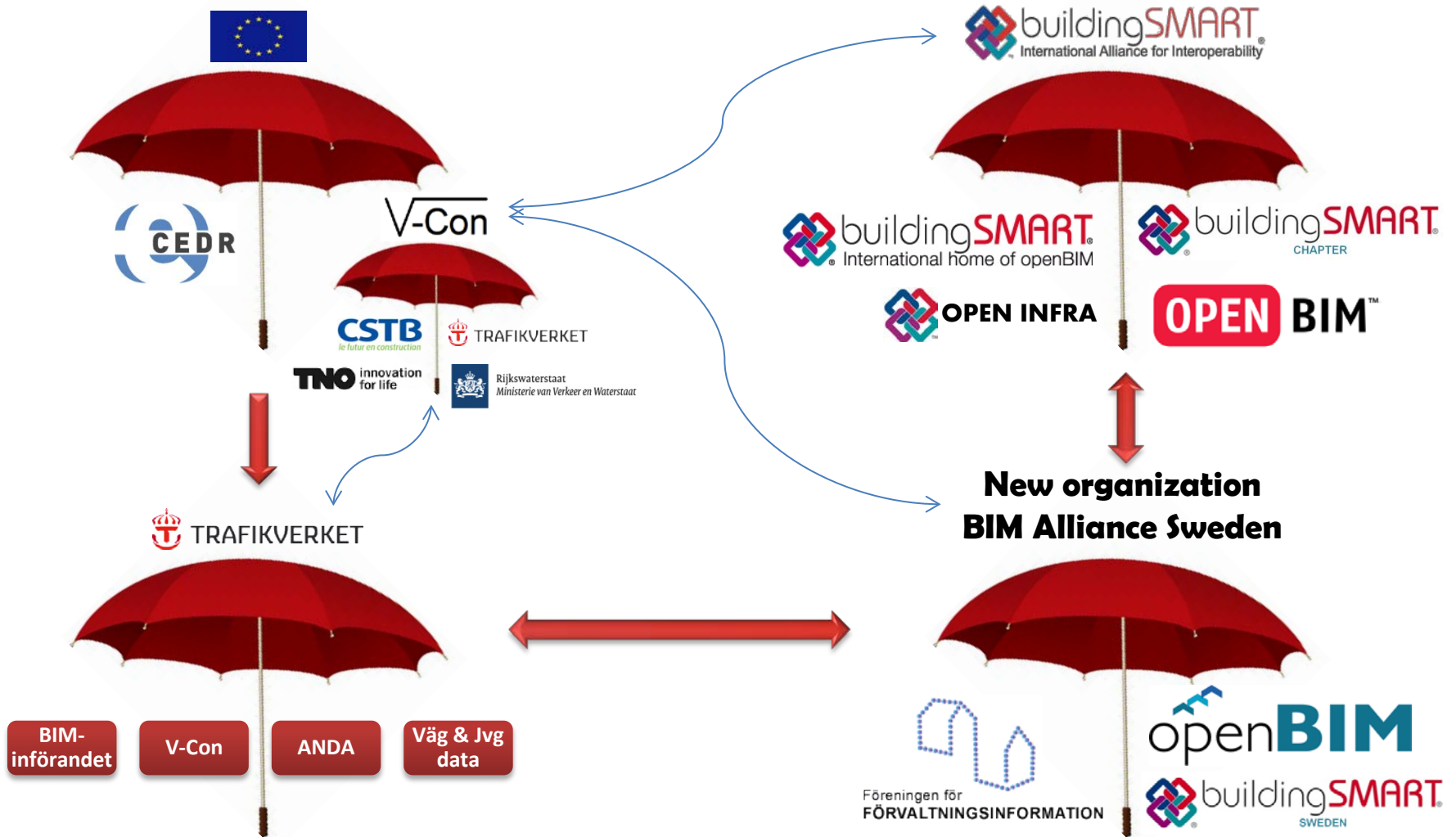
CEDR



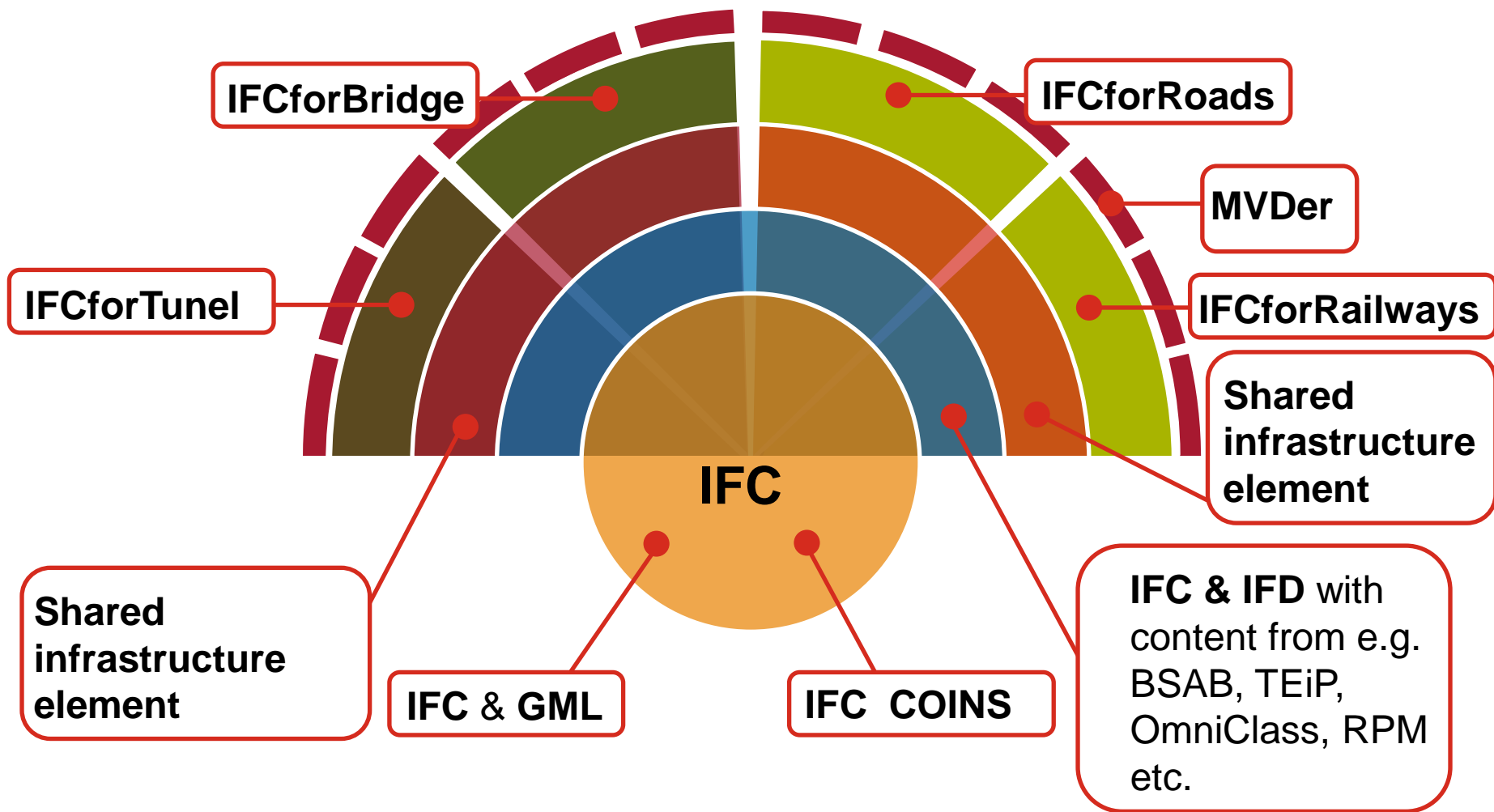
- CEDR (*Conference of European Directors of Roads*) is an organization for road administration directors in Europe
- CEDR is represented by 24 countries in EU
- BIM standardization is a project in CEDR
- V-Con is collaborating with CEDR's BIM project



Establishment of V-Con



IFC for Infra





buildingSMART based solution for V-Con

▪ **Conceptual dictionary model:**

- IFD ISO 12006-3 (Conceptual model)
- Classification ISO 12006-2

▪ **Conceptual candidates:**

- BSAB, TEiP ISO 12006-2
- Functional requirements ISO 12006-2
- RPM Based on Step
- COINS

▪ **Process model**

- IDM ISO 29482
- IDM Part 2 ISO_PRF 29481-2

▪ **Conceptual information model**

- IFC ISO 16739
- GML ISO 191xx- Standards / OGC

Integrating approach using OWL to combine ontologies

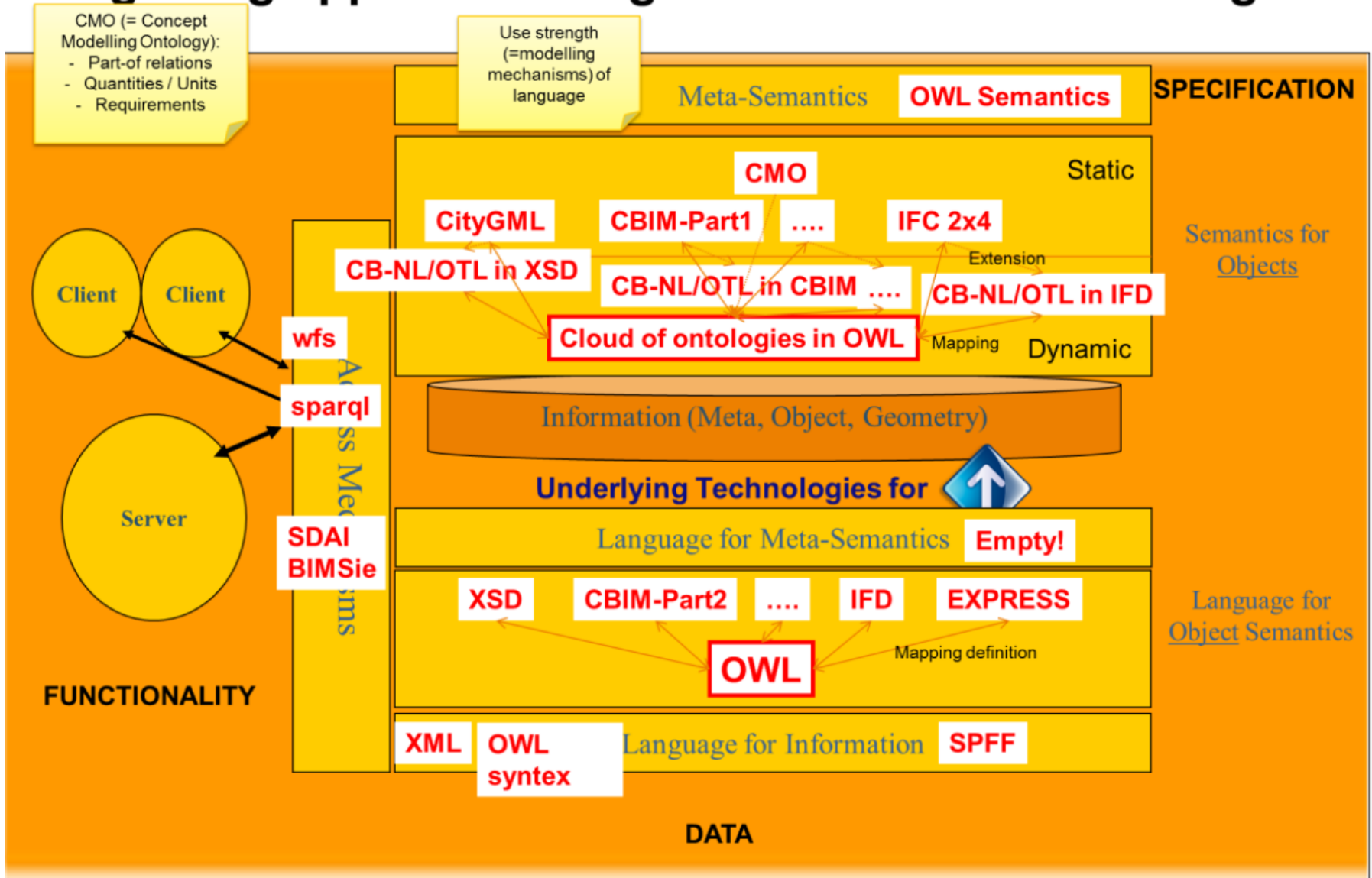


Figure 6-1 V-Con scenario within the V-Con framework

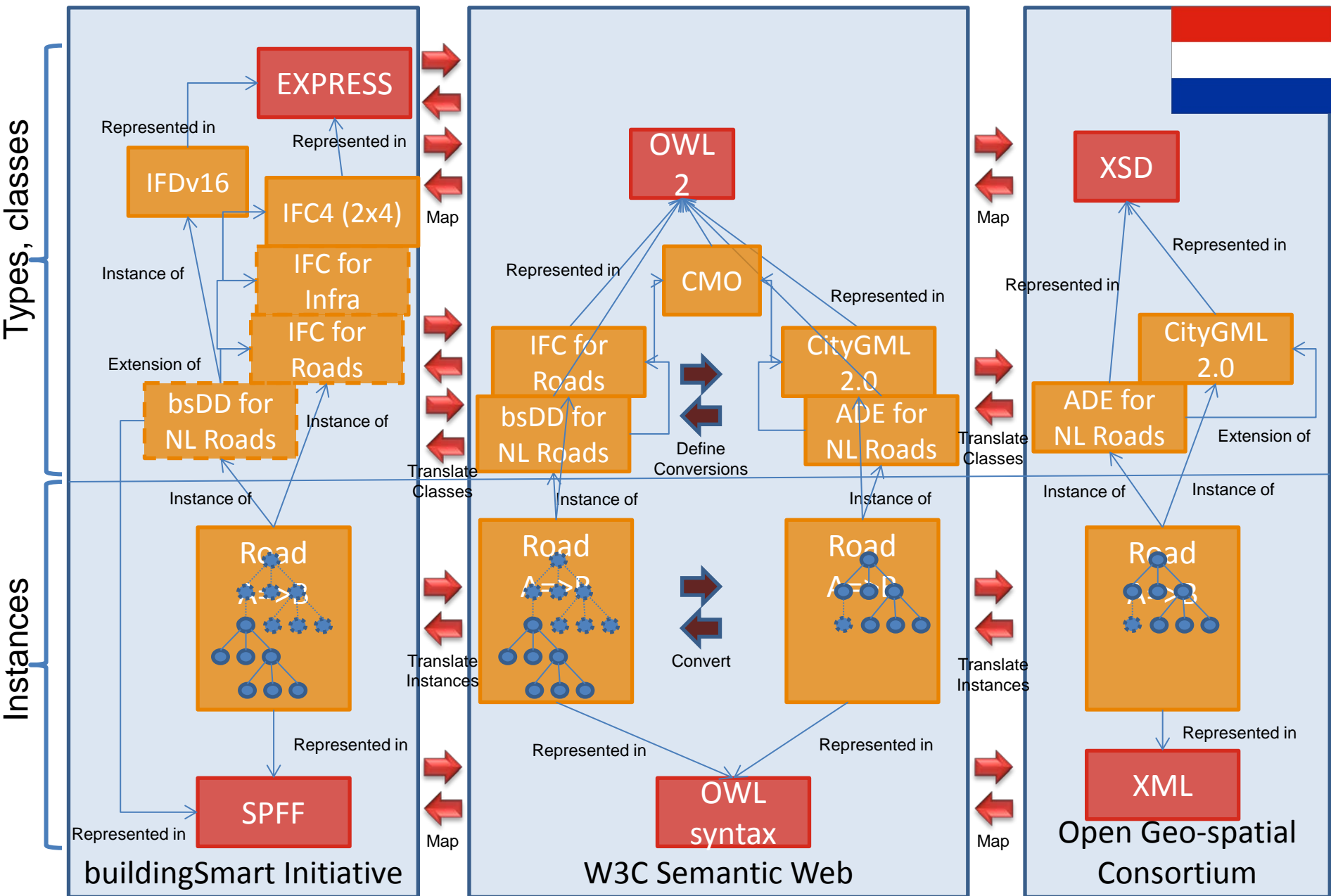


Figure 6-2 Linking BIM and GIS in V-Con scenario.

WT3: Workpackage descriptions

WP1

Management: To ensure sound, efficient, and transparent coordination and management of the project over the technical, administrative, legal and financial aspects, which are responsible for high-quality deliverables, productive collaboration between partners, and clear reporting throughout the project.

WP2

Support PCP process: To specify server software and interfaces with end-user software, design and launch of the call, evaluation of the tenders, and coordination of the PCP process (WP 4).

WP3

Standardisation: Inventory of existing info exchange standards, to define and agree upon a Road Information Structure, to extend IFC for roads, and to develop National Object Type Libraries for highways.

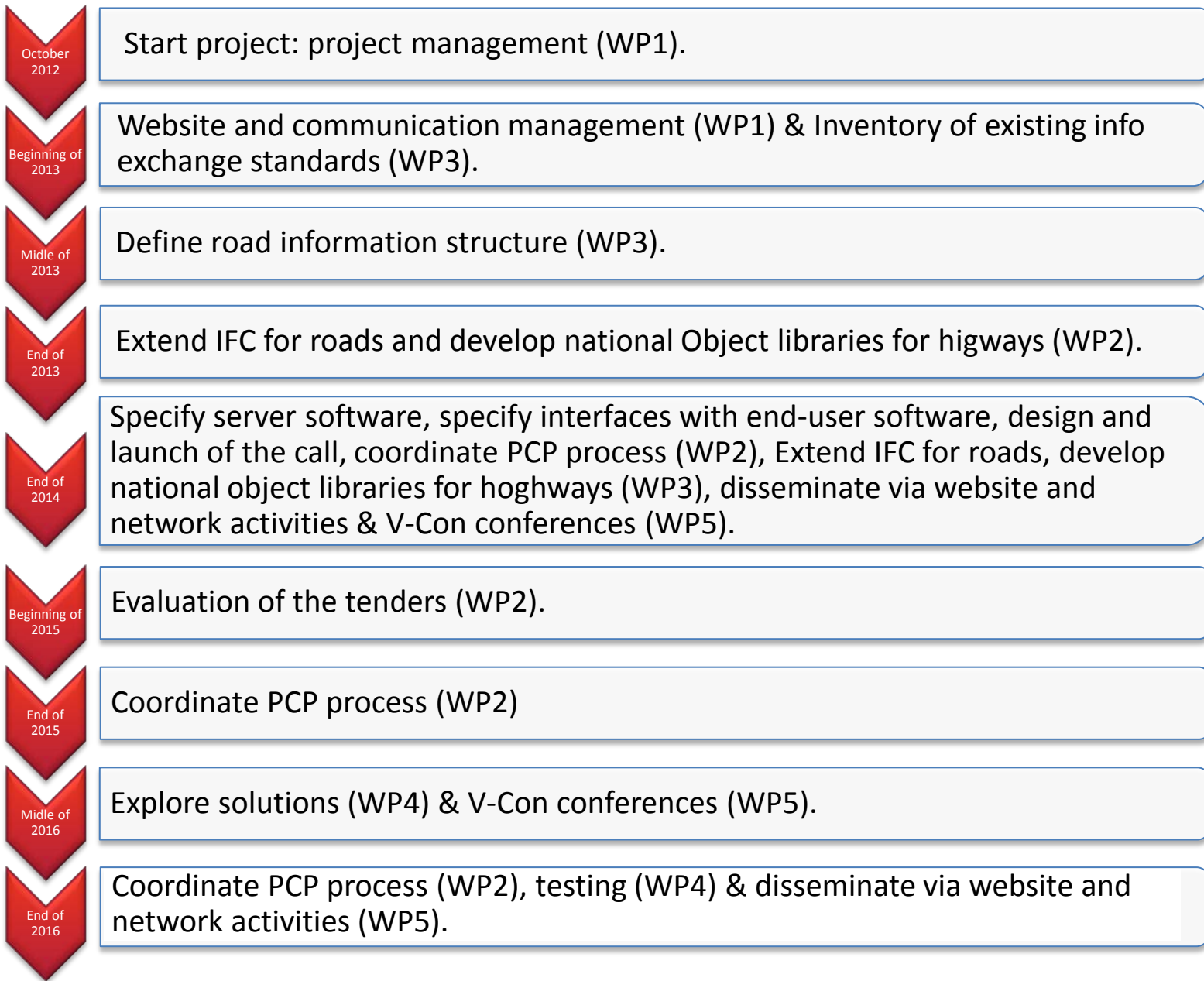
WP4

Prototype development and pilot Implementation: To explore solutions, prototyping, and testing in order to develop new ICT solutions procured through the joint PCP call for tender.

WP5

Dissemination: To disseminate the results of V-Con to the road infrastructure sector and appropriate networks of ICT companies (software vendors/developers) and BIM specialists via website, network activities, and V-Con conferences.

Time schedule for WP 1-5



WP=Work package

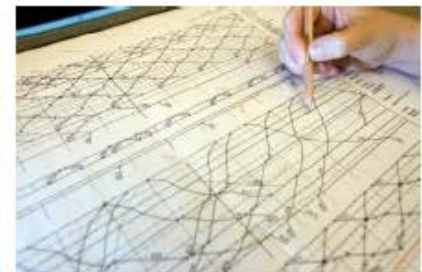
Implementation of BIM The Stockholm bypass

Johan Asplund
Rogier Jongeling

BIM-coordinator



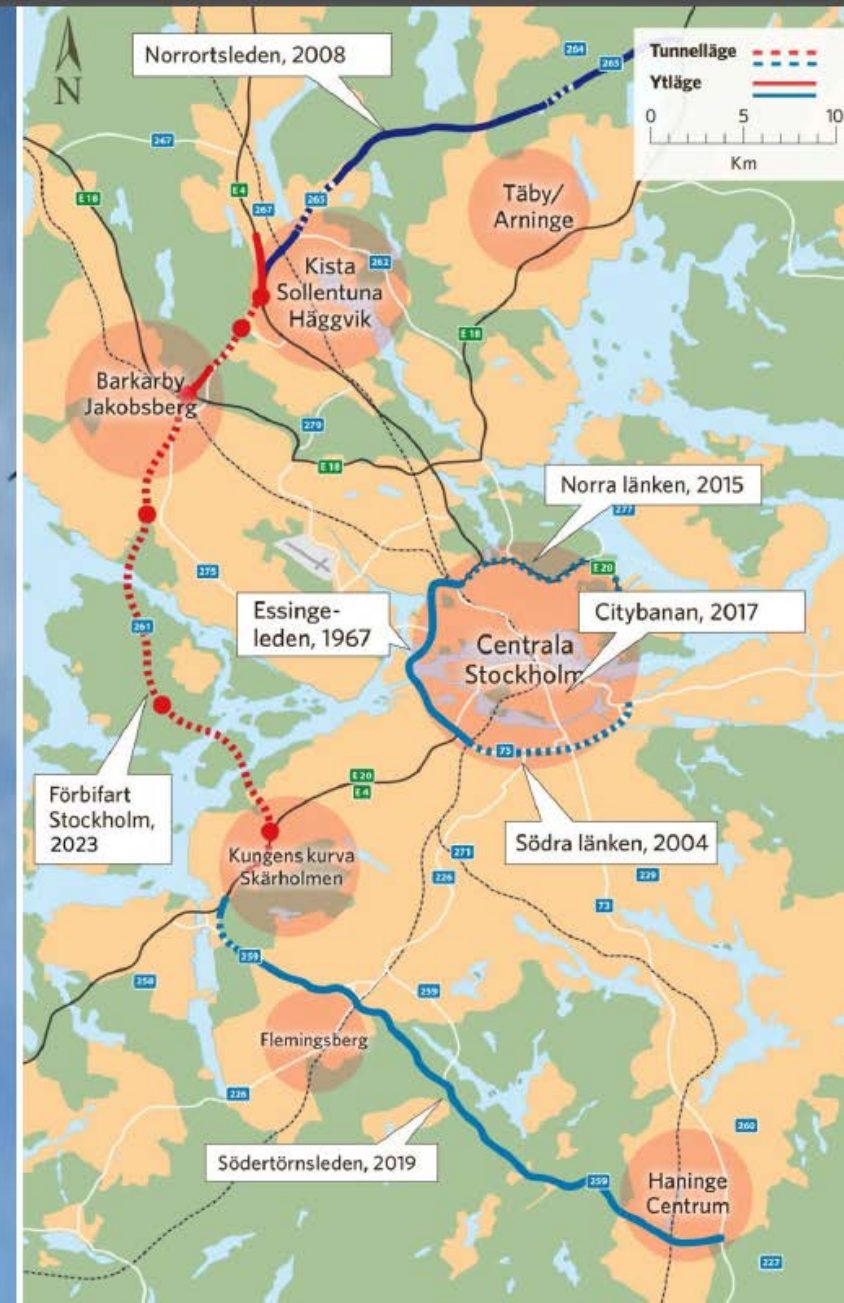
TRAFIKVERKET



Regional development plan

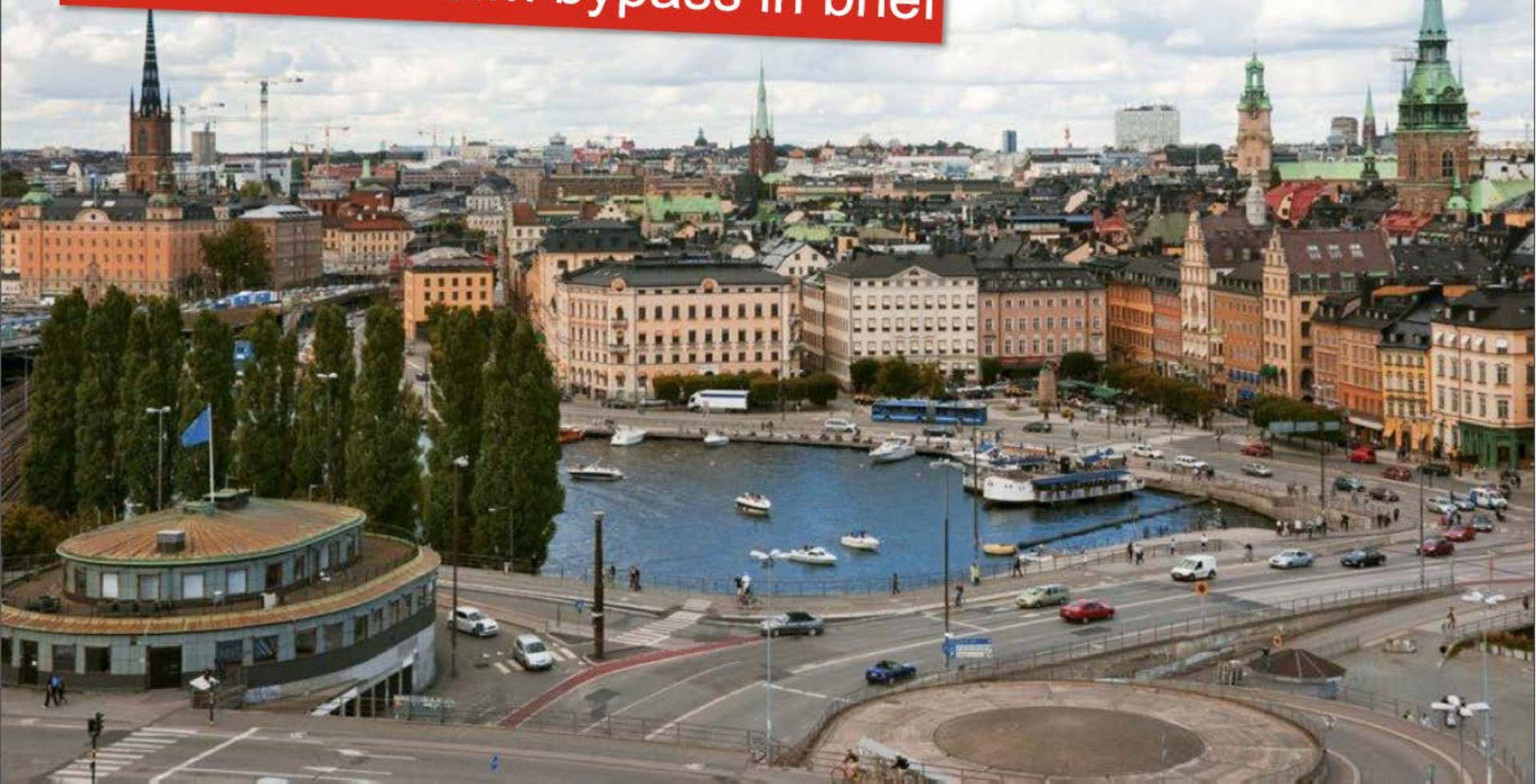
The Stockholm bypass:

- Will form an outer ring road together with Norrortsleden and Södertörnsleden
- Will link north and south and many of the regional urban cores
- Will create a single market for jobs, homes and services



» E4 Förbifart Stockholm

The Stockholm bypass in brief



A city on water



The Stockholm bypass

Length:	just over 21 km
Tunnel:	just over 18 km
Travel time:	approximately 15 minutes
No. of lanes:	three in each direction
Junctions:	six
Traffic 2035:	140,000 vehicles/day
Build start:	late 2013
Completion:	about 10 years
Cost:	SEK 27.6 billion EUR 3.1 billion (2009 prices)

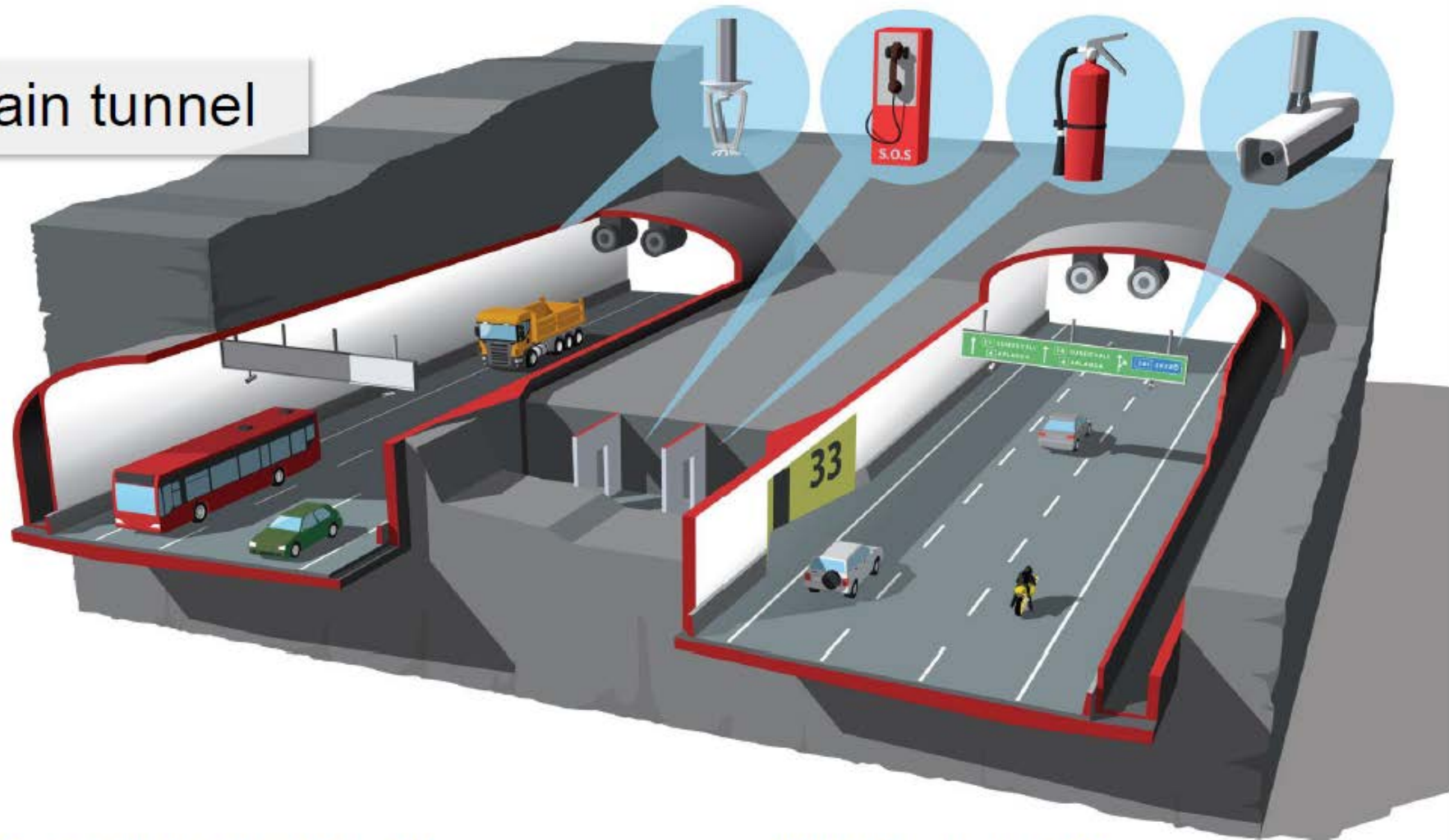


Just over 18 out of 21 km in tunnels



Stockholm bypass cross-section with slopes up to junctions at Lovö and Vinsta. Note that the drawing is not to scale

Main tunnel



- 2 parallel main tunnels
- 3 lanes in each direction
- Emergency exits every 100 m

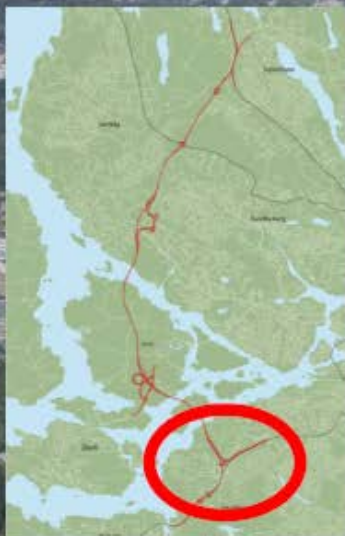
- 17+1 km in length
- Normal section approx. 135 m²
- Ramp tunnels approx. 20 km

Rock tunnels in brief

- Length main tunnels: 2x18 km
- Length ramp tunnels: approx. 14 km
- 3 temporary harbours
- Total rock: 19 million tonnes
- Boring method: Drill & blast
- 6 main contracts



Kungens kurva today



Interchange Kungens kurva



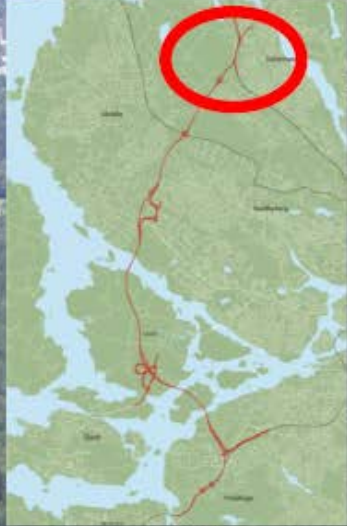


Hjulsta today



Interchange Hjulsta

Akalla today



Interchange Akalla





Häggvik today



Interchange Häggvik

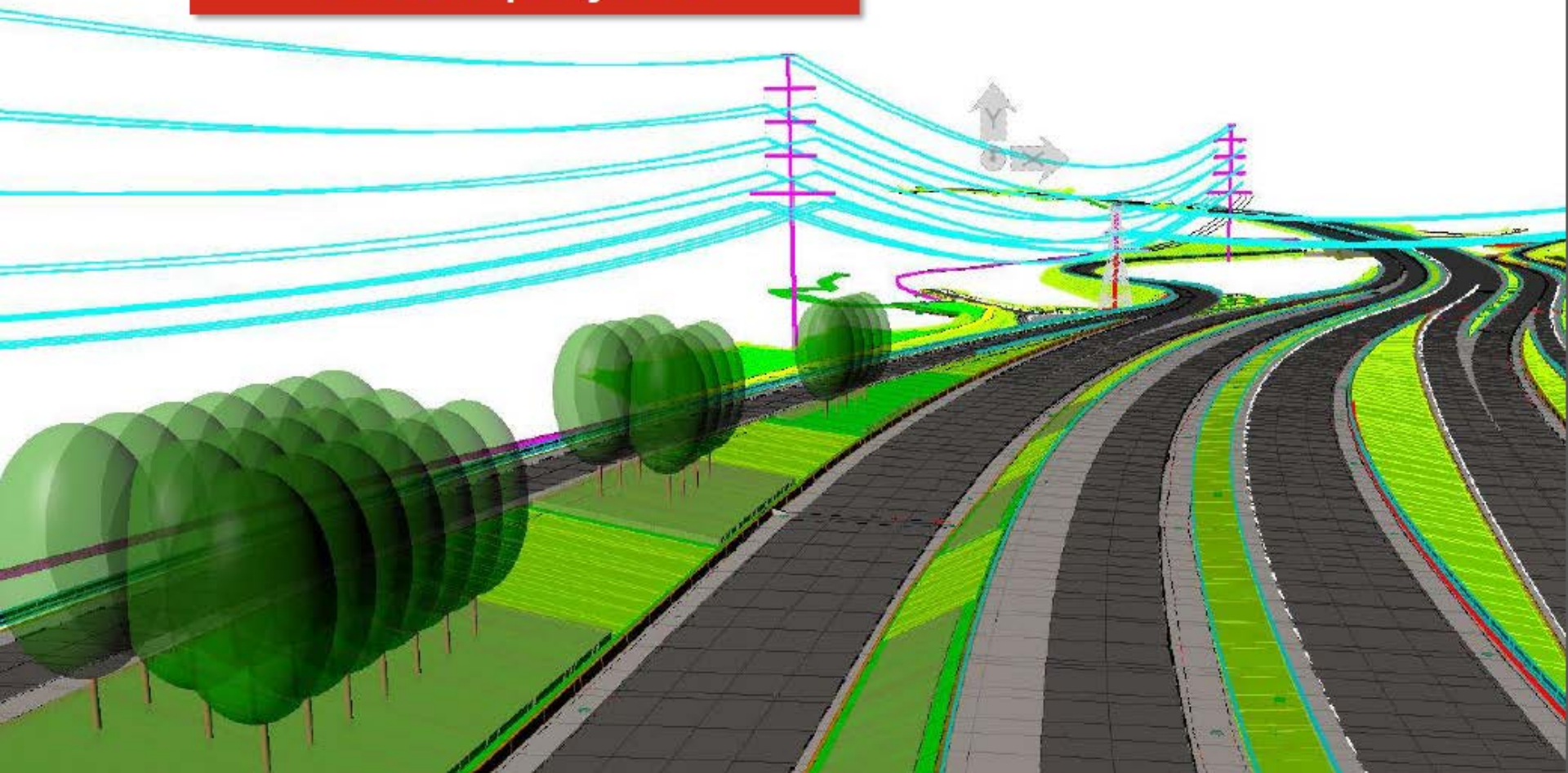


Contract forms

Somewhat simplified, the contract forms can be summarised as follows.

- Rock tunnels and work tunnels are procured as build only contracts, based on BQ.
- Bridges and concrete tunnels for junctions are procured as design-build contracts.
- Roads and reconstructions of existing installations are procured as build only contracts based on BQ.
- Installations in tunnels are procured as design-build contract, based on system and functional requirements.

What makes Stockholm bypass a BIM project?



E4FS 2012:0076

BIM-strategy says...

Review and client approval shall be carried out with 3D coordination models as the essential basis but can be supplemented with drawings and other materials if necessary.

Uppgat av (Efternamn, Förnamn, org) Ulrik Eriksson	DokumentID (DokumentID)	Version 1.0
Förskjatt av (Kenneth Nordstrand) tf Projektchef	Dokumentdatum 2012-02-16	
BIM strategi för E4 Förbifart Stockholm		

Inledning

Detta dokument redovisar strategin för införandet och tillämpning av BIM inom projektet E4 Förbifart Stockholm (FS).

Definition av BIM

BIM som begrepp definieras enligt BH90 Del 7 utgåva 2 som en databas innehållande information om projektet, till exempel i form av tredimensionell geometri och egenskaper som material, kvalitet, kostnad och produktionsmetod. BIM definieras i samma avsnitt även som processen där själva modellen skapas och förvaltas. BIM inom FS avser byggnadsinformationmodellering och arbetsansatt enligt följande strategi.

Principerna för krav och anvisningar

Utgångspunkt för strategin är att så långt som möjligt använda etablerad teknik, metodik, processer och organisation samt etablerade principer för klassifikation enligt DSAB 96 och databasordning inom Trafikverket. En av grundförutsättningarna är att själva projekteringen sker i 3D CAD-verktyg med hjälp av mark- och anläggningsmodeller definierade enligt BH9017-2.231 och -2.232. Principen för tillämpning av BIM baseras i stort möjliga mån på branschgemensamma rekommendationer och redovisas i IT-manualens BIM-kapitel.

Effektmål för användning av BIM

Då begreppet "BIM" är nytt för många kommer det att uppstå frågor gällande tillämpning av BIM principerna i projekteringen. Här är det viktigt att projektets BIM-samordnare konsekvent används som stödperson vid frågor som uppstår – såväl av beställarrepresentanter som leverantörer. Det behövs från projektdrivningens sida en förståelse för att arbetsättet snarare kommer att kräva mer tid och resurser än i en konventionell projektering. Projekteringsledare behöver också förstå att en del frågor vad gäller BIM är nya även för CAD-projektörer och kan därvid hänvisa till projektets BIM-samordnare vid oklarheter.

Målformulering

Bättre projektering

- Projektörer, projekteringsledare och specialister ska ha bättre och aktuare bild av helheten jämfört med 2D-projektering => effektivare möten och säkrare samgranskning (färre fel)
- Projektdeltagare och andra berörda ska uppleva 3D-modeller som effektivare kommunikationsverktyg jämfört med ritningar => fokus på "rätt saker"

Säkrare projektkalkyler

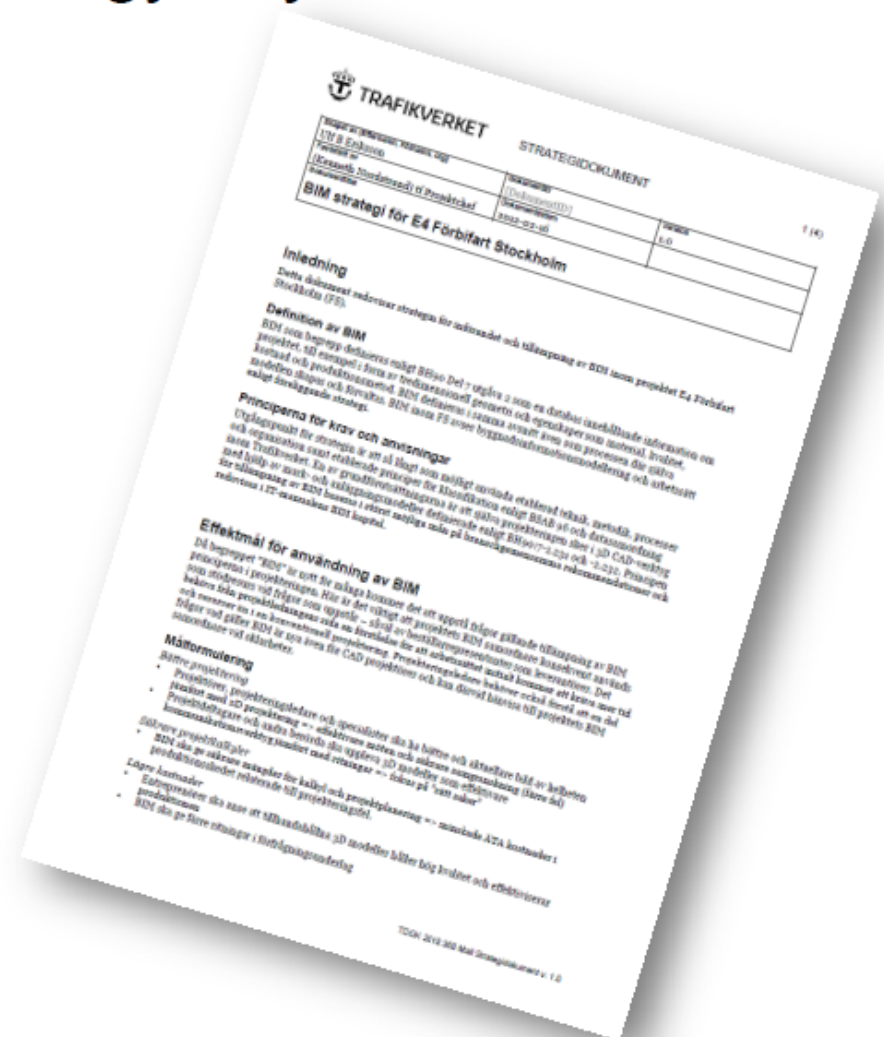
- BIM ska ge säkrare mängder för kalkyl och projektplanering => minskade ÅTA-kostnader i produktionskedjet relaterade till projekteringsfel.

Lägre kostnader

- Entreprenörer ska anse att tillhandahållna 3D-modeller håller hög kvalitet och effektiviserar produktionen
- BIM ska ge färre ritningar i förfrågningsunderlag

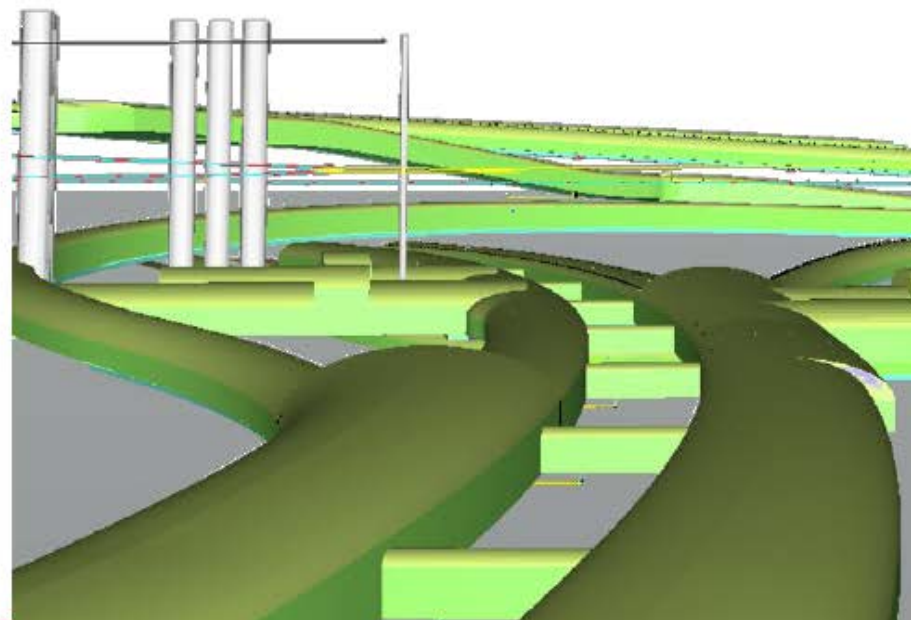
E4FS 2012:0076 BIM-strategy says...

With the support of "OpenBIM:s contract appendix" shall contracts be procured with the model as a part of the contract documents in tenders and be ranked on the same level as the technical description under AB and ABT.



"A single source of truth"

Projectwise



Stockholm Bypass – Document / Tender Package Approval Matrix

Organisation	ProjectWise State	Minor Versions /Major Revisions	Superseded Copy Created on Rejection	Document Status	Responsibility	Action	Review Location / Mark Up Tech'	Document Permissions	Document Type	
Work in Progress (WIP)	01 Work in Progress - Design	._n → ._n+1 → A.1	YES	S0 – Not Suitable for Coordination	Discipline Engineer	Discipline Engineer conducts "Own Checking". Approve/Reject?	Discipline office. Hardcopy or Electronic Mark-Up using ProjectWise & Bentley Navigator	Own Discipline: Read/Write Others: No Access Client: Read	Native Document Types DGN/DWG/DOCX etc.	
	02 Work in Progress - Shared	._n	YES	S1 – Suitable for Internal Review & Comment	Responsible JV Rep'	Responsible JV Rep' conducts review of Swedish standards compliance. Approve/Reject?		Own Discipline: Read Others: No Access Client: Read	Native Document Types DGN/DWG/DOCX etc.	
	03 Functional Manager Approval	._n	YES	S1 – Suitable for Internal Review & Comment	Functional Manager	Functional Manager conducts review of engineering content & approves proposed option. Approve/Reject?		Own Discipline: Read Others: No Access Client: Read	Native Document Type DGN/DWG/DOCX etc.	
	Shared	04 Shared	._n	YES	S2 – Suitable for Coordination	Tender Manager	IDC check. IRT final eng' review. Tender Manager to Approve/Reject Package?	Discipline office. Hardcopy or Electronic Mark-Up using ProjectWise & Bentley Navigator	Own Discipline: Read Others: Read Client: Read	CAD Model: DWG CAD Drawing: PDF Coordination Model: IDGN Document: PDF
		05 For Trafikverket Approval	._n	YES	S2 – Suitable for Coordination	Trafikverket PM Team	Trafikverket PM Team conducts review & verifies requirements. Approve/Reject?	Trafikverket office. Hardcopy or Electronic Mark-Up using ProjectWise & Bentley Navigator	Own Discipline: Read Others: Read Client: Read	CAD Model: DWG CAD Drawing: PDF Document: PDF
	Client Approval	06 Approved by Trafikverket		NO	D2 – Suitable for Tender	Document Manager	Document Manager monitors documents approved by Trafikverket & moves forward to "Published"	JV Office	Own Discipline: Read Others: Read Client: Read	CAD Model: DWG CAD Drawing: PDF Document: PDF
		07 Published		YES	D2 – Suitable for Tender	Document Manager	Document Manager prepares "Published" documents for upload to CHAOS	JV Office	Own Discipline: Read Others: Read Client: Read	CAD Model: DWG CAD Drawing: PDF Document: PDF
CHAOS	Upload to CHAOS		YES			Document Manager uploads document(s) / tender package to CHAOS and records upload details in document register	AF Office	Own Discipline: Read Others: Read Client: Read	CAD Model: DWG CAD Drawing: PDF Document: PDF	

Notes

- A major revision is only created when a document is approved by Trafikverket.
- The first major revision of any document does not show a notation. Subsequent major revisions follow the sequence A,B,C etc.
- A minor version is created when a document is rejected at any stage prior to Trafikverket approval.
- The first minor version of any document is shown as ".1". Subsequent minor versions follow the sequence .2,.3,.4 etc.
- ProjectWise will automatically control the application of minor versions and major revisions and capture the name of the individual approving or rejecting a document.
- IDR – Inter Disciplinary Coordination / IRT – Independent Review Team.
- A document register will be maintained at all times by the FSK document manager and the Discipline Design team.
- If the JV Rep' conducting the Swedish design standards review is also a Functional Manager then this process will happen simultaneously
- The term "Own Checking" refers to a process where the originator of a design checks compliance with project and own internal quality assurance requirements.

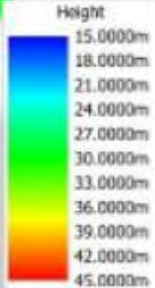
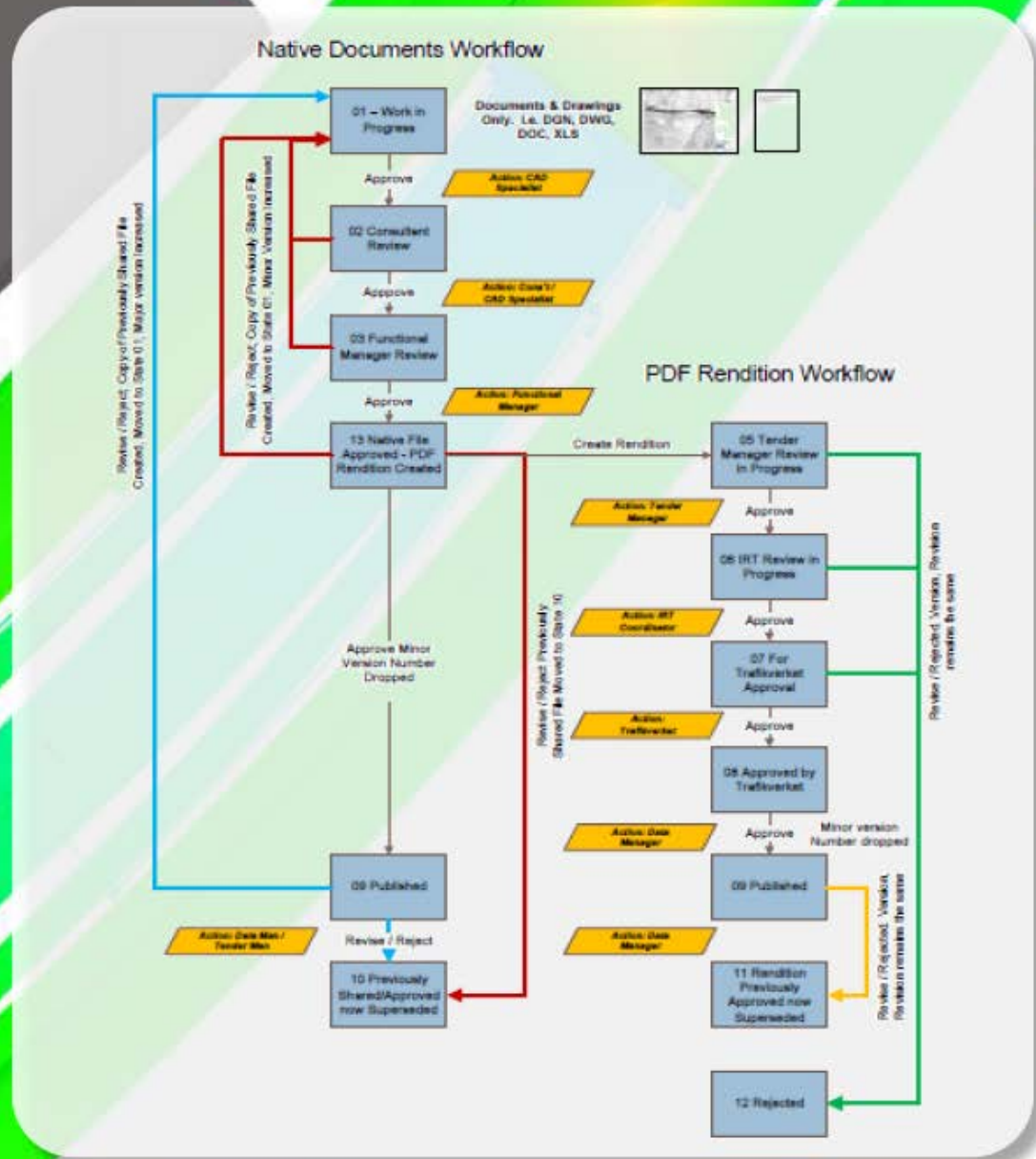
Aurora Mike Clarke
Functional BIM Manager

Stockholm Bypass



1/25/2012

Review process



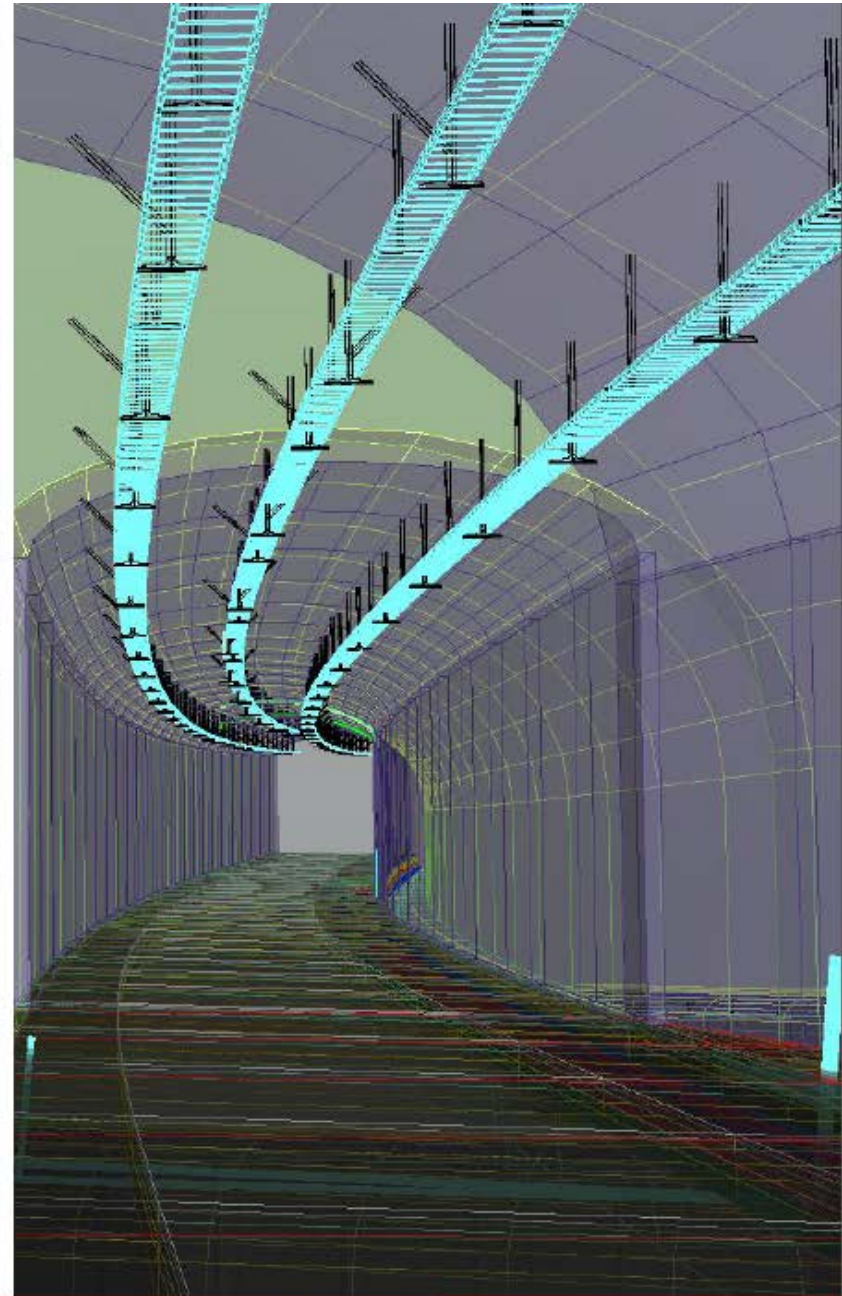
A 3D CAD model of a tunnel interior, showing a curved roadway with a grey textured floor and a yellow curb. The tunnel walls are purple and green. A red text box is overlaid on the top left, containing the text "A common coding standard for CAD layers".

A common coding standard
for CAD layers

Ability to choose software

We require our design teams to use (and develop) BSAB's building elements standardized codes for CAD layers

Allowing them to freely choose the best CAD tools within each technical discipline



A common standard – the foundation for BIM

Object attributes

agent responsible	=	Used in Stockholm Bypass synonymous with technical discipline
element	=	Designates the more or less composite physical objects in building structure that layer name attributed to: a wall, a sink, a road structure, etc.
presentation	=	Specifies how an object is presented in the model (plan, profile, 3D, etc.)
status	=	Indicates whether the item is "new", "existing", "removal", etc.
object status	=	Represents an item's status according to the review and approval process
origin	=	Method for preparation
position	=	Specifies the exact position of the design information within an object
structural ID	=	Is a geographical division of the project without overlapping
phase	=	Used to divide the project in relation to time

Element code

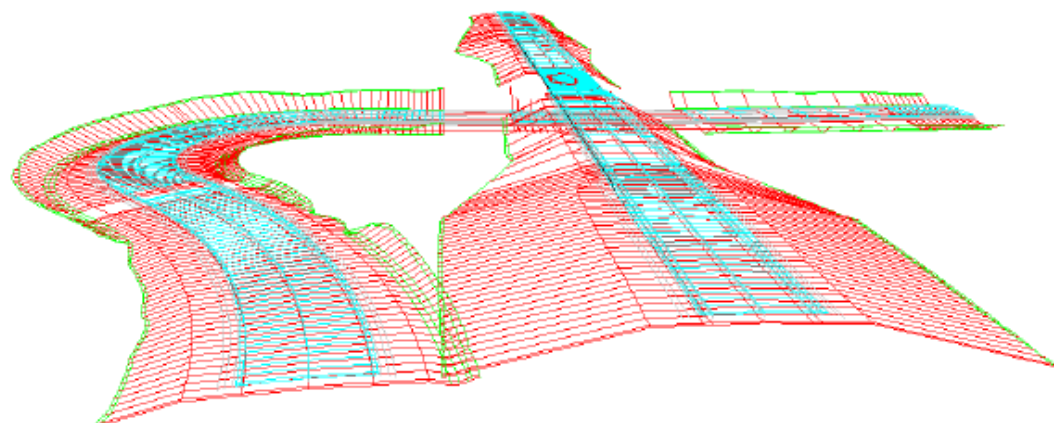
BSAB functional parts 96

3 - ÖVERBYGGNADER OCH ANLÄGGNINGSKOMPLETTERINGAR

30 - SAMMANSATTA HUSBYGGDELAR

31 - ÖVERBYGGNADER

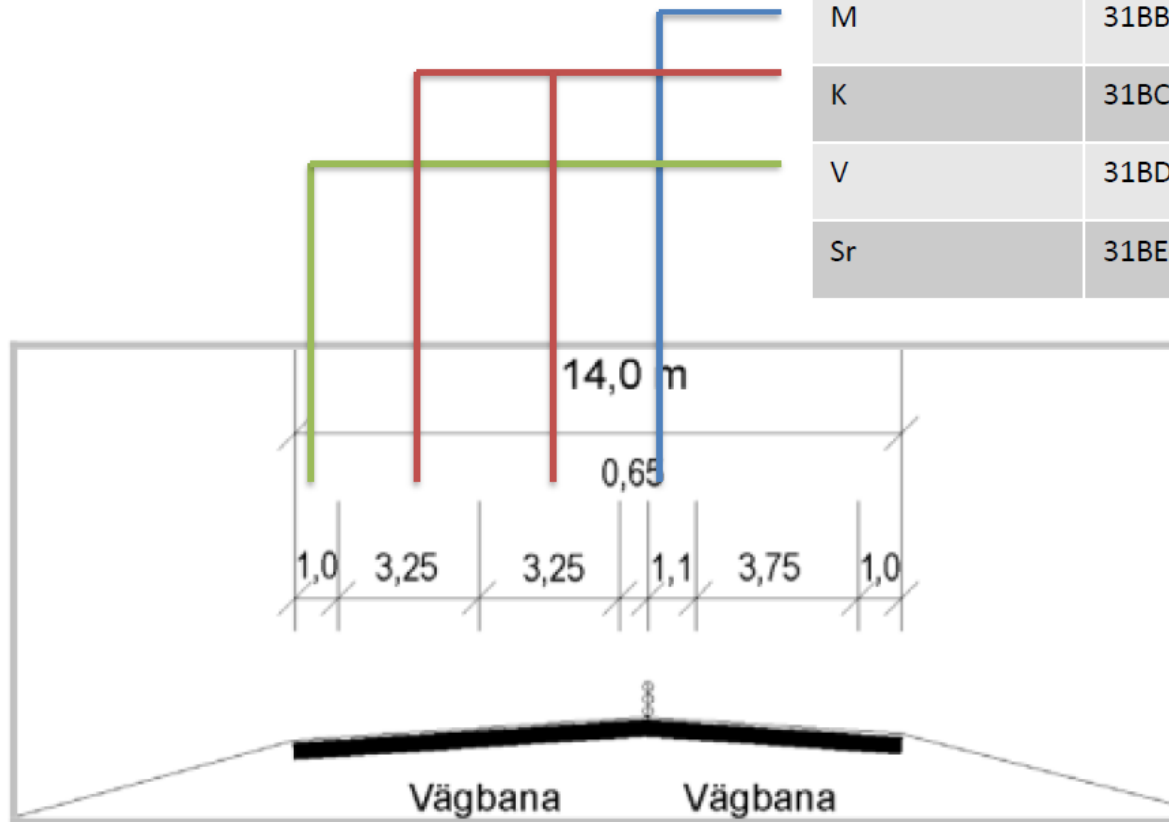
- 31.B - Överbyggnader för väg och plan
 - 31.BB - Mittvägrenar
 - 31.BC - Körbanor
 - 31.BD - Vägrenar
 - 31.BE - Stödremсор
- 31.C - Överbyggnader för spåranläggning
- 31.D - Överbyggnader för flygplatsbanor
- 31.E - Överbyggnader för slänter
 - 31.EB - Innerslänt
 - 31.EC - Ytterslänt
- 31.F - Överbyggnader för vegetationsytor
 - 31.FB - Naturmark
 - 31.FC - Gräsytor
 - 31.FD - Planteringsytor
- 31.H - Överbyggnader för vägbro
- 31.J - Överbyggnader för järnvägsbro
- 31.K - Överbyggnader för kaj o d
- 31.Y - Diverse överbyggnader i mark
 - 31.YB - Sandytor
 - 31.YC - Ytor belagda med konstmaterial
- 31.Z - Övriga överbyggnader



Element

BSAB Byggdelar 96

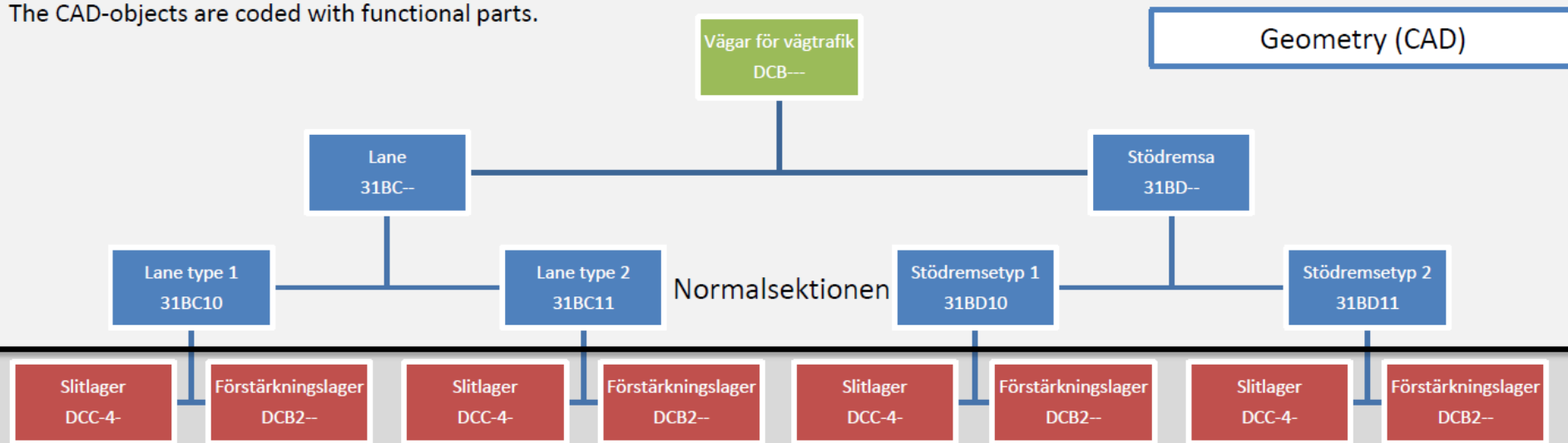
VGU Naming	Function part	Description
M	31BB--	Middle
K	31BC--	Lane
V	31BD--	verge
Sr	31BE--	Stödremsa



FIGUR 5-6 Typsektion för mötesfri landsväg vid nybyggnad och breddning

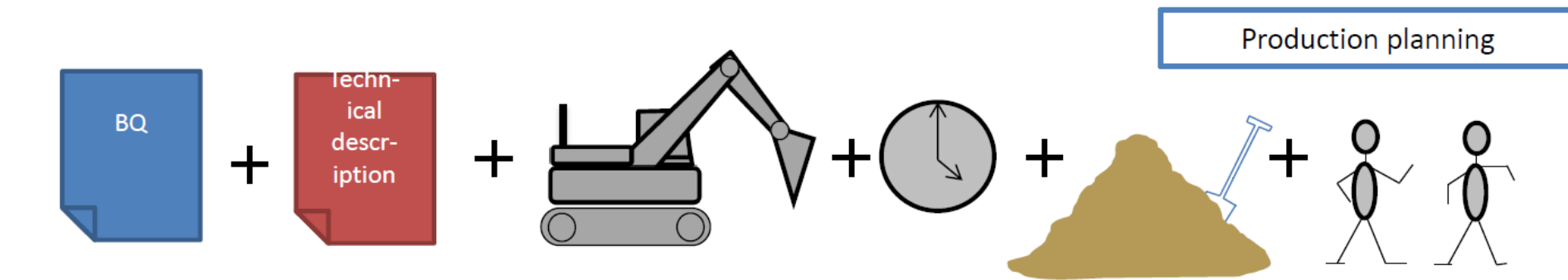
V1,0+K3,25+K3,25+M1,75(0,65Rä1,10)+K3,75+V1,0

The CAD-objects are coded with functional parts.

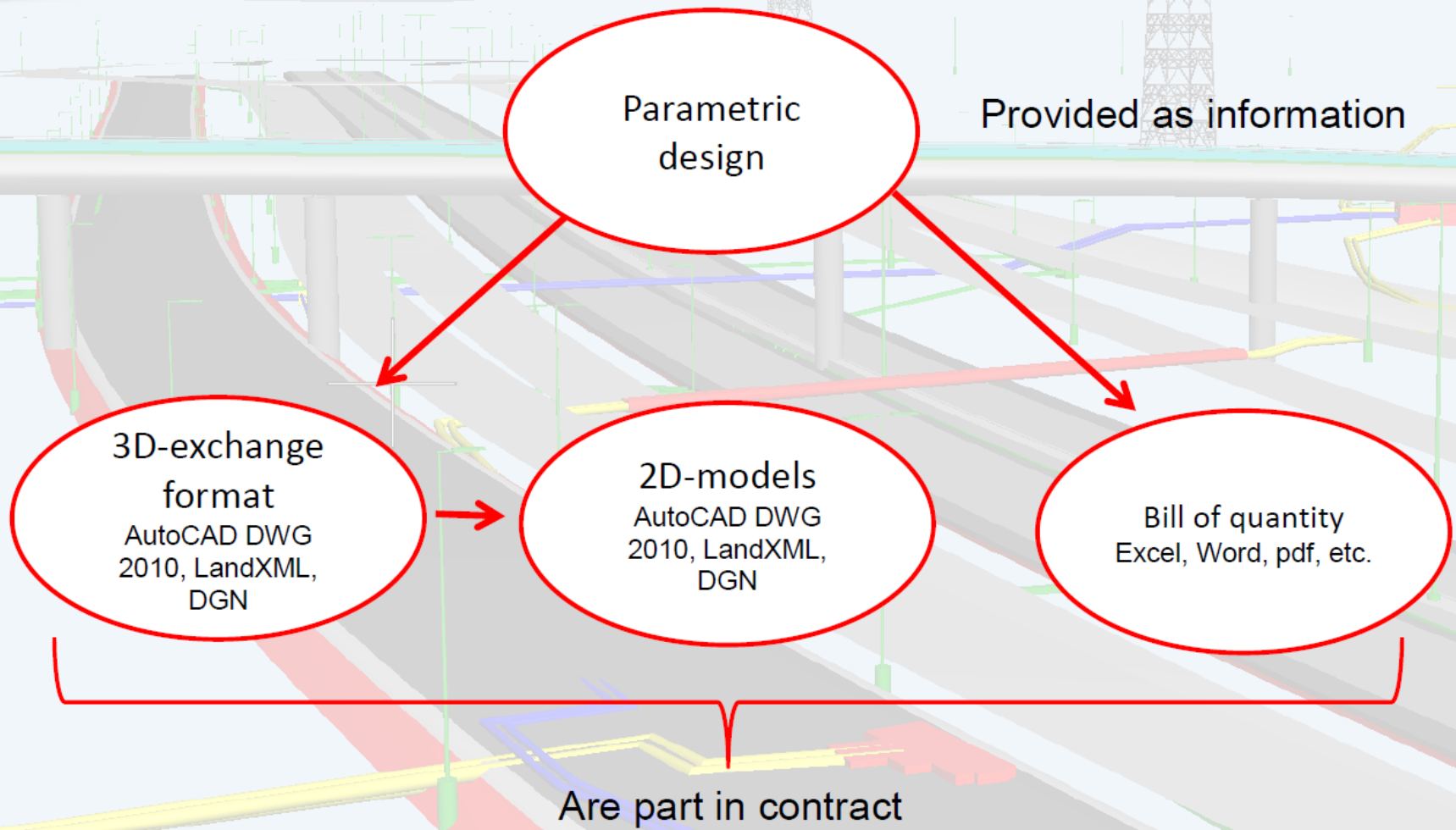


Byggdelstyperna kopplas ihop med Produktionsresultat via den tekniska beskrivningen. Om möjligt kan produktionsresultatet kodas in som metadata i CAD-elementen.

Technical description(Text)



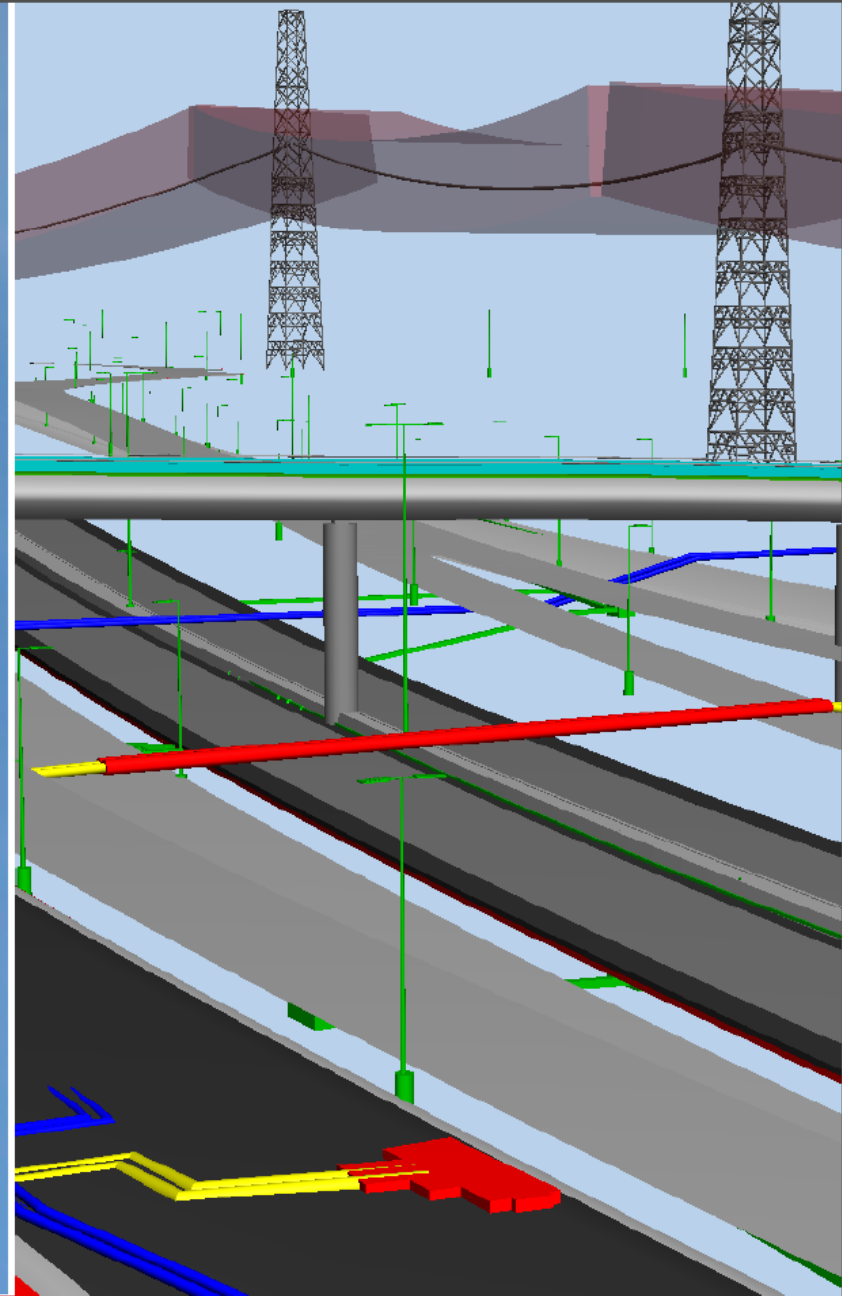
3D design in tenders

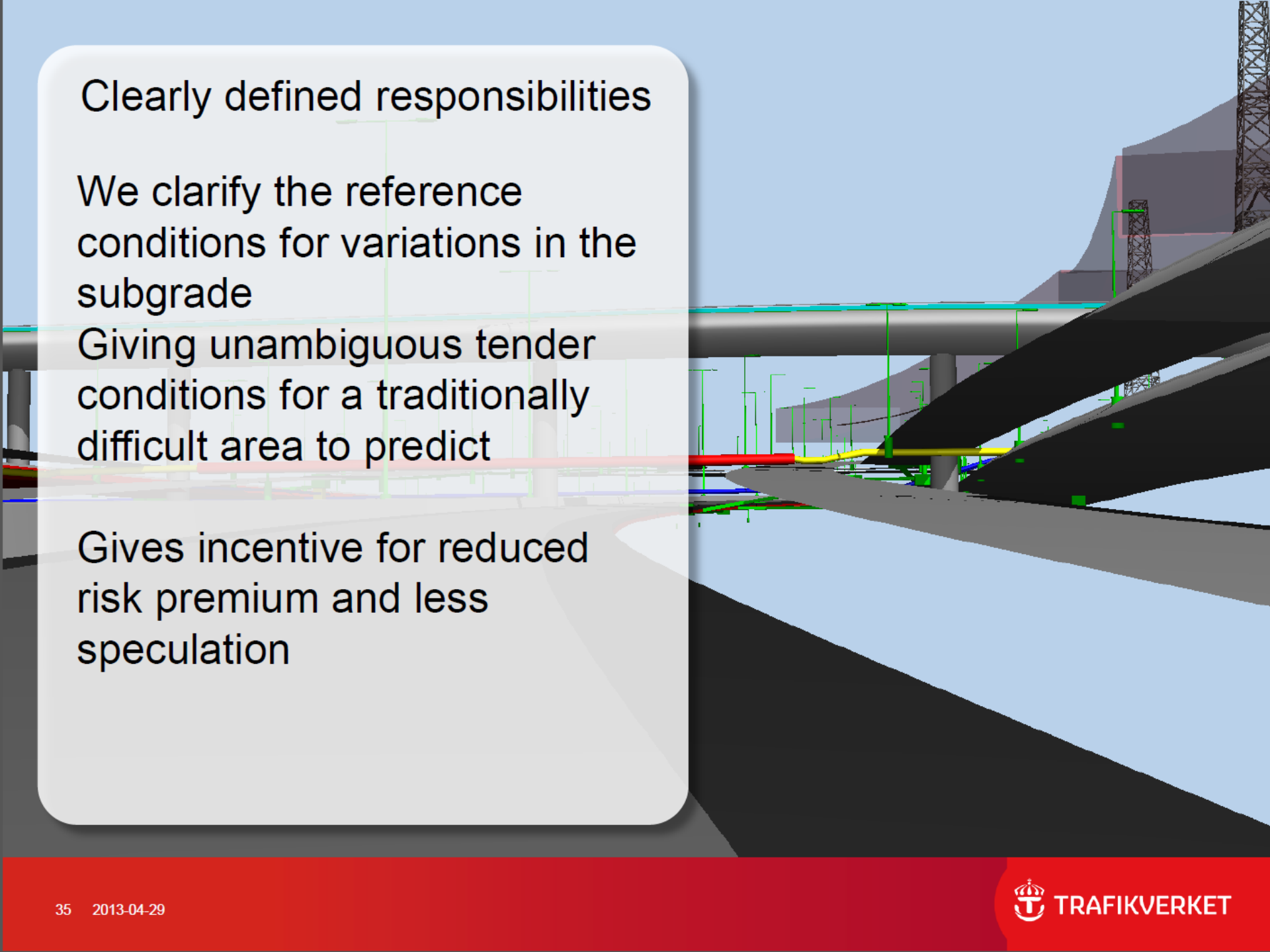


Correct data

We use our detailed CAD-models as a foundation in the tender documents for construction work which gives better bases to bids and for enhance production

Increases productivity in the construction industry



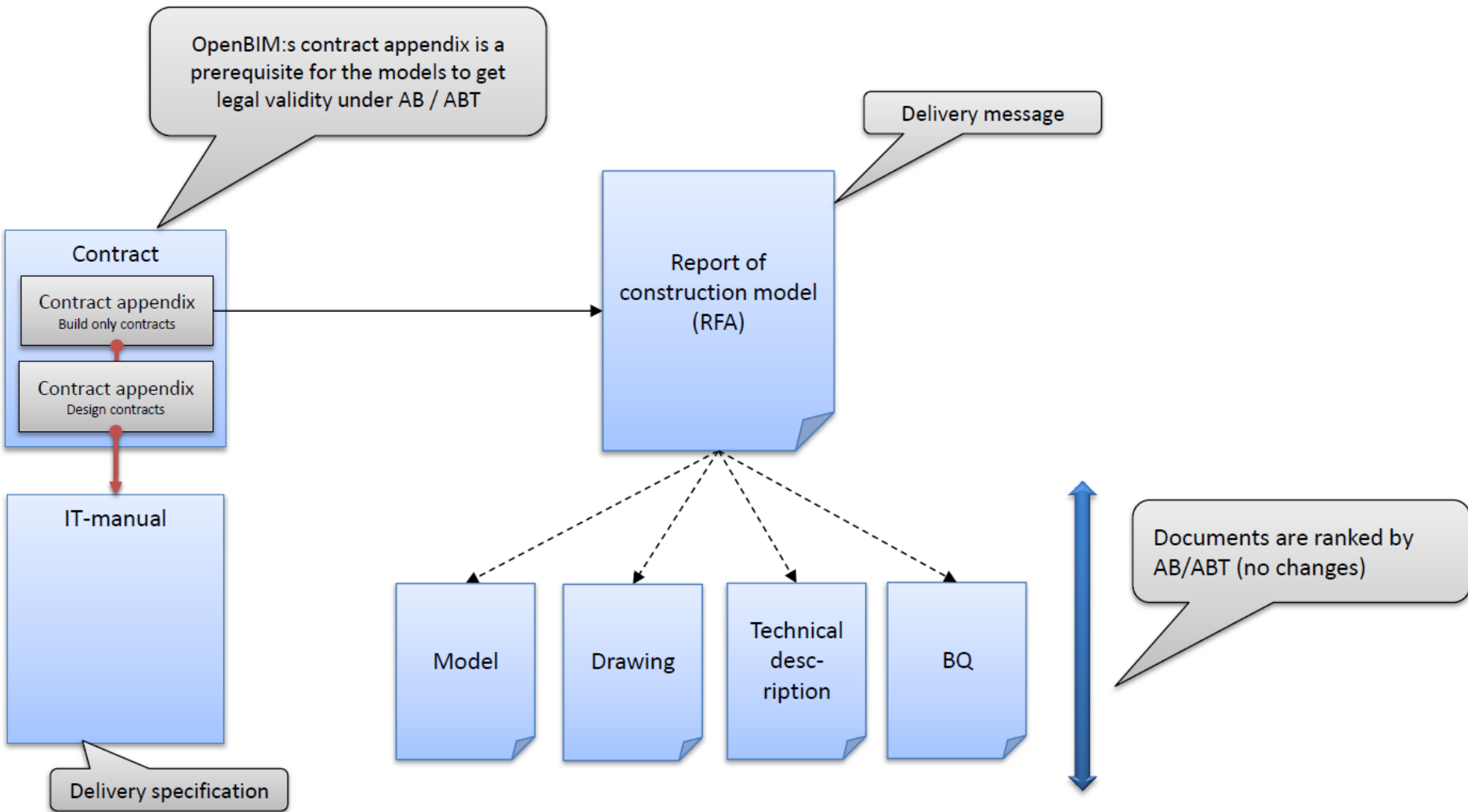


Clearly defined responsibilities

We clarify the reference conditions for variations in the subgrade

Giving unambiguous tender conditions for a traditionally difficult area to predict

Gives incentive for reduced risk premium and less speculation



Summary

- A total of about 50 different contracts
- Both construction contracts and design-build contracts
- We have started our BIM-journey
- A common coding standard
- Models in tenders

Please visit us at:
**[www.trafikverket.se/
thestockholmbypass](http://www.trafikverket.se/thestockholmbypass)**

**Bridge over the Arbogaån river
at Röfors**

Mikael Malmkvist



TRAFIKVERKET

Röfors bridge, built 1919

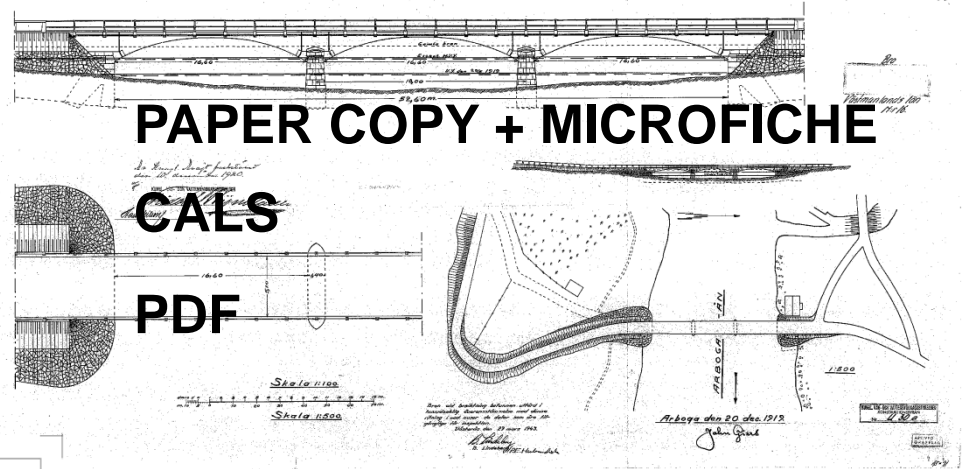


VÄGBRO ÖVER ARBOGA-ÅN vid RÖFORS.



**RÖFORSBRON DRAWN
ORIGINALLY ON CLOTH**

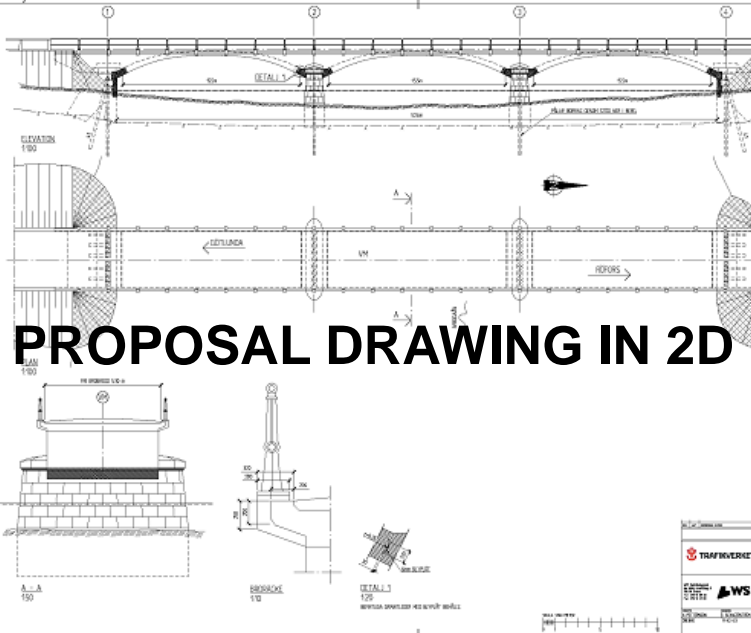
VÄGBRO ÖVER ARBOGA-ÅN vid RÖFORS.



PAPER COPY + MICROFICHE

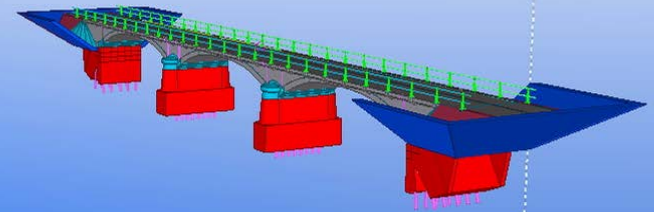
CALS

PDF



PROPOSAL DRAWING IN 2D

NEW RÖFORS BRIDGE IN 3D



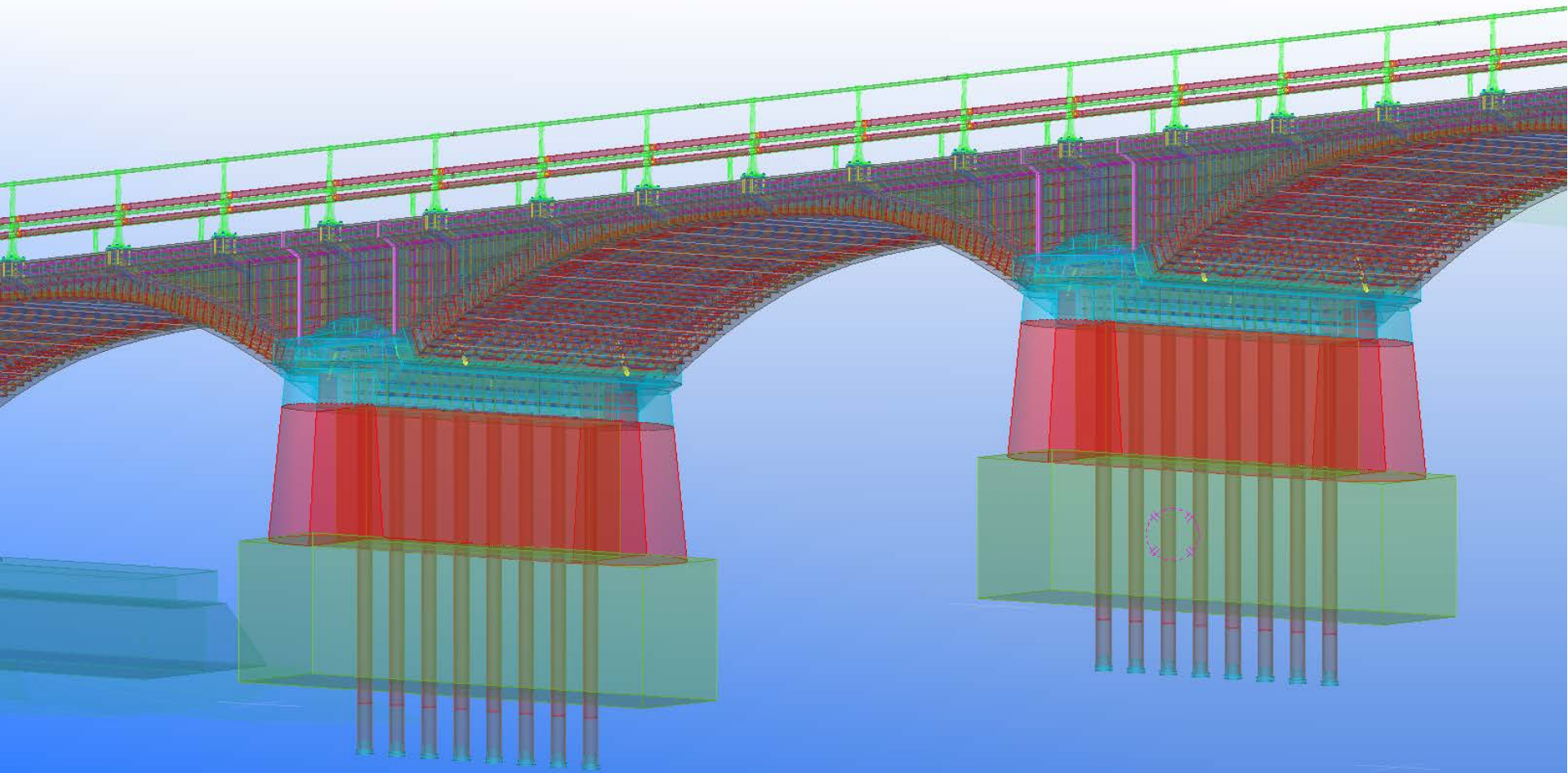
The Rölfors bridge

In order to test the applicability of BIM for use in bridge projects Trafikverket has decided to implement the tool into a pilot project that is the Rölfors bridge.

The project is the ***first of its kind in Sweden to adopt the use of BIM tools throughout the whole project life***, including the production phase of its construction. The Rölfors bridge is a 100-year-old three span, concrete bridge crossing the river Arbogaån in Arboga. The bridge offers significant cultural history to the area and is to be reconstructed to replicate its existing form. The ***BIM design model was created by WSP before it was handed over to Skanska*** for the production of the bridge.

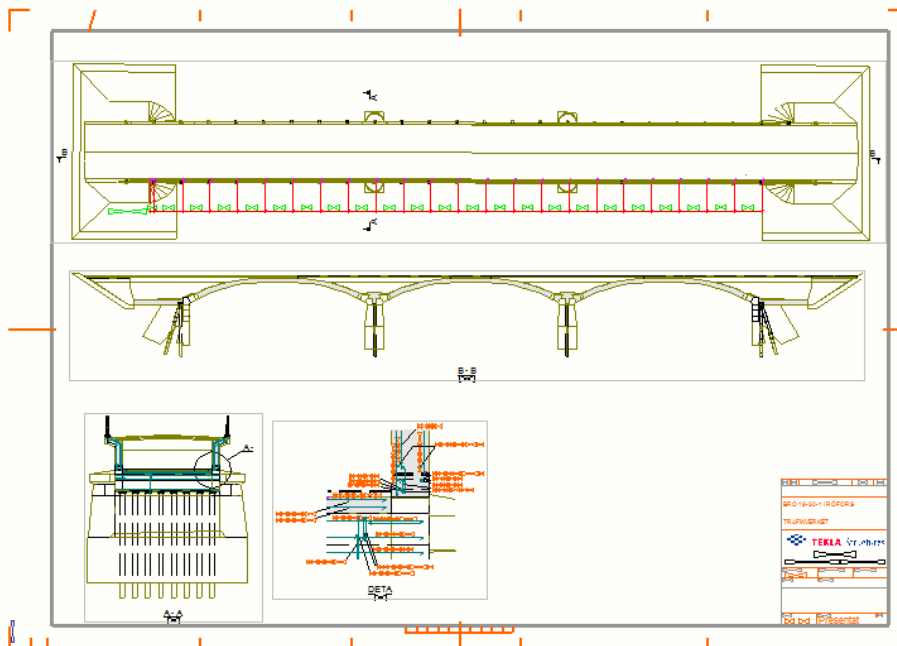
The Rölforsbron project was a BIM project ***using a 3D model. Tekla Structures*** was the software used to design all aspects of the model. The model included all components of the sub-structures and super structures. The model also ***included all the temporary structures***, which comprised cranes, storage boxes, form stands and public pathways. The fittings and finishes were also modeled.

BIM in Rölfors project

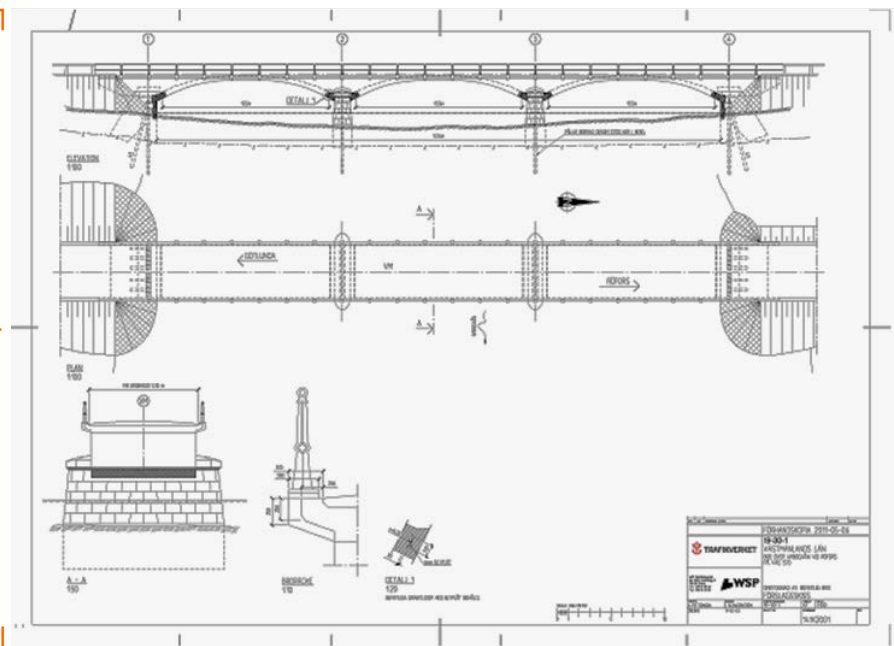


Generation of 2D - & 3D drawings

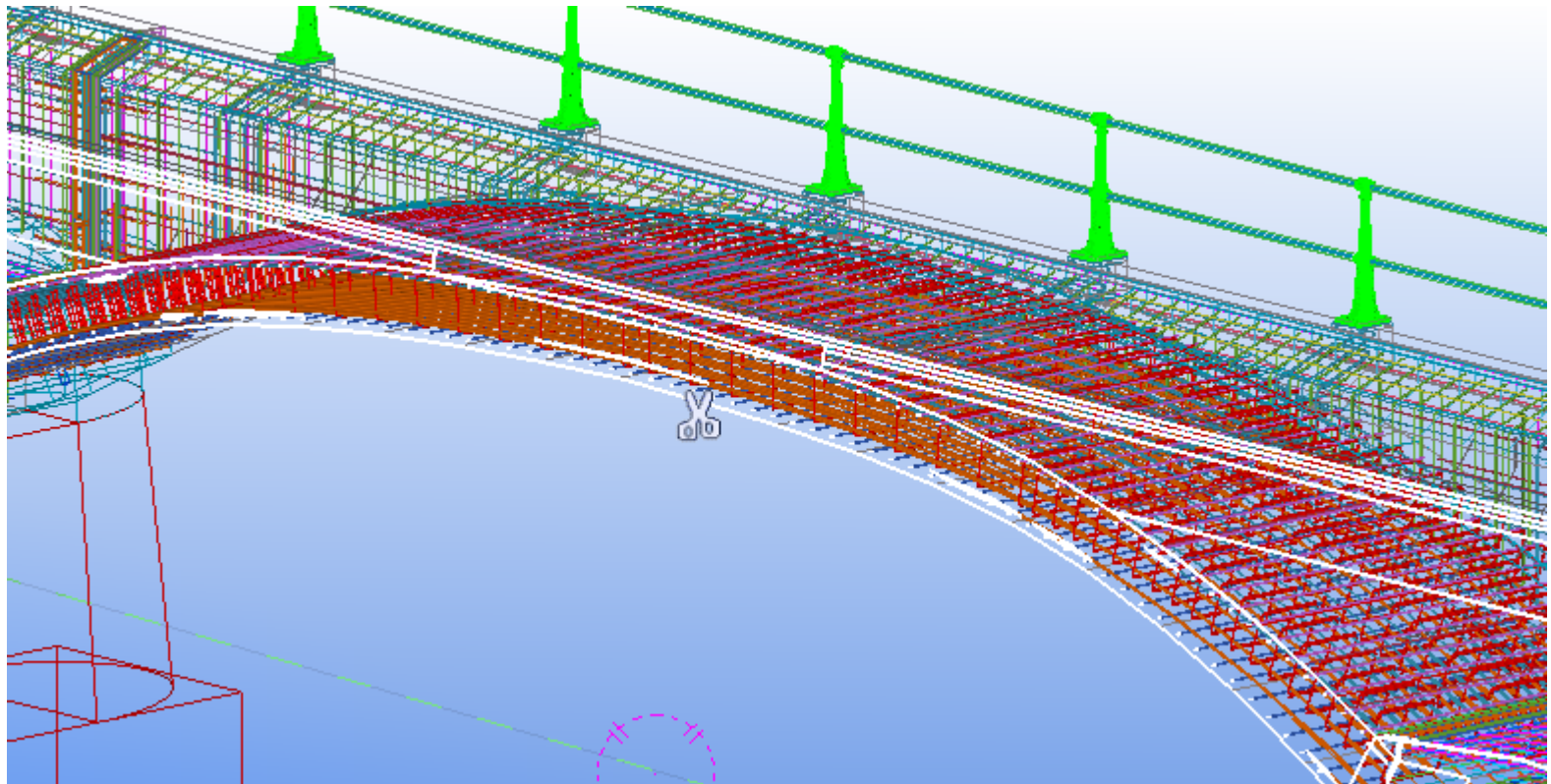
2D drawing from Tekla structures



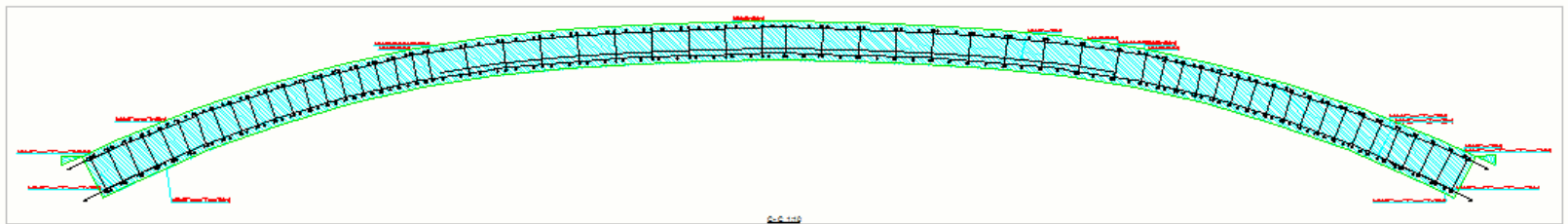
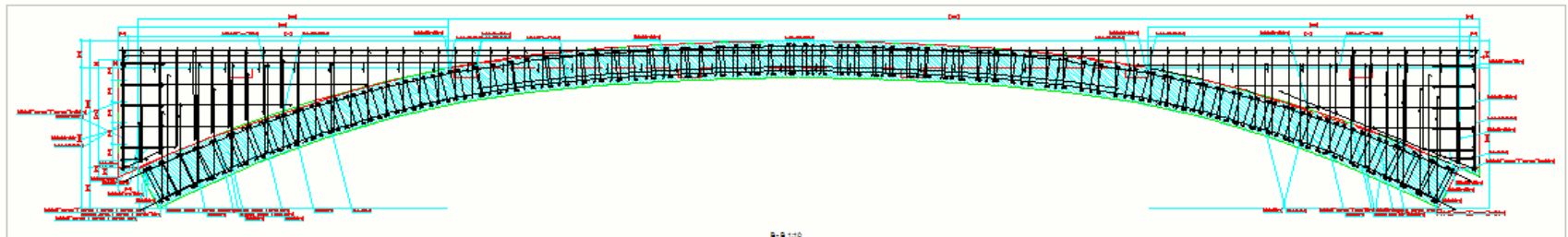
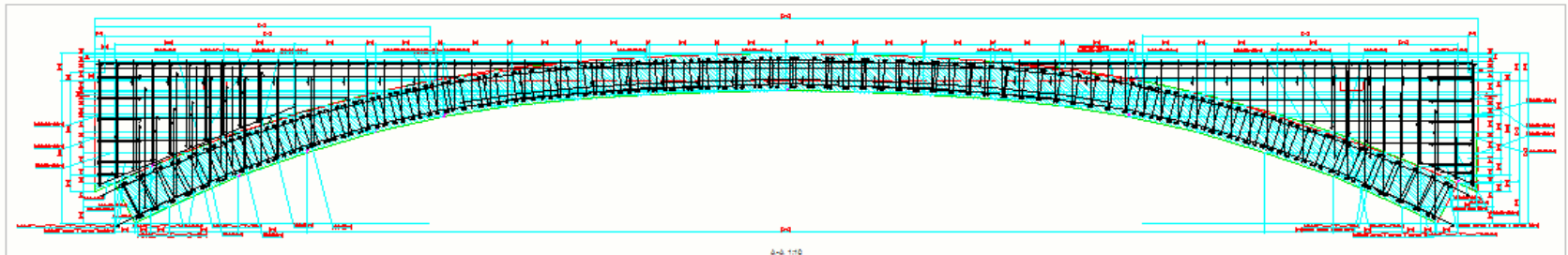
Traditional 2D drawing



Sections to be generated

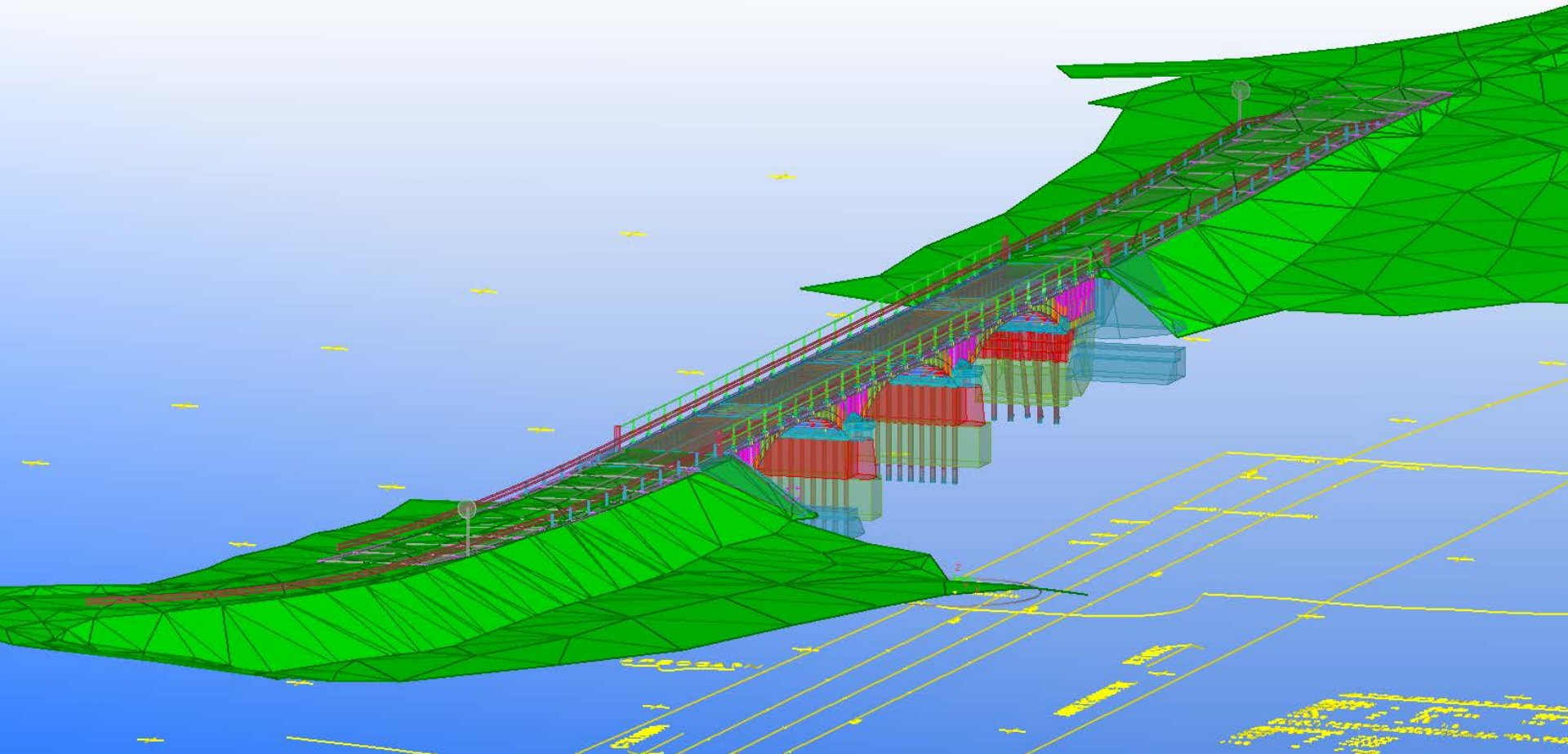


Production taylored views

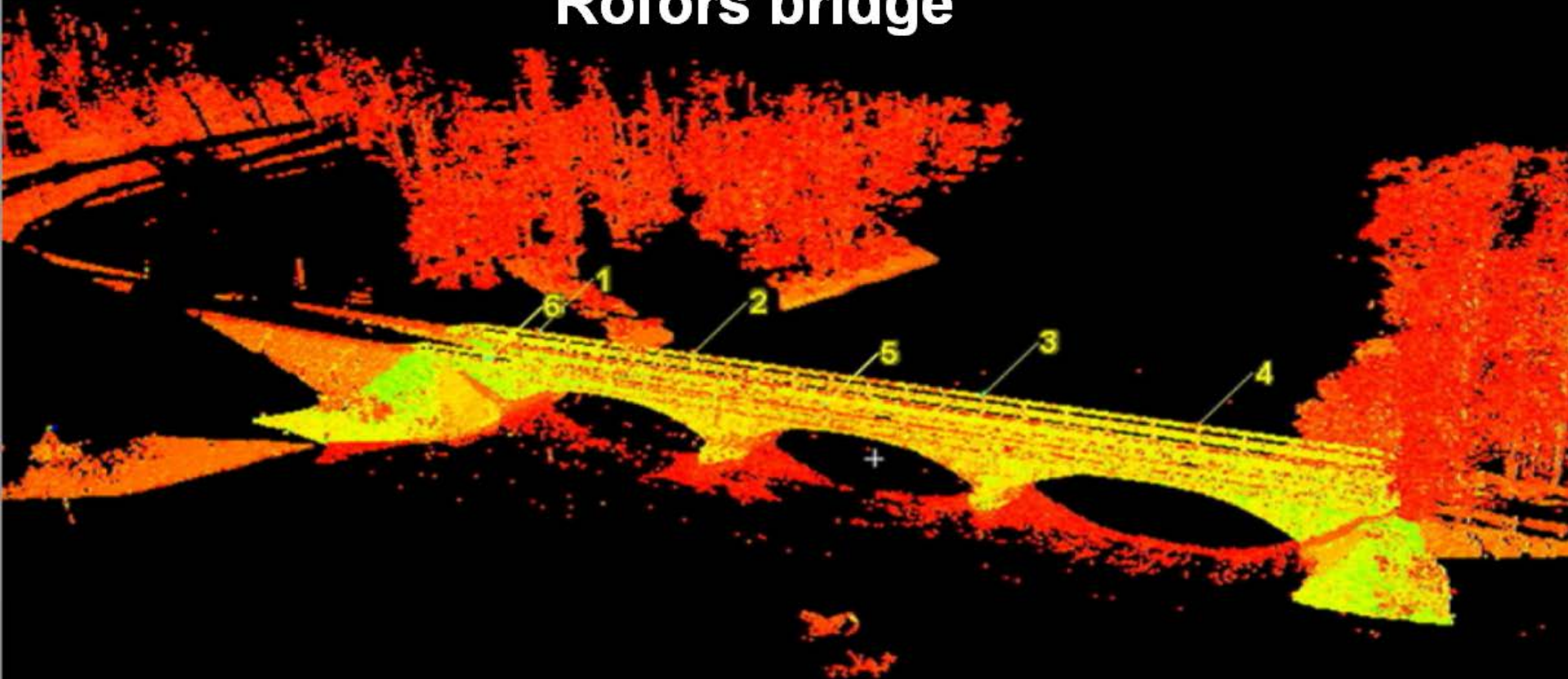


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Röfors bridge



Laser scanning of the bridge generated a virtual copy for the future

Laser scanning gave the designers a point cloud to use as reference for the design of the new bridge

Conclusions

The Swedish Transport Administration wants to:

- cooperate with the other Nordic Transport Administrations when developing and implementing IFC based infraBIM
- use international and open standards for their future processes

V-con can be the start, as the Swedish Transport Administration is committed to involve buildingSMART in securing the future of the open INFRA standards