SOFiSTiK

Client | Location | DD Mmmmm 2019

BIM for Buildings
Analysis & Design within Revit + Connected Workflows

SOFiSTiK AG

Founded in 1987
- Spin-off of Technical University of Munich
- FEA development since 1973
- Autodesk ADN Member since 1985

Main location: Munich & Nuremberg Germany;
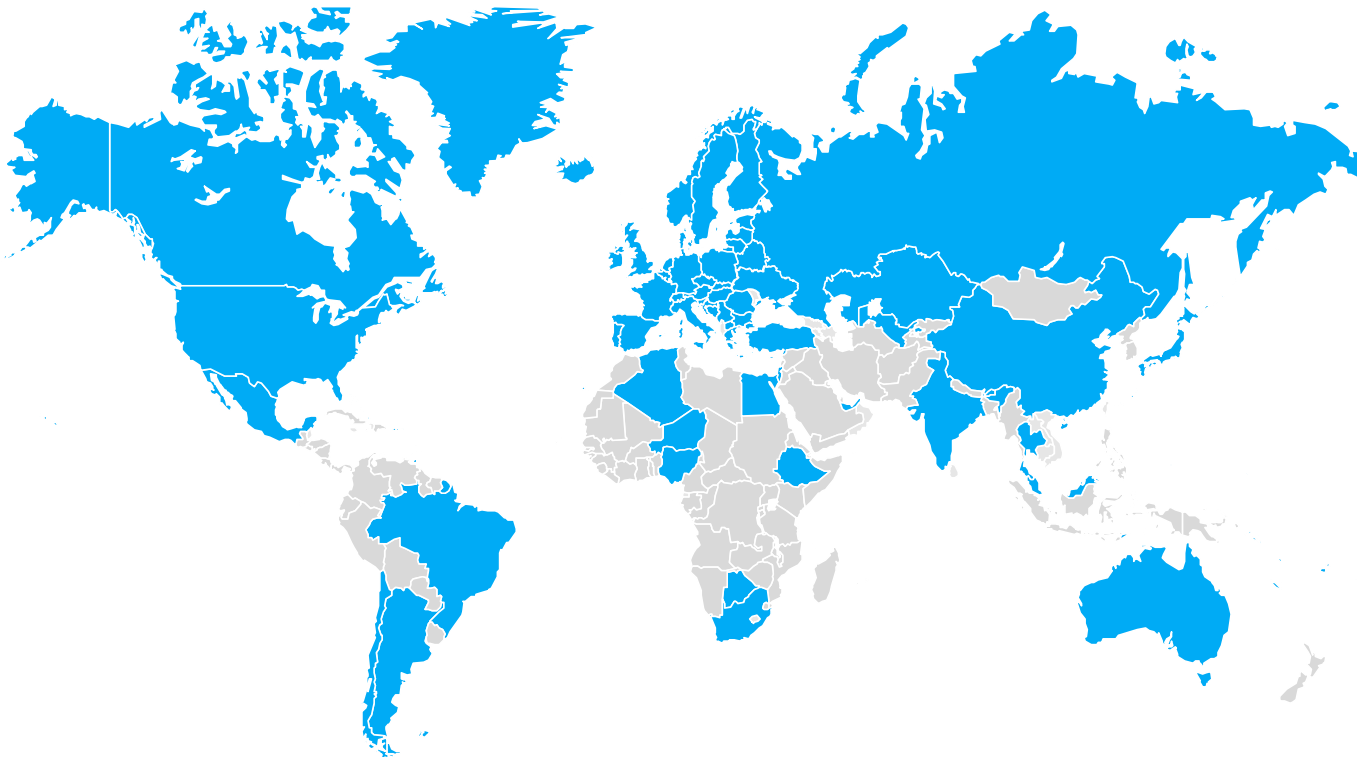Sales branches: Austria, South Africa, UK; Middle East, Scandinavia.
Subsidiary: BiMOTiON

Focus: Professional FE and drafting software solutions for structural and civil engineering

80+ employees + external staff

Autodesk Industry partner

International Presence

6.000+ customers in 60+ countries

10 competence centers

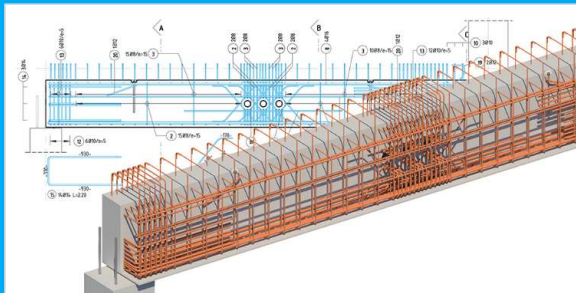30 international partners/distributors

30 international partners/distributors

Product

FEA
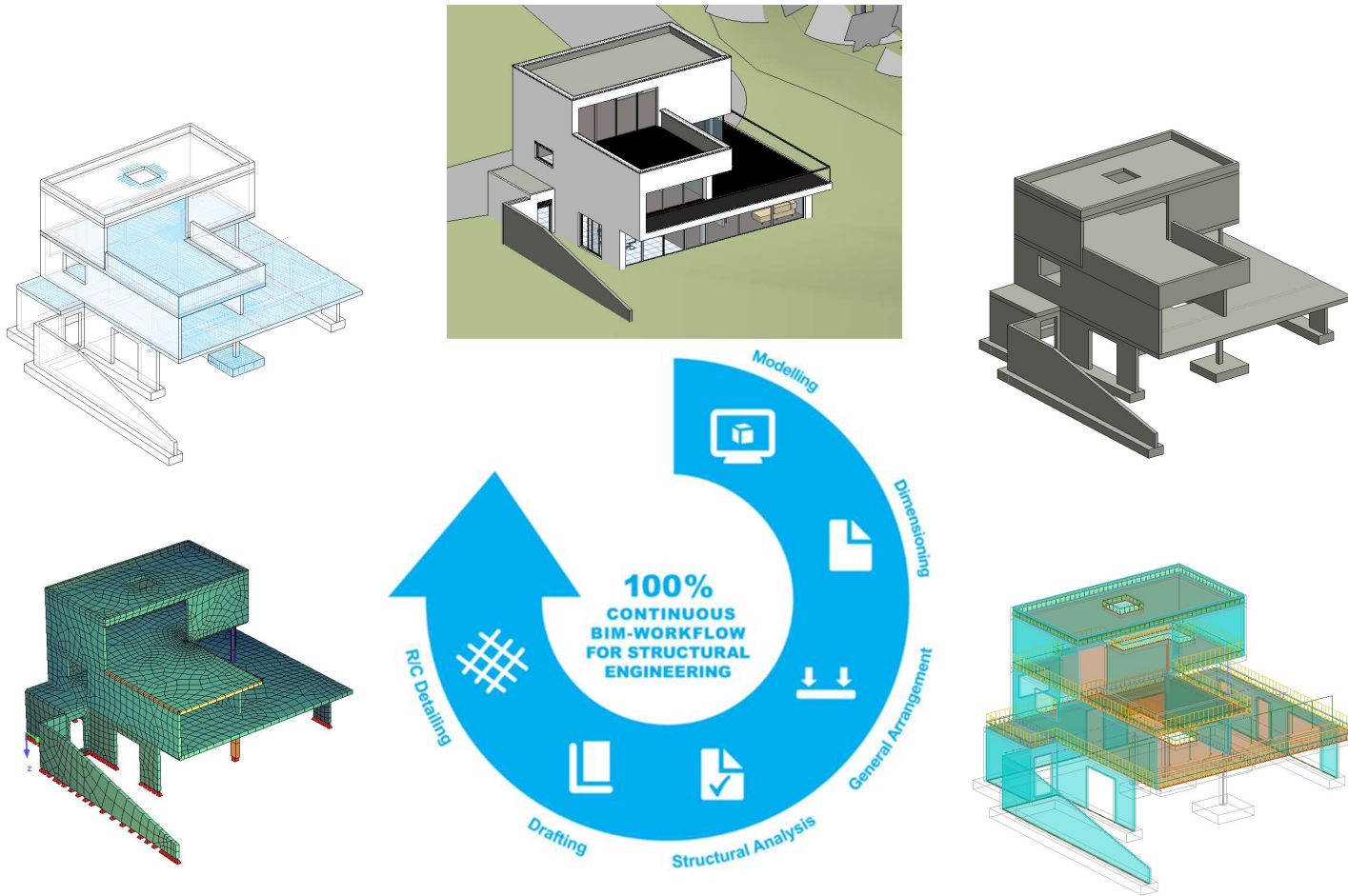Software for Finite Element Analysis & Design
CAD/BIM

Reinforcement
Structural Detailing of Rebar Models
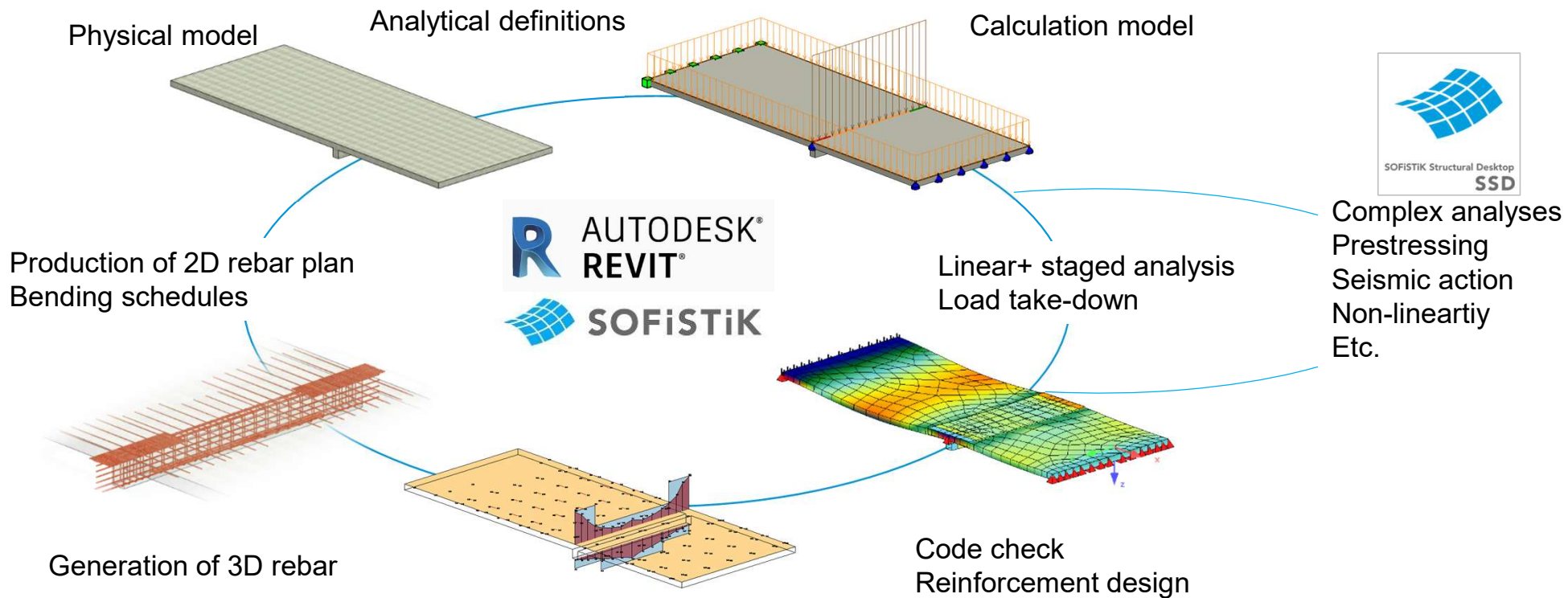CAD/BIM

BIM Bridge
Parametric Modelling of Infrastructure Projects
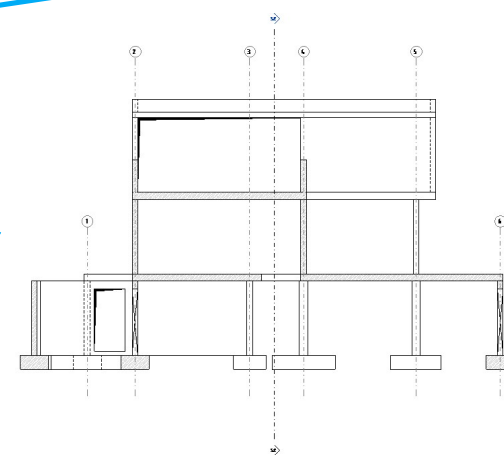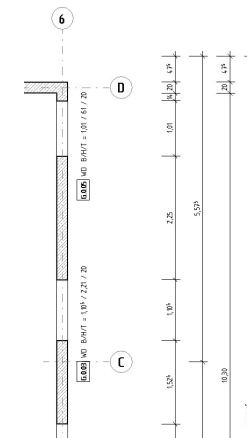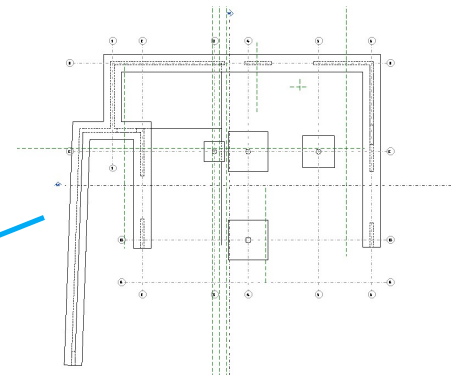
High-quality support and consulting

SOFiSTiK BIM Workflow

Full integration of structural engineering in the BIM workflow

Physical model

Analytical definitions

Calculation model

Complex analyses
Prestressing
Seismic action
Non-lineartiy
Etc.

Production of 2D rebar plan
Bending schedules

Linear+ staged analysis
Load take-down

Generation of 3D rebar

Code check
Reinforcement design

SOFiSTiK Structural Desktop
SSD

Formwork & Position

Integrated analytical model
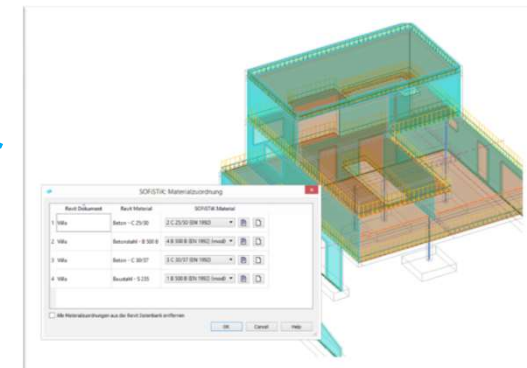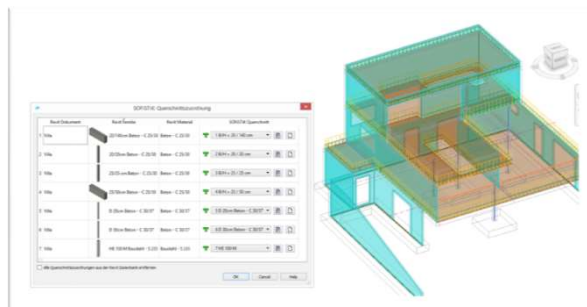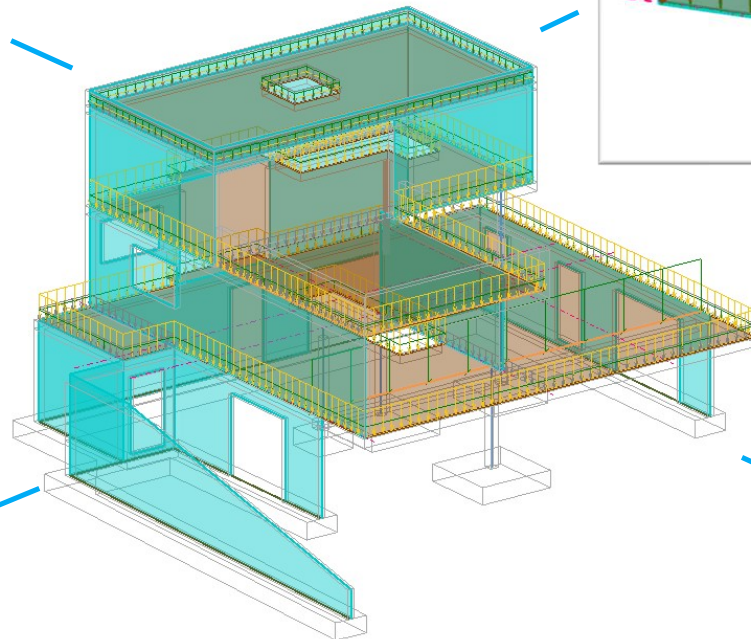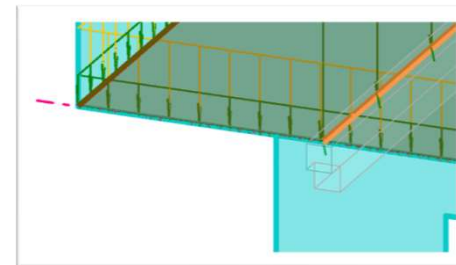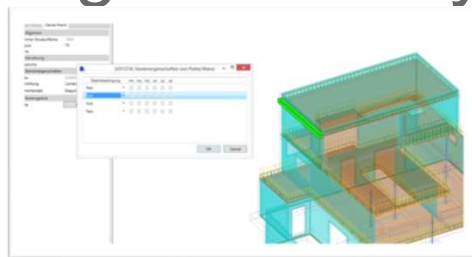
Analysis & Design

4D
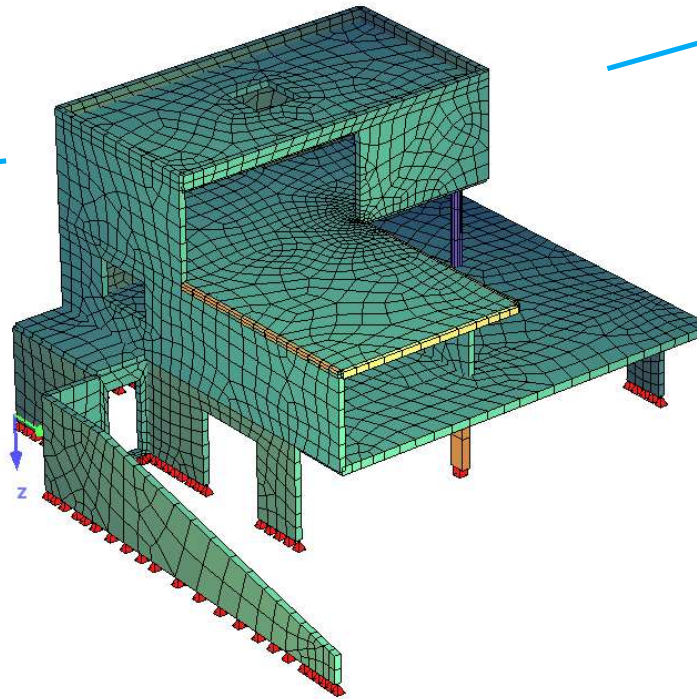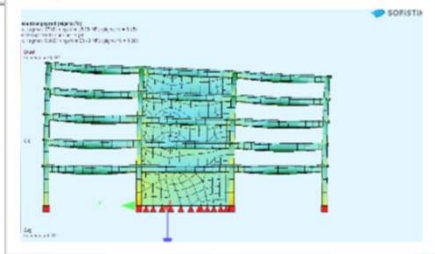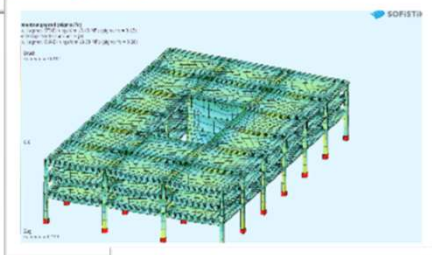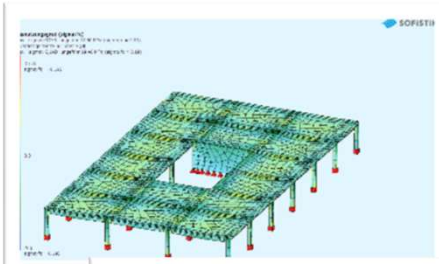
2D
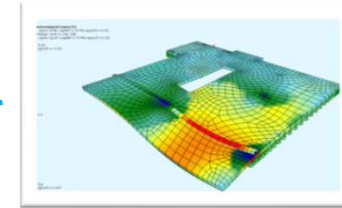
3D
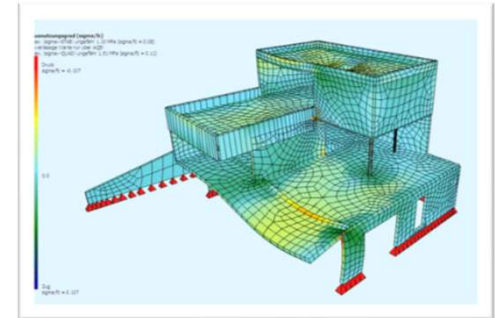
5D…

3D Reinforcement + Schedules
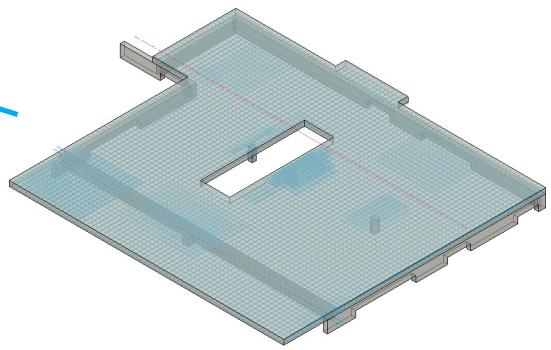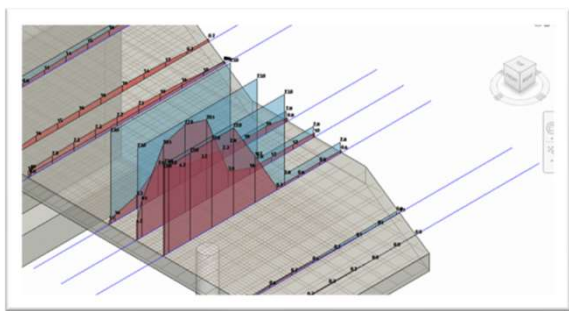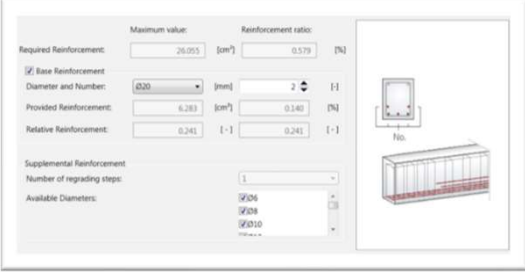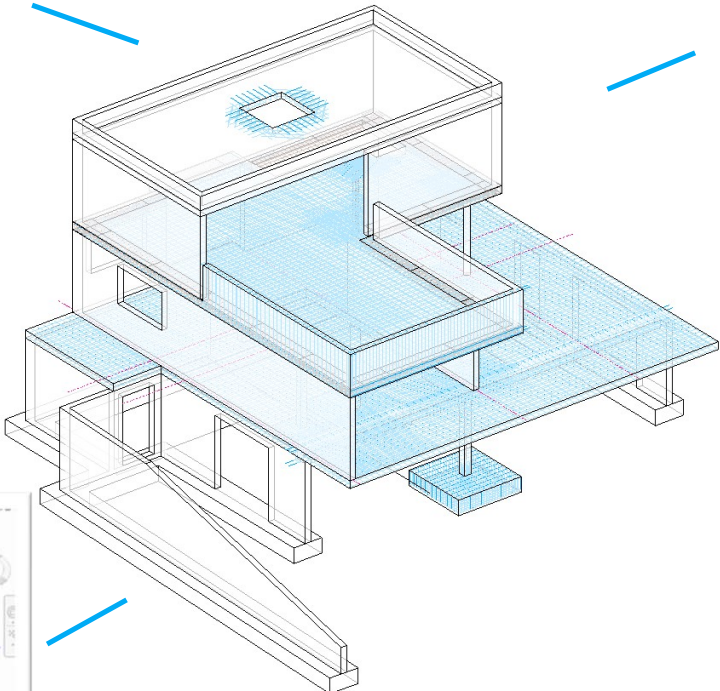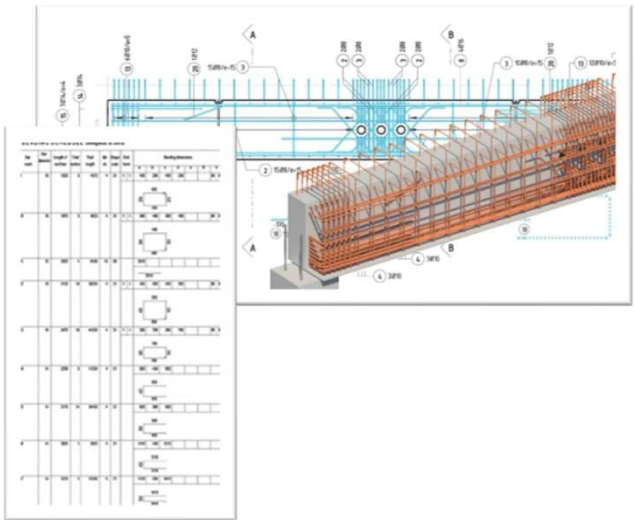
Flexibilité d'implémentation

	Analysis + Design	Reinforcement Generation	Reinforcement Detailing	3D PDF	Modèle 3D
Modèle Revit	Calcul & Dimensionnement	Création d'armature	Plans & Nomenclatures	Documents interactifs	Documentation de projet
	SOFiSTiK FEA				Plans 2D
	SOFiSTiK Structural Desktop SSD				

Modules disponibles séparément mais interconnectés pour une utilisation flexible
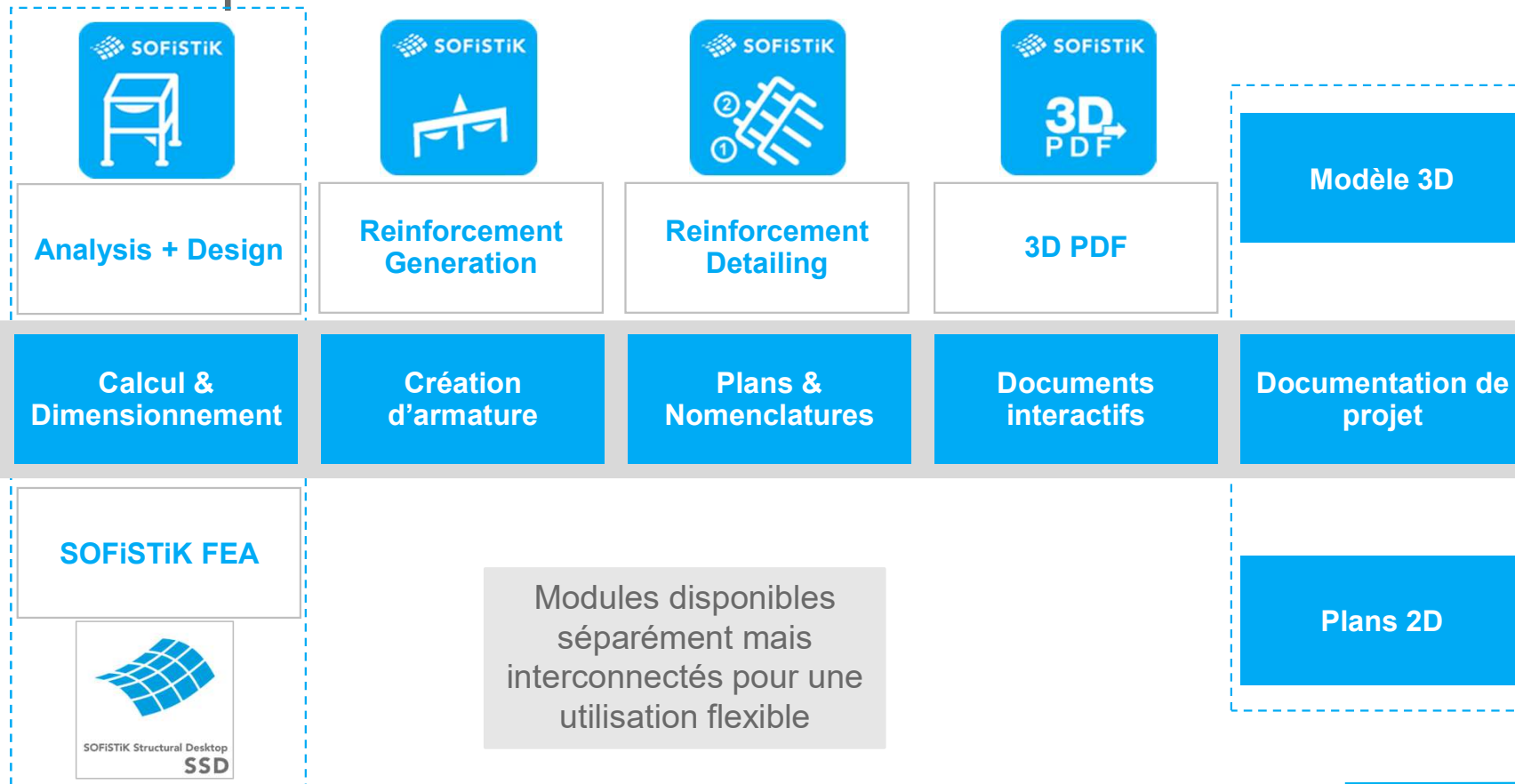
Revit as a structural analysis plateform

Linear analysis and preliminary design within Revit

Extracting data from the architectural model

BIM = Transfer of information

+ Automatic mapping of families and properties of the Revit model to SOFiSTiK data
  + Materials
  + Cross-sections
  + Level
  + Load types
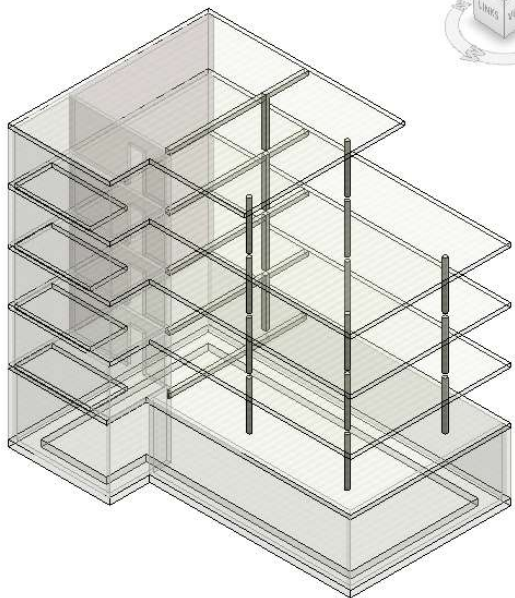
	Revit Document	Revit Section		Revit Material		SOFiSTiK Section		
1	3d_building_UK	C25 - 300 x 1500mm		Concrete, Cast-in-Place - C25	⊤	1 B/H/Bw/Hf 1000/1500/300/250 mm	▾	
2	3d_building_UK	C25 - 400 x 1500mm		Concrete, Cast-in-Place - C25	⊤	2 B/H/Bw/Hf 3300/1500/400/250 mm	▾	
3	3d_building_UK	C30 - 300 x 300mm		Concrete, Cast-in-Place - C30	⊤	3 B/H = 300 / 300 mm	▾	
4	3d_building_UK	C30 - 300mm		Concrete, Cast-in-Place - C30	⊤	4 C30 - 300mm	▾	
5	3d_building_UK	C30 - 400 x 400mm		Concrete, Cast-in-Place - C30	⊤	5 B/H = 400 / 400 mm	▾	

☐ Delete All Section Mappings From Revit Document

OK   Cancel   Help

Control over data in the calculation model

+ Manual override of values
+ User-defined properties
+ No black box
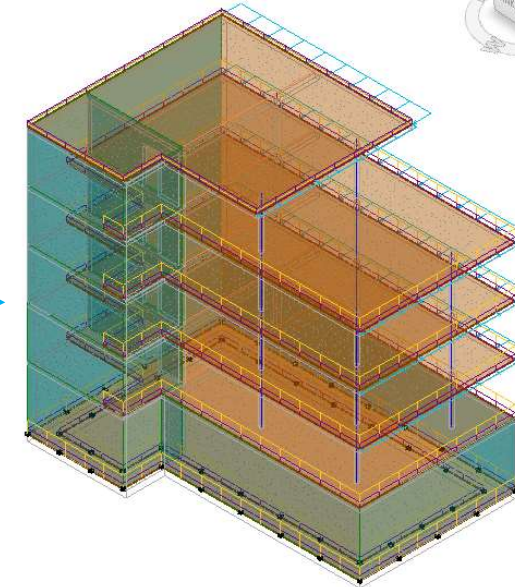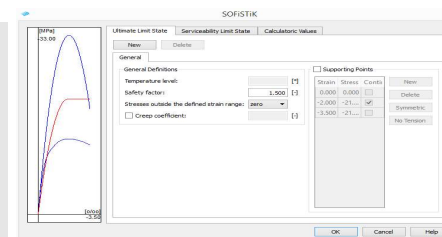
Defining & Checking the calculation model

Engineering-oriented properties

+ SOFiSTiK Structural properties for each type of calculation object
+ Storage of definitions/data within the RVT file for better collaboration and compatibility
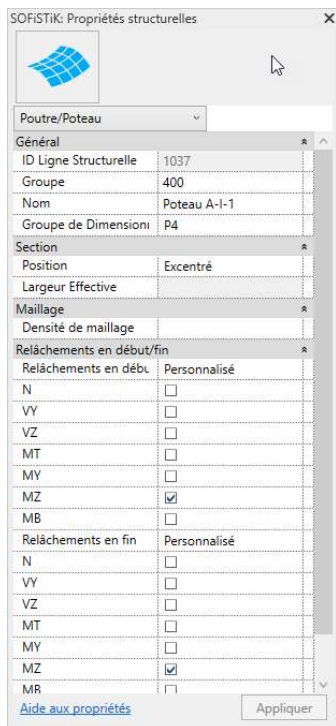
Architectural model
≠
Calculation model
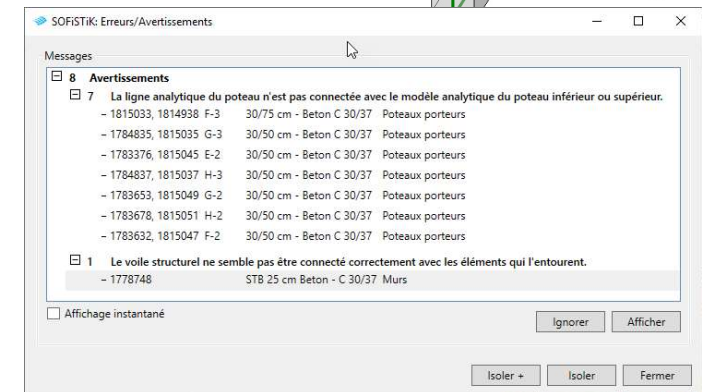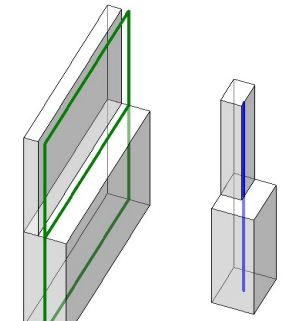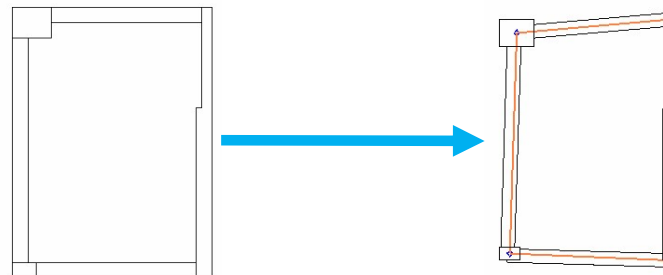
Error detection

+ Control of the calculation model for typical problems (alignments, load transmission, etc.)
+ Focus tools for easier adjustment by the engineer

Analysis & Modularity

Current System:

Main System

--
Main System
Subsystems
Level 0
Level 1
Level -1
Level 2
Level 3

Load takedown
+ Transfer of loads and support reaction by levels
+ Automatic support condition for subsystems
+ Load specification for each submodel
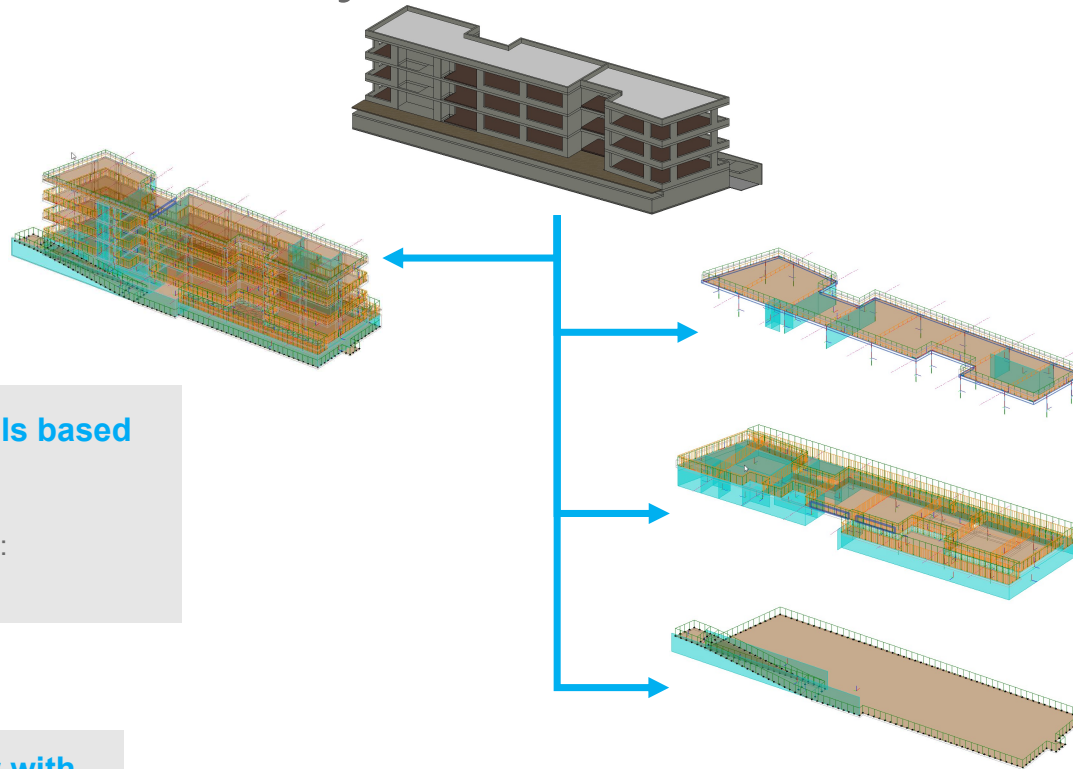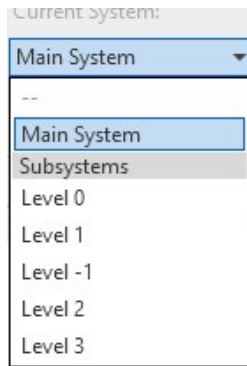
Multiple calculation models based on a same Revit file
+ 3D main system
+ 2D/3D local subsystems (ex.: slabs/levels/frames)

Full compatibility/transfer with SOFiSTiK Structural Desktop
+ Advanced tools
+ Complex analysis
+ etc.

SOFiSTiK Structural Desktop
SSD

Construction staging
+ Compatibility with Revit phases
+ Accounting for the evolution of the structure in the analysis

SOFiSTiK Analysis + Design

Direct design of the Revit model

Object-based design:
+ Columns
+ Beams
+ Slabs

Column Beam Slab

Design

⚠ *Currently only with EN norm*

Design management within Revit:
+ Grouping similar objects
  → Similar to hand design approach
+ Simple preparation & update of calculations

SOFiSTiK Analysis + Design

Visualisation of results Revit

Storage & Collaboration within Revit
+ Storage of key results in the RVT file
+ Easy sharing & collaboration with all parties of the project
+ Visualisation possible without SOFiSTiK tools/license

Moments Mxx (< kN-m/m >)

Model: Office_RxA
Load case: 01 SelfWeight

SOFiSTiK_FEA (2019-03-28 19:37:22)
Structural Analysis
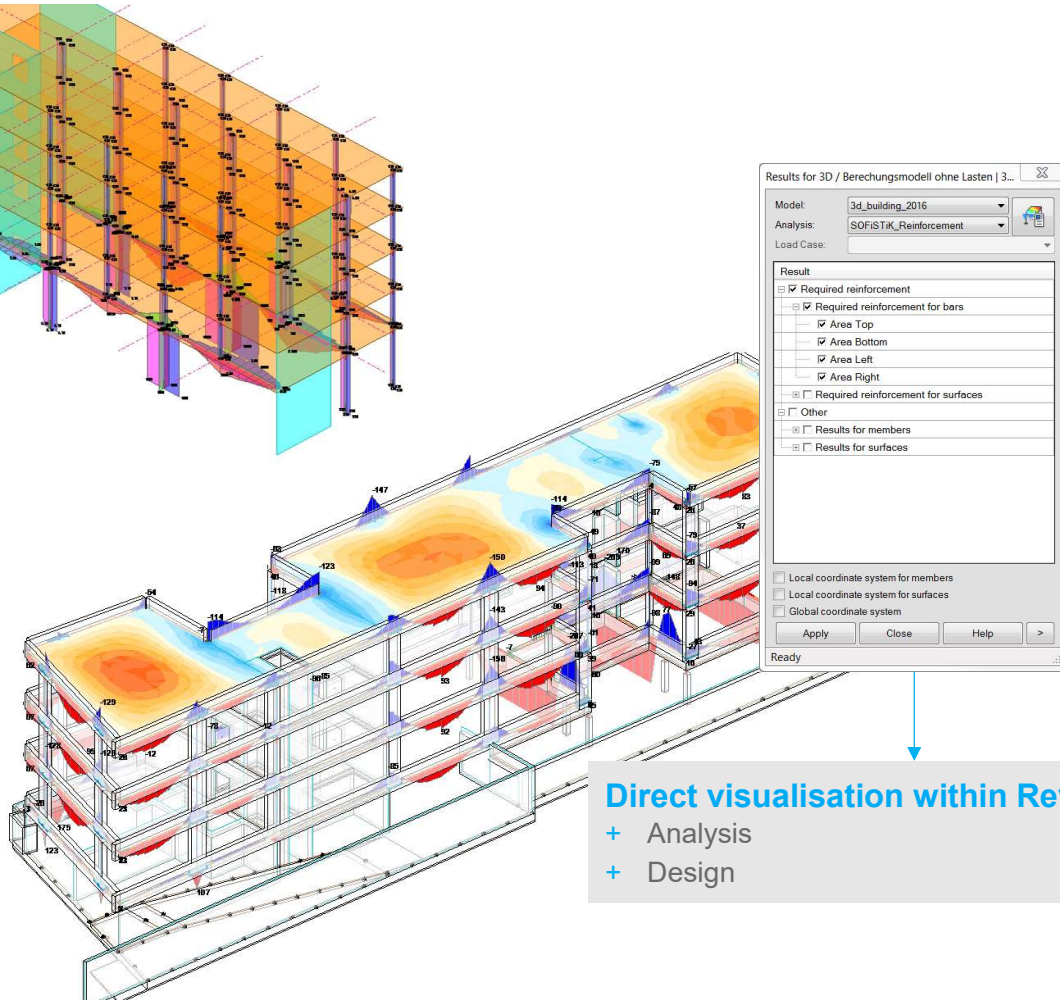
Direct visualisation within Revit
+ Analysis
+ Design
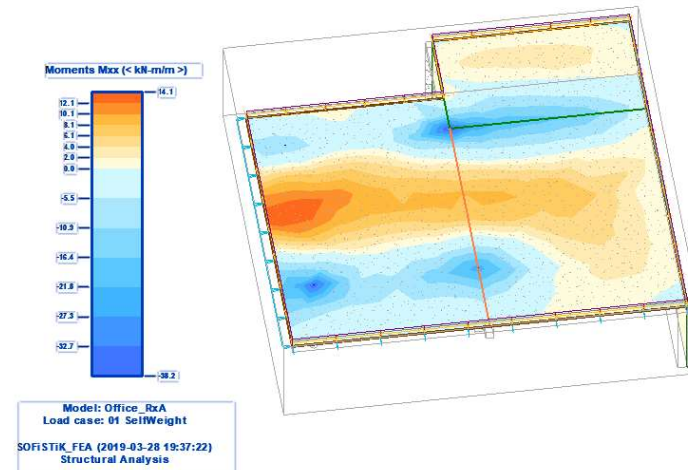
Revit as a modelling plateform

Complex analysis & design connected to the Revit model
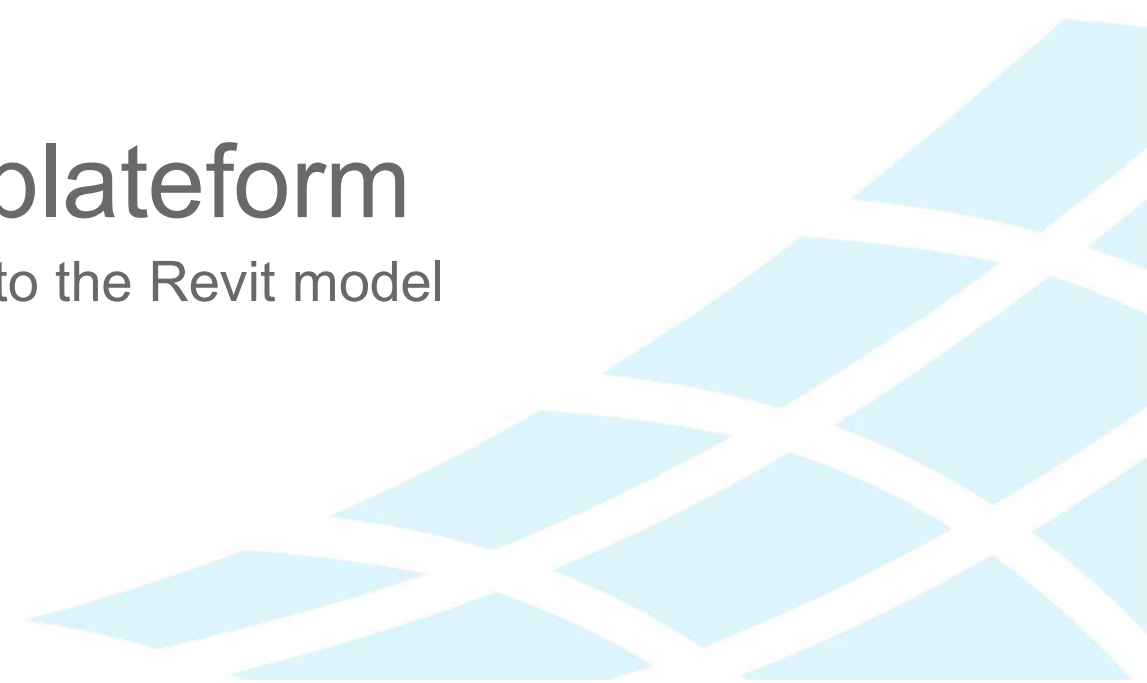
Transfer Revit models ↔ SOFiSTiK Structural Desktop

Adjustment-free transfer
+ Structural model in Revit = Calculation model in SOFiSTiK
+ No additional definition/adjustment required

SOFiSTiK file for each submodel
+ Ideal for work sharing between different engineers
  + Autonomeous work within the SOFiSTiK Structrual Desktop
  + Update from the common Revit model
+ Transfer of results/support reaction also through external workflow
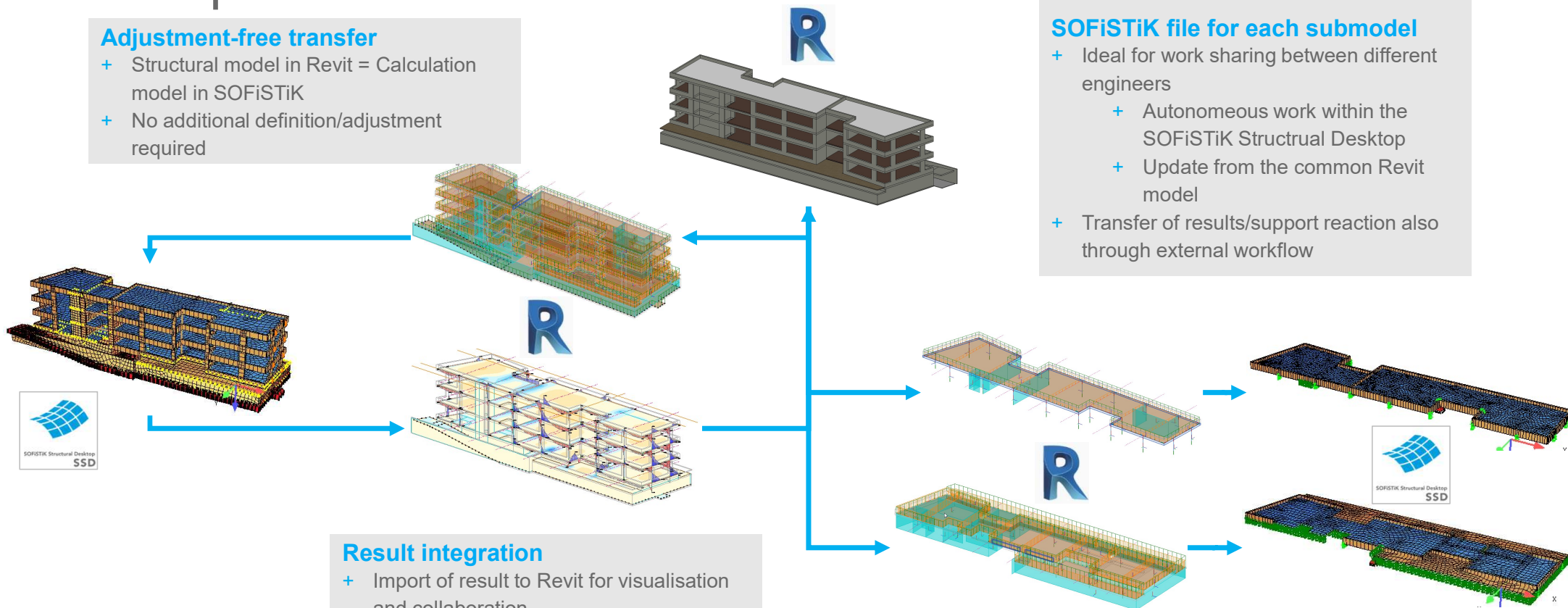
Result integration
+ Import of result to Revit for visualisation and collaboration
+ Versioning for comparison between calculations or between models

Additional definitions for further analysis

Slab prestressing
+ Definition of geometry & prestressing method in Revit
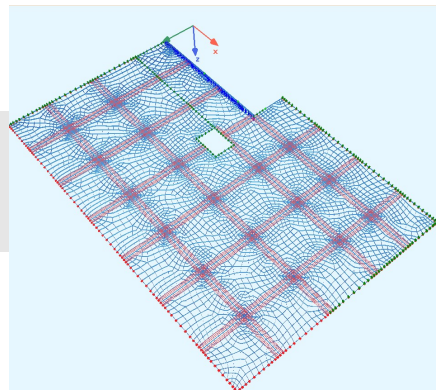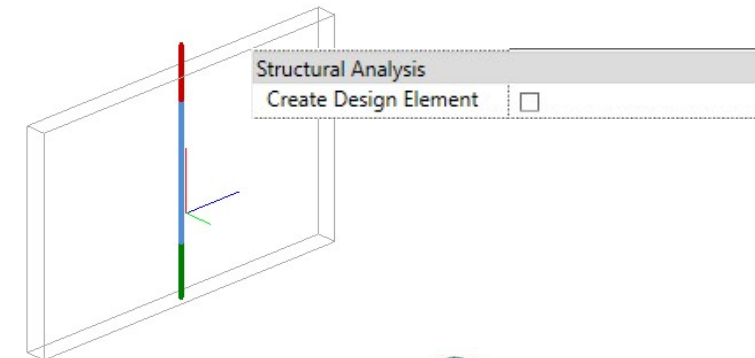+ Simple 2D line modelling → 3D spline generation

Transforming walls into columns
+ Converting walls into design column objects
+ Integration to seismic workflow

Structural Analysis
Create Design Element ☐

Storey Properties

Calculation Parameters

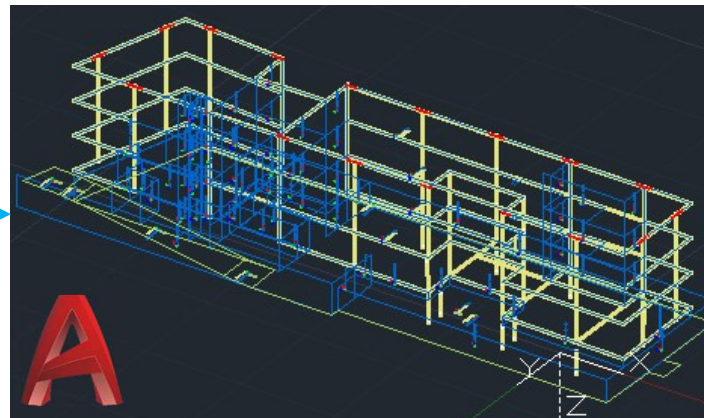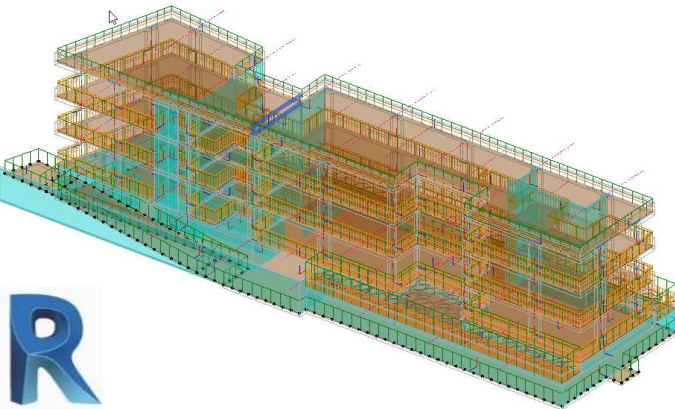| Stiffness of Walls		⊼
Consider shear stiffness	☑	
Consider in-plane bending	☐	
Consider lateral bending	☐	
Upper fixation degree	50%	
Stiffness of Columns		⊼
Consider bending	☐	
Upper fixation degree	50%	
Calculation of Capacity		⊼
Max shear stress concrete	600,00 kN/m²	
Max shear stress steel	150000,00 kN/m²	
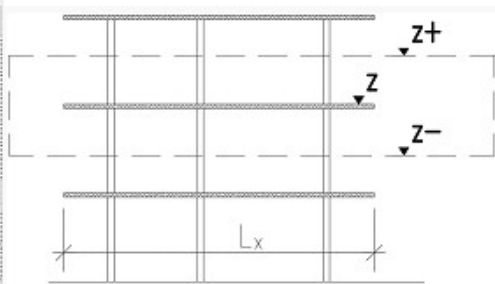
Seismic properties
+ Levels definition
+ Calculation of centre of mass and rigidity for preliminary design (Excel export)
+ Transforming walls into virtual columns for correct design
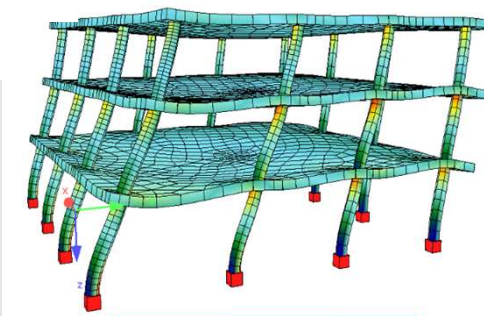
Additional definitions outside of Revit

Adding calculation objects not possible in Revit
+ Complex geometry
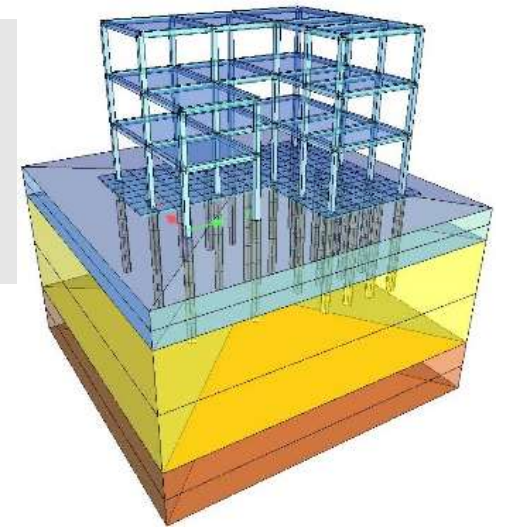+ Beam prestressing
+ Volumetric meshing
+ Geotechnical definitions

Mixing plateforms
+ Import of Revit calculation model into SOFiSTiK AutoCAD interface
+ Adding objects not modelled in Revit
+ Programming with Text input

SOFiSTiK Reinforcement Generation

Automatic modelling of 3D rebar based on design results

Manual modelling = Inefficiency
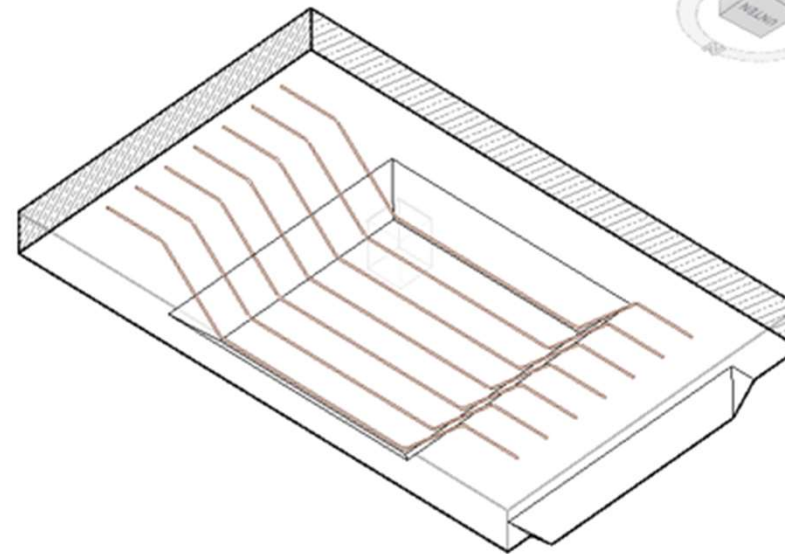
Manual data reading from paper reports

+

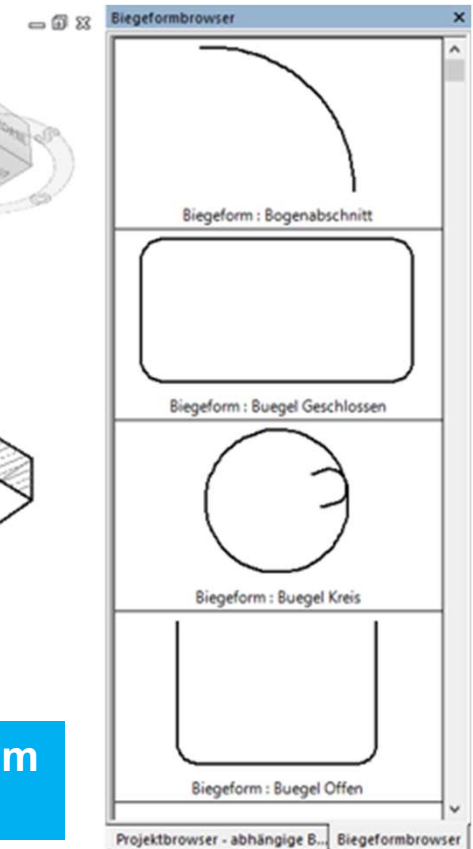Adjustment of standard shapes or user-defined input

+

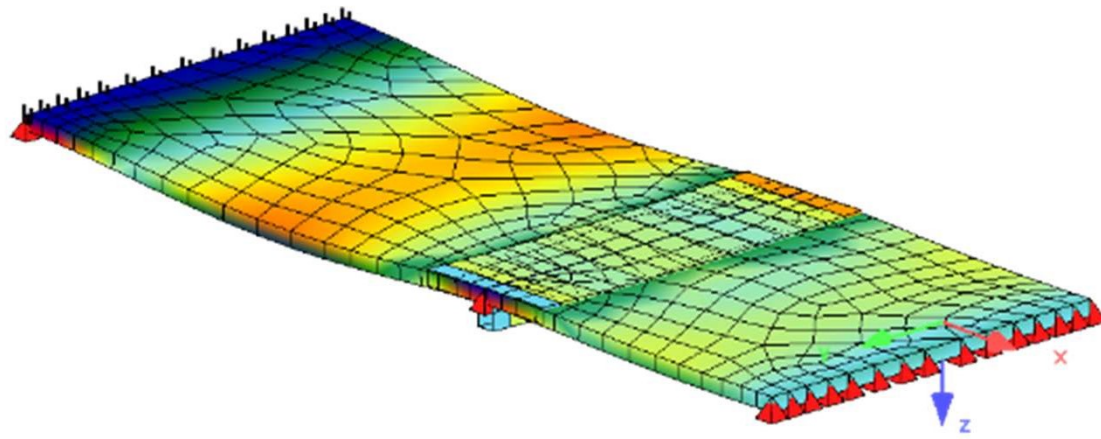Manual positioning and distribution of rebars

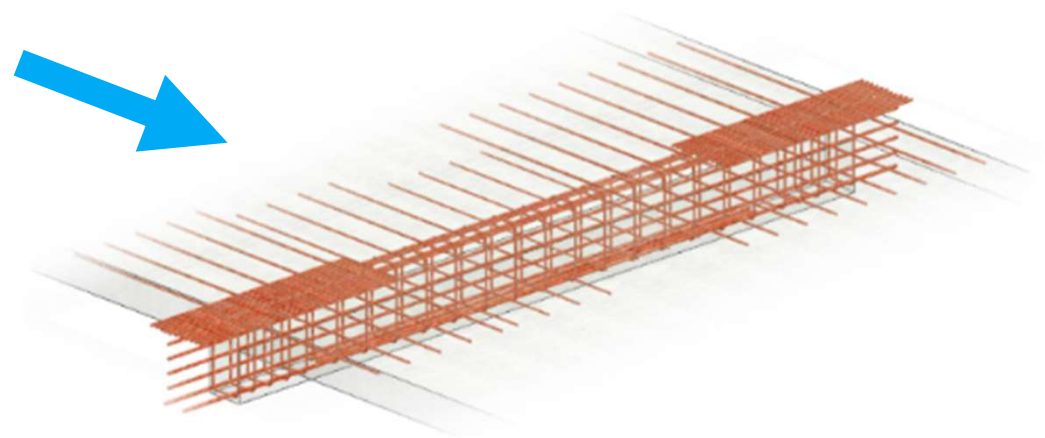**Long and tedious work**

Automatization possible with results from digital calculation

Conversion of the digital design results

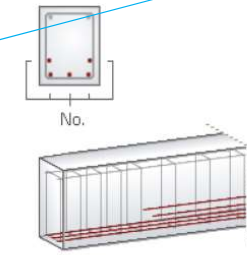3D rebars automatically generated based on design results

FEA calculation results compatible with Revit

- Columns
- Beams
- Slabs
- Walls

Automatic generation of reinforcement

Layout setting based on **norm** and **user-defined** parameters

Setting base reinforcement and additional rebars **for each layer**

	Maximum value:			Reinforcement ratio:	
Required Reinforcement:	26.055	[cm²]		0.579	[%]
☑ Base Reinforcement					
Diameter and Number:	Ø20 ▾	[mm]	2 ⇕		[-]
Provided Reinforcement:	6.283	[cm²]		0.140	[%]
Relative Reinforcement:	0.241	[-]		0.241	[-]

No.

General

Selection

Settings

Floors, Walls, Slabs

Top / Exterior Major Direction

Top / Exterior Minor Direction

Bottom / Interior Major Direction

Bottom / Interior Minor Direction

Beams

Data source
- ◉ SOFiSTiK Database (.cdb)
  - C:\Users\XM\Documents\Beispiele\BIM\UK_2015\3d_building_UK.cdb ▾
  - Design case: 1 ▾
- ○ Revit results package

Ø6
Ø8
Ø10

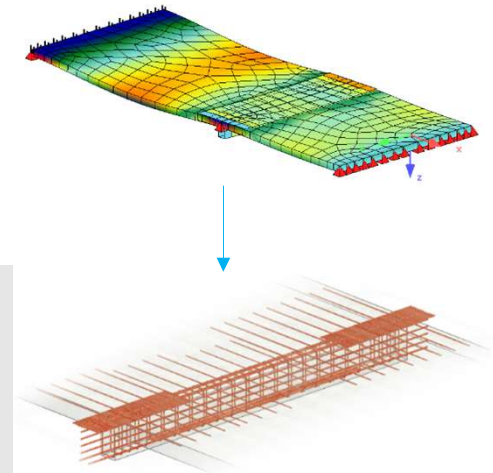Selection of model components
- ○ Selected elements   Select elements
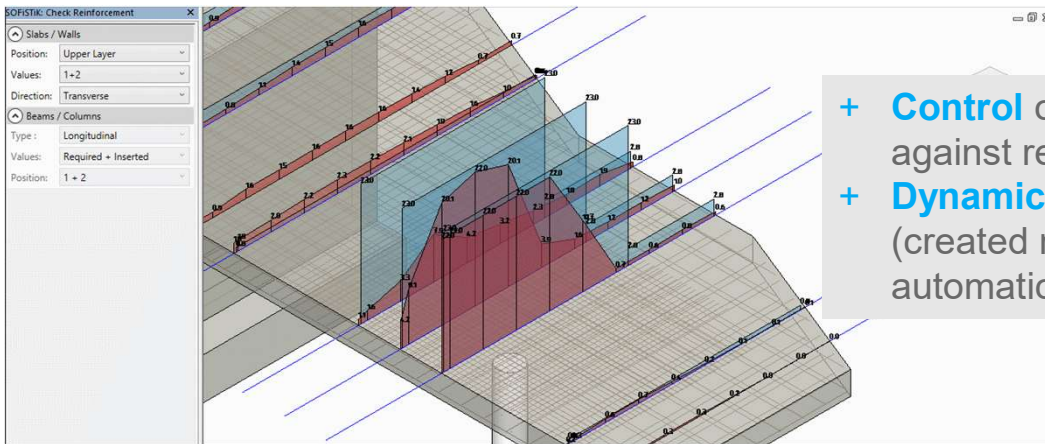- ◉ All visible elements with design results
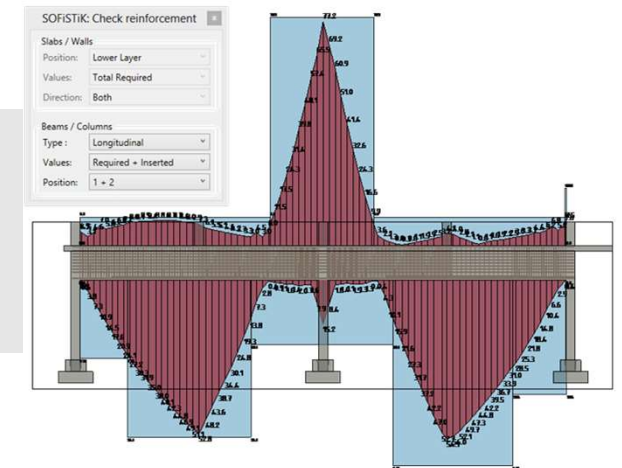- ☑ Delete existing reinforcement

Compatibility with
+ SOFiSTiK Results
+ External results (via Revit Results Package):
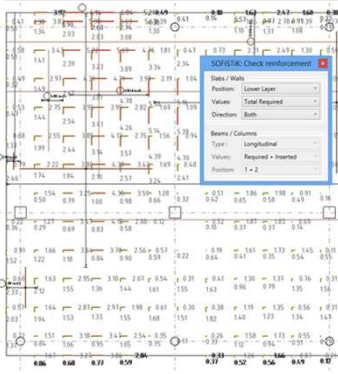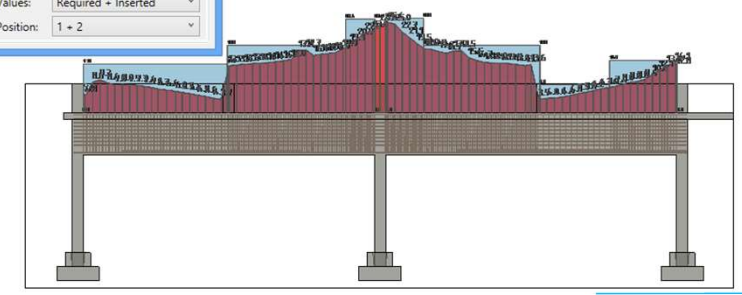 - Robot Structural Analysis
  - Dlubal RFEM
  - …

Verification tools

+ **Control** of provided rebars against required values
+ **Dynamical check** of all rebars (created manually or automatically)
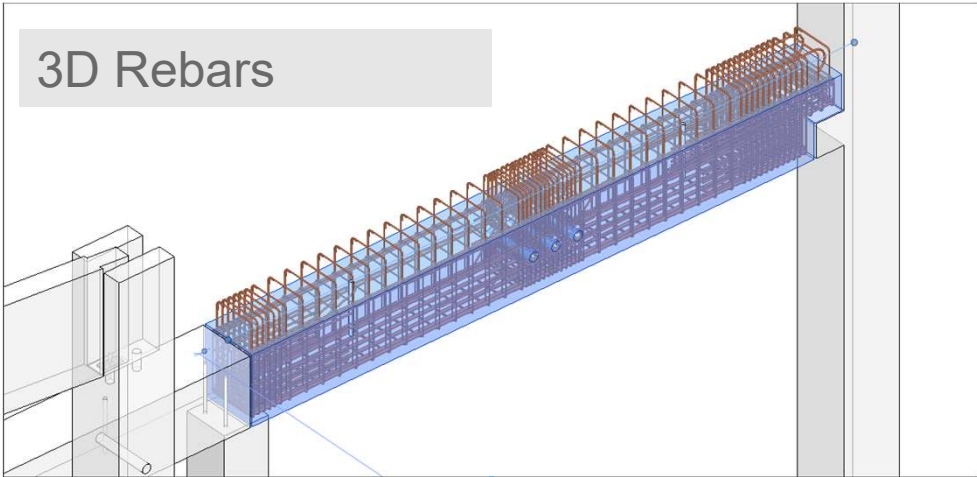
Slabs & Walls

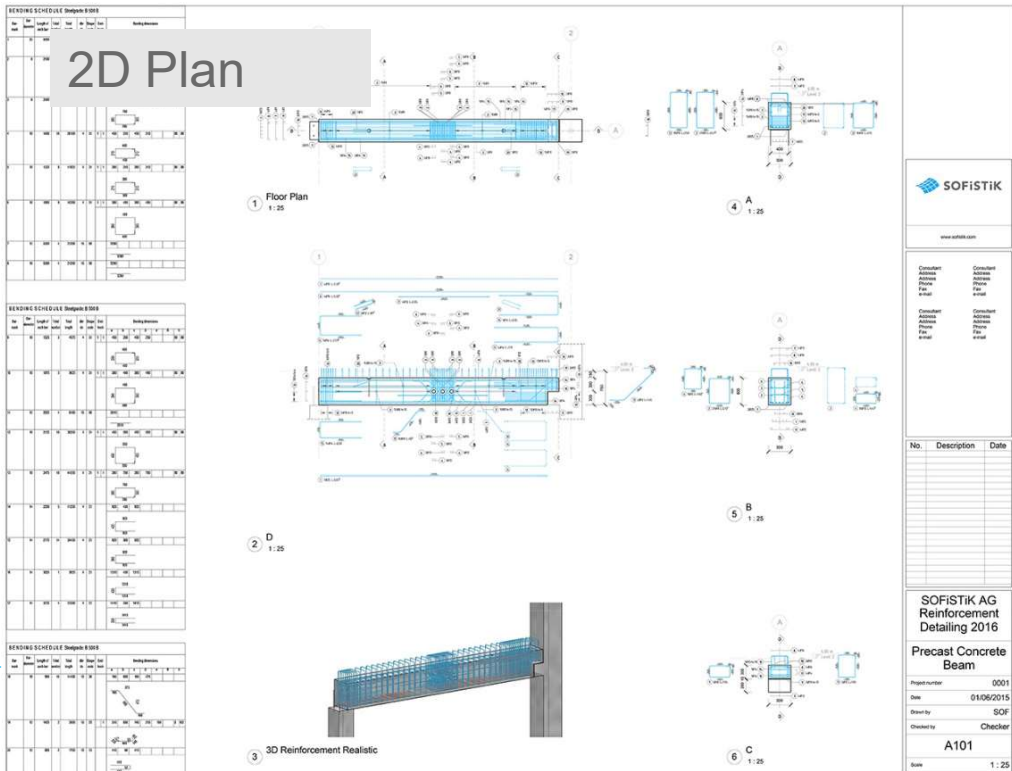Columns & Beams

Reinforcement Detailing

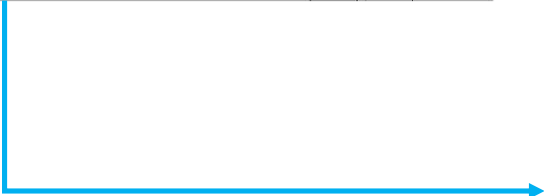Production of 2D rebar plans & schedules/lists from 3D model

Simplified production of rebar drawings in Revit


3D Rebars

2D Plan

Modelling help – Complex geometry

Efficient modeling for bridges and civil engineeringt
+ Interpolation / Extrapolation of rebar geometry. E.g. :
    • Box girder wth variable height
    • Structures with double curves
    • Rotation & Streching of cross-section goemetry
+ Detectinon & Alignement on the geometry of the concrete componant
+ Generation of rebars on surfaces with multiple curvatures
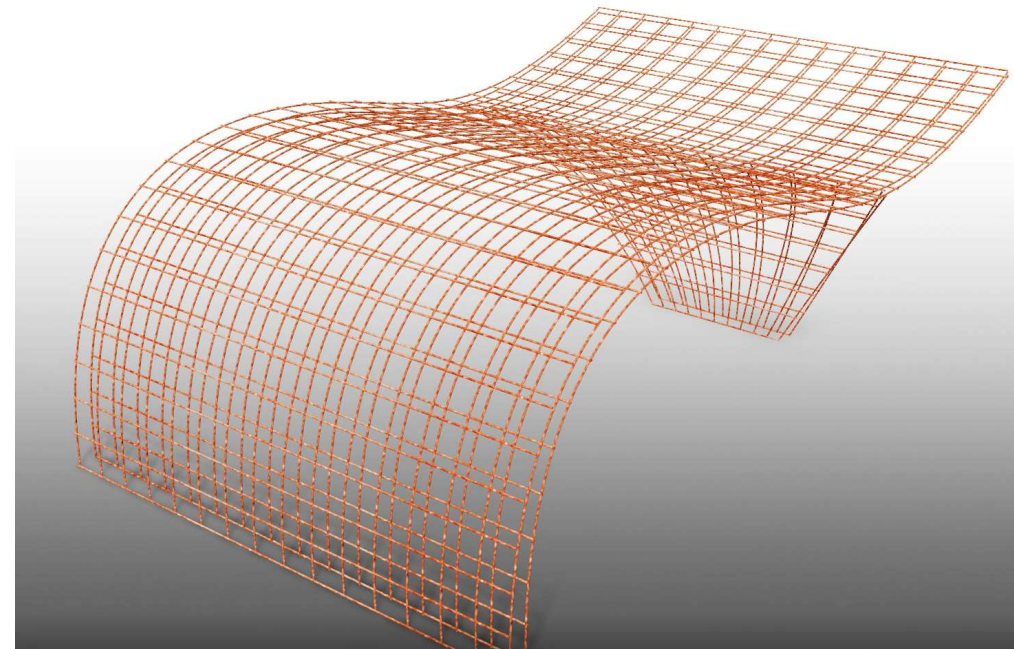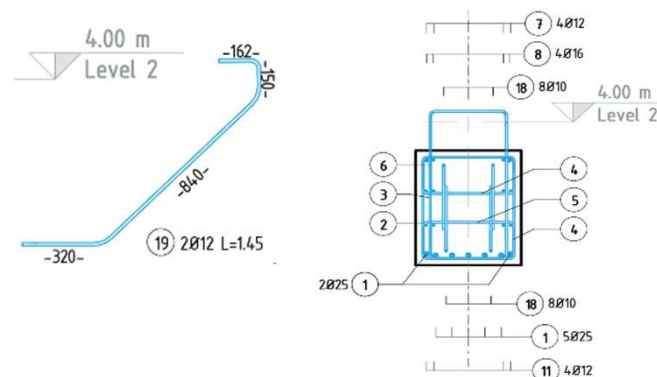
Automatization of rebar drawing
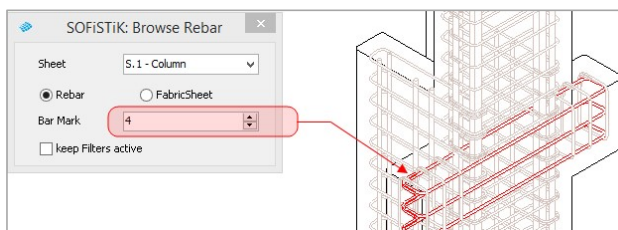
Bar marking & numbering
+ Numbering per:
    + Sheet
    + Project
    + Object
+ Layer detection
+ Copy or freeze rebar information
+ Rebar browsing

Tagging
+ Automatic tagging
+ Distribution of rebar
+ Display of layer / bar end
+ Shape details

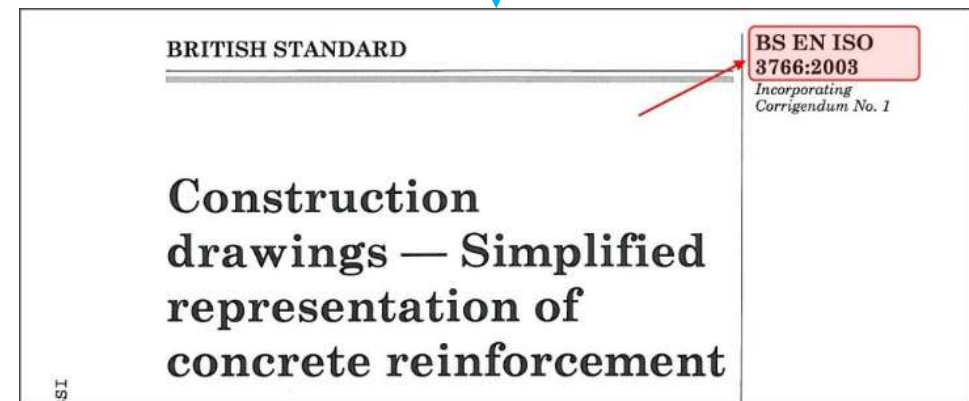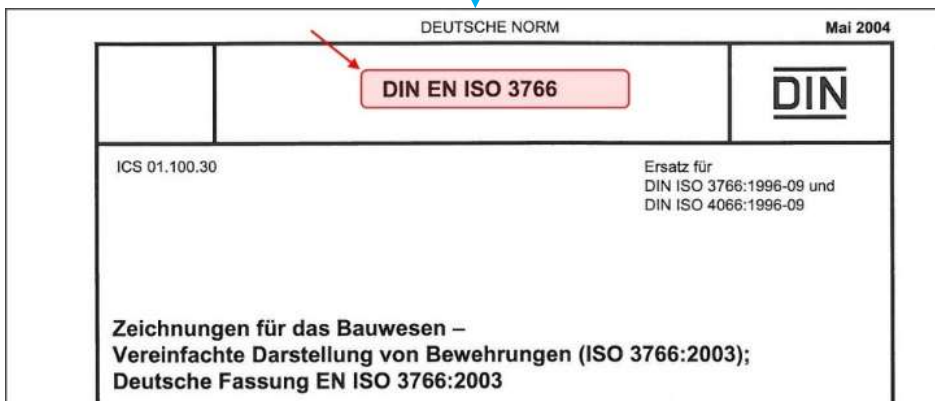**Schedules**
+ On plan
+ External documents (Word file)
    + Standard templates
    + User-template
+ Shape symbols for Revit Schedules
+ Revisions
+ Bending machine file (BVBS)

Personalization / Localization

Different rules of drawing view and symbols.
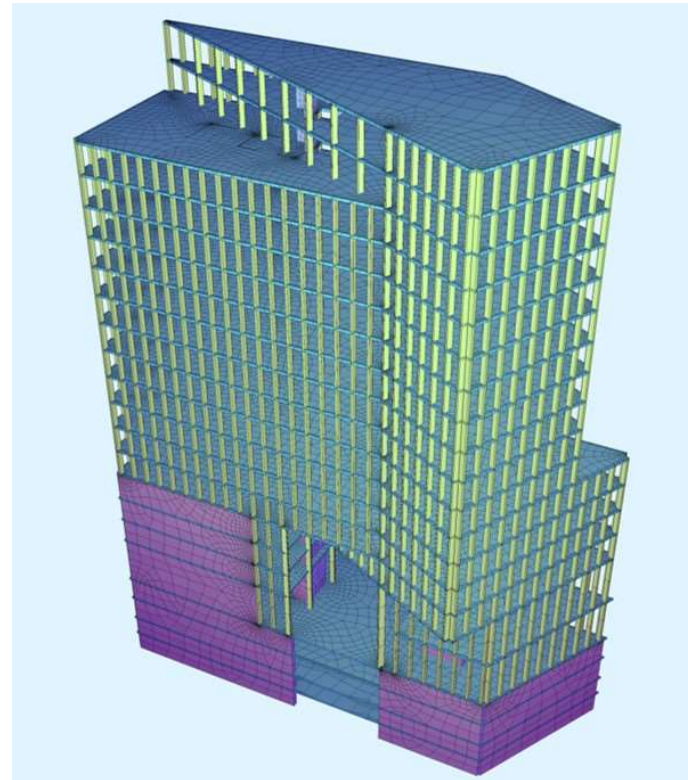(ex.: "EN ISO 3766" vs. "BS 8666")

Content Pack based on Revit families
↓
Arbitrary personalisation possible (company standards/ project specifications)
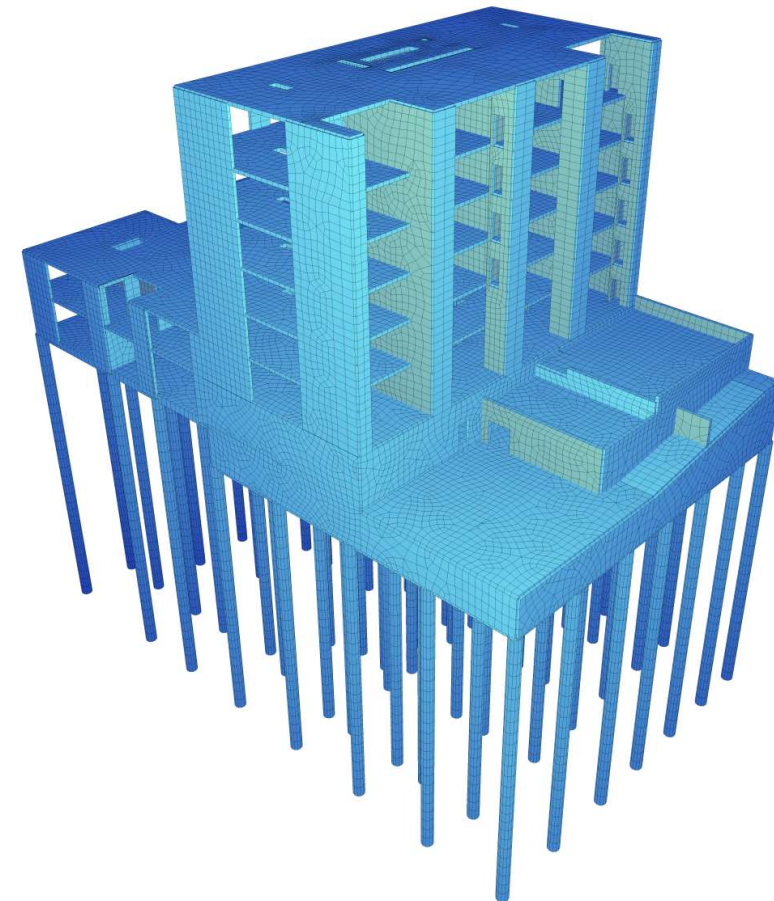
References
Building

Examples FEA – Building Construction

Mediacomplex / Barcelona
Architecture: CARLOS FERRATER
Engineering: Pondio ingenieros

Examples FEA – Building Construction

Think K Stuttgart Killesberg
Engineering: WSP CBP Tragwerksplanungs GmBH
Architects: CAP Architects, Baumschlager
& Eberle und David Chipperfield Architects
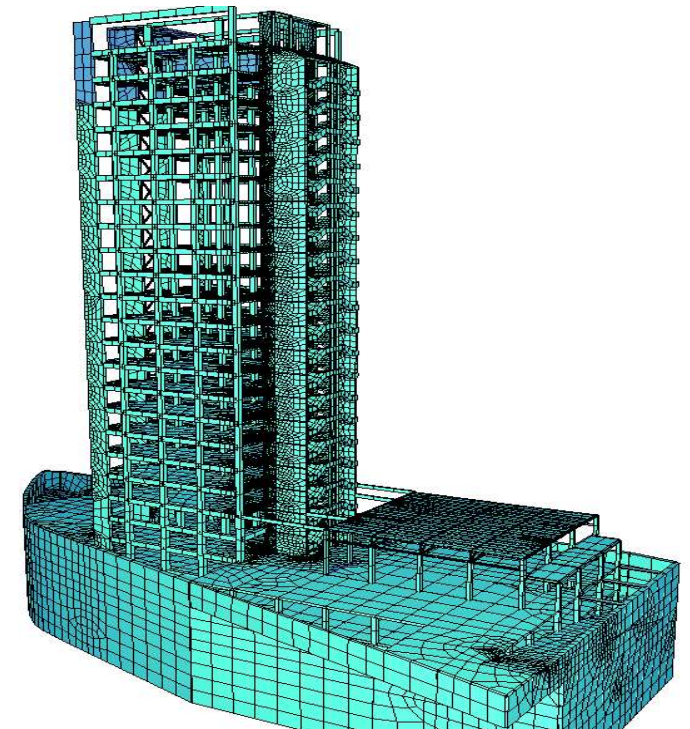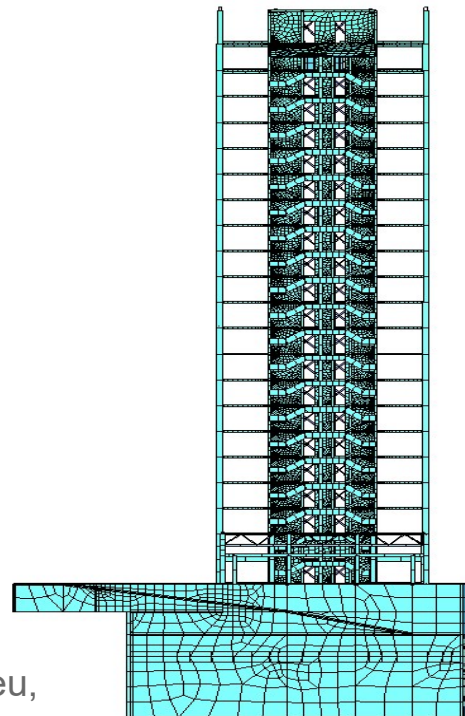
Examples FEA – Building Construction

Hospes Huerto del Emir Hotel, Murcia
Client: FCC
Architects: Francisco Lorente, Rafael Masaveu,
Mariano Sánchez, José Luis Cano Clares
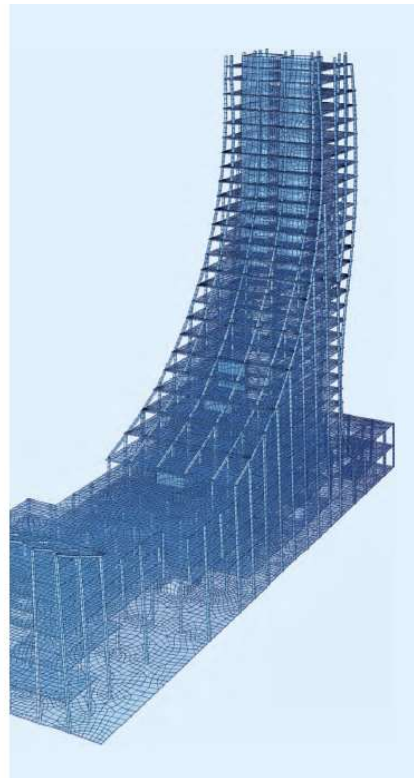**Structural design:** Calter Ingeniería, Madrid

References
BIM

Examples BIM

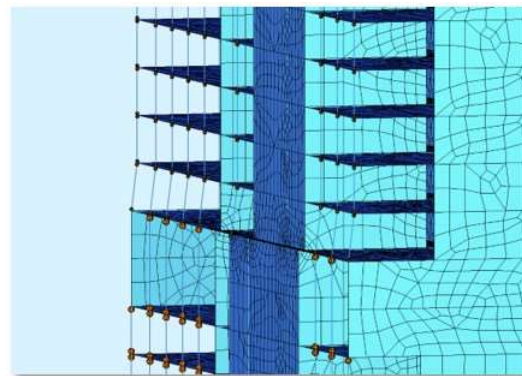**New construction 5* and 6***
Lusail Katara Hotel, Doha (Katar)
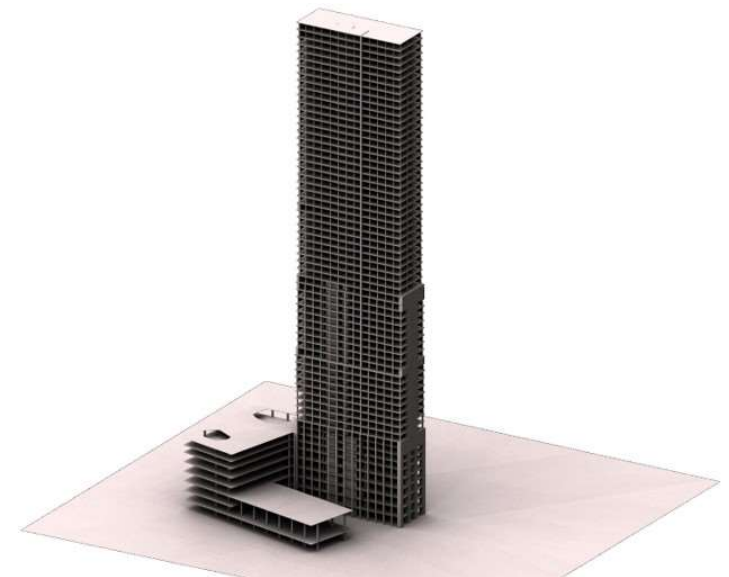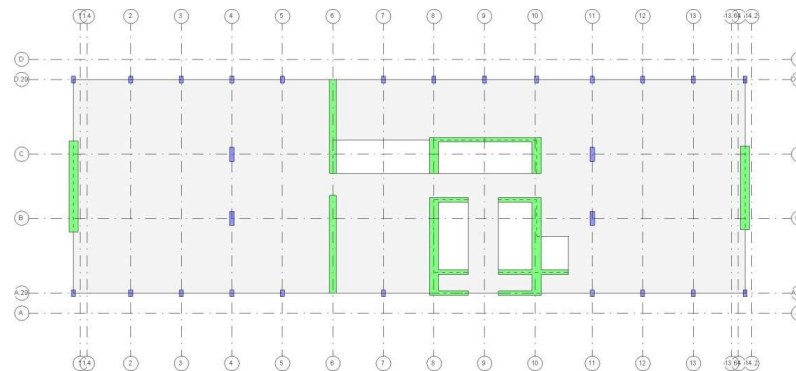**Client:** Katara Hospitality, Doha (Katar)
Engineering: Kling Consult Planungs- und Ingenieurgesellschaft für Bauwesen
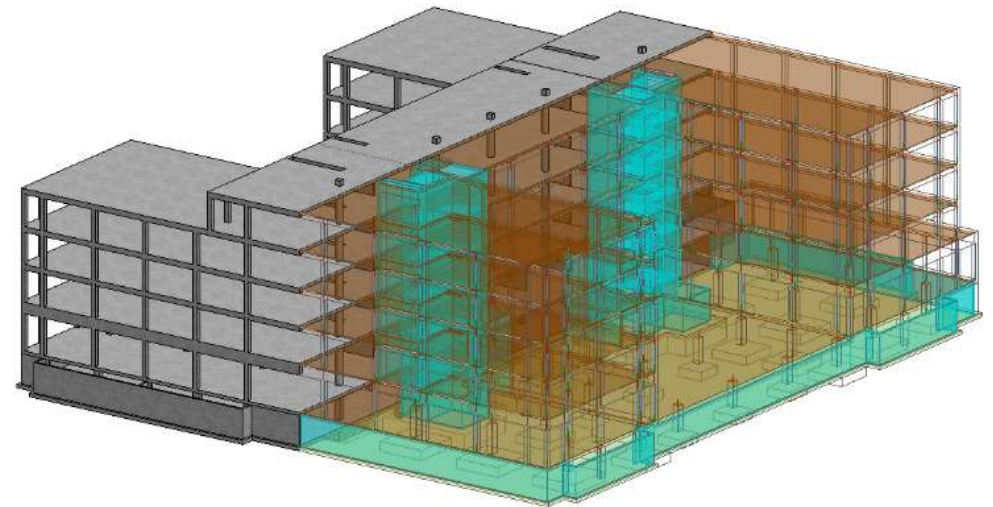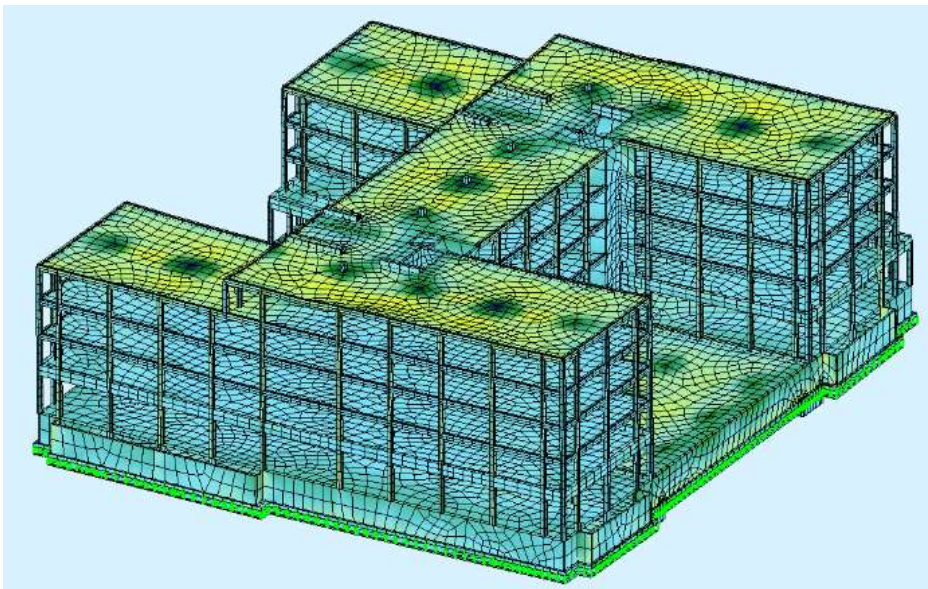**Software:** Autodesk Revit Structure, SOFiSTiK FEM Software

Examples BIM

Kempinski Jeddah – Saudi Arabien
**Engineering:** Boll und Partner, Ingenieurbüro für Tragwerks- und Objektplanung

Examples BIM

Multi-purpose complex building
Engineering: Ingenieurbüro Müller Marl GmbH
Software: Autodesk Revit Structure + SOFiSTiK FEM Software

Examples BIM

Highway Bridge
Engineering: Obermeyer Planen + Beraten GmbH
Software: Autodesk Revit Structure + SOFiSTiK FEM Software

Examples BIM
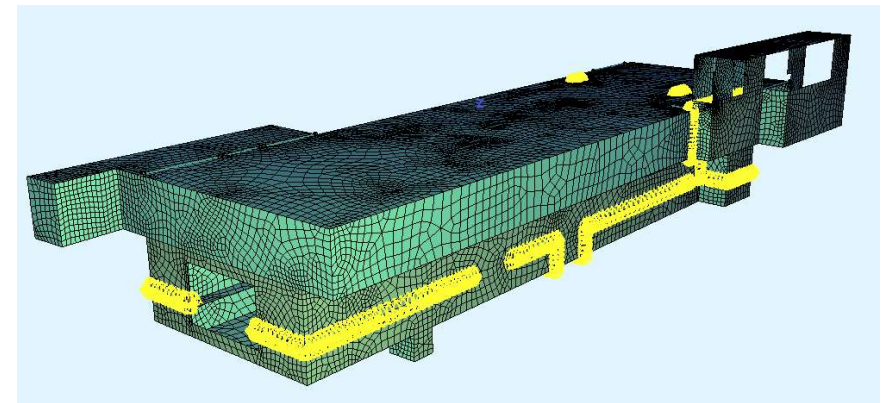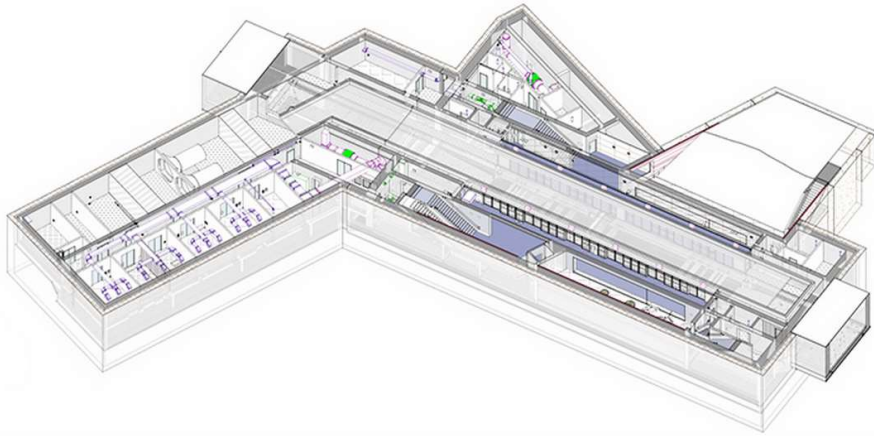
Undergroud stations Rennes, France
Engineering: Groupe Legendre-Ingénova
Software: Autodesk Revit Structure + SOFiSTiK FEM Software