



ES9599

Involve Analysis from Predesign Through to Documentation Phase in Your BIM Process

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 [@BIM4Struc](https://twitter.com/BIM4Struc)

Class summary

In this session you will learn how to perform early-stage analysis on your structural models in Revit in order to define the right foundation design. You will discover how to detect structural problems in your predesign stage of your Building Information Modelling (BIM) process using cloud analysis in Revit with the Structural Analysis toolkit. Finally, we will evaluate the predesign decisions with comprehensive detailed analysis of your structural model in Robot Structural Analysis.

Key learning objectives

At the end of this class, you will understand how:

- to perform load takedown with Gravity Analysis for Revit
- to analyse your Revit model in the cloud to evaluate early stage design
- to build up detailed structural analysis models with Revit and RSA
- structural analysis can be introduced earlier in your BIM workflow

About me

- Technical Specialist Structural Solutions @ Autodesk
- Working for EMEA NE region
- Structural Engineer based in Belgium
- +15 years experience in structural engineering
- “Revit Beyond BIM” & “BIM Toolbox”



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www.linkedin.com/in/dietervermeulen



www.youtube.com/user/RevitbeyondBIM



www.revitbeyondbim.wordpress.com



www.autodesk.typepad.com/bimtoolbox/

Target Persona



Structural Designer

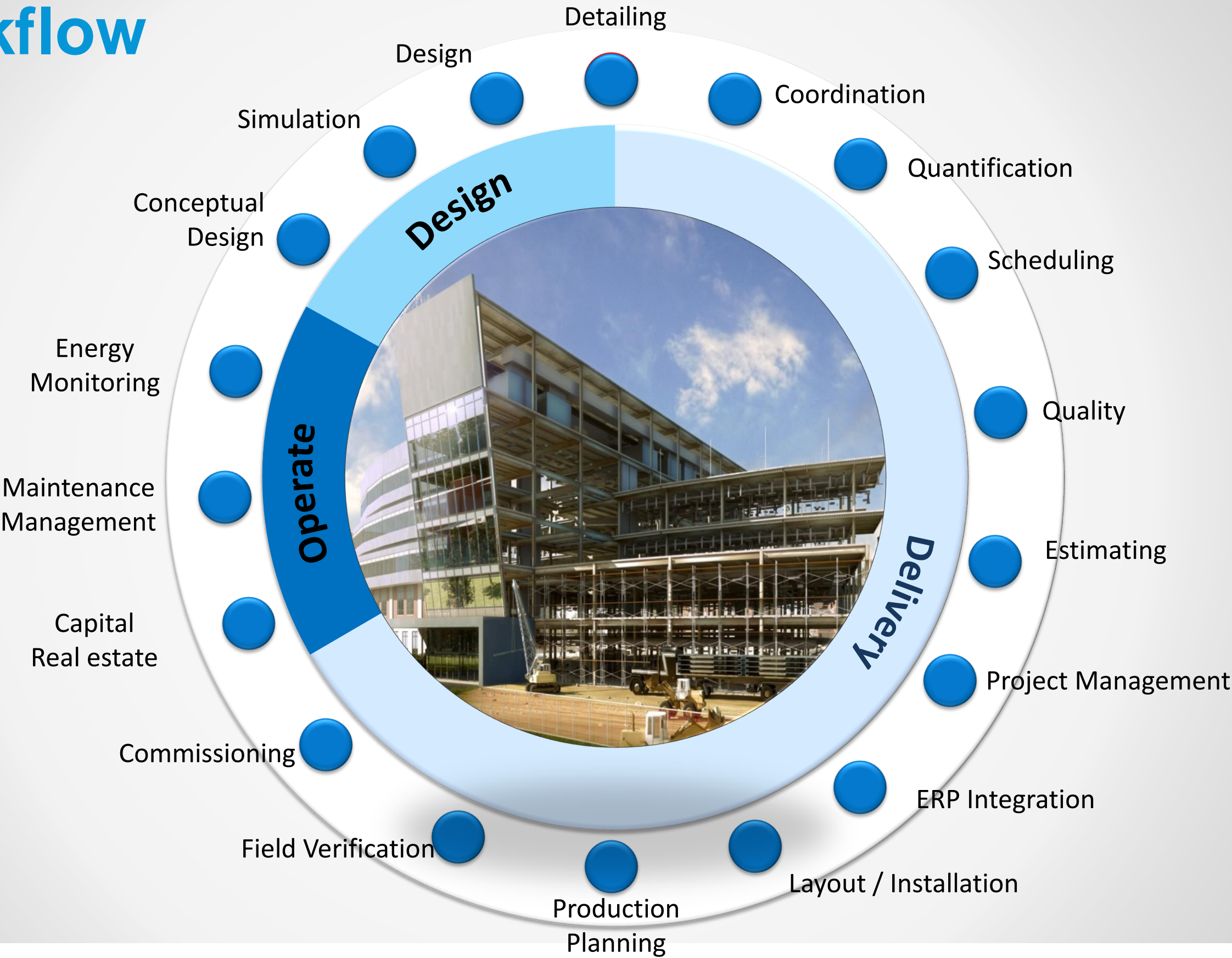
- Creates structural model based on architectural intent
- Creates the physical and the analytical models
- Works closely with structural engineering team



Structural Engineer

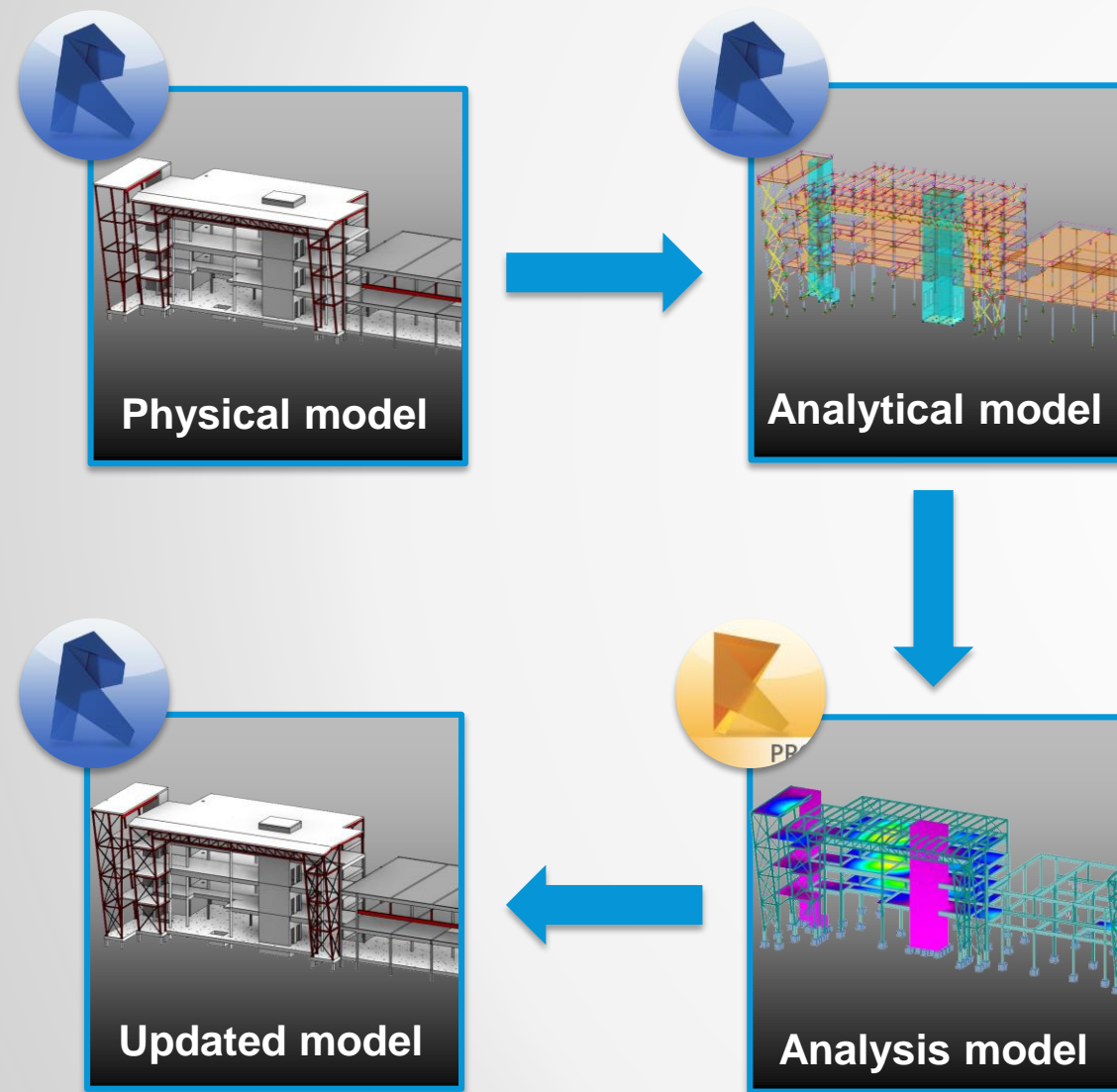
- Reviews structural (analytical) models provided by designers
- Performs structural analysis in the early stages of design processes
- Takes structural model for comprehensive analysis and code-checking

BIM Workflow



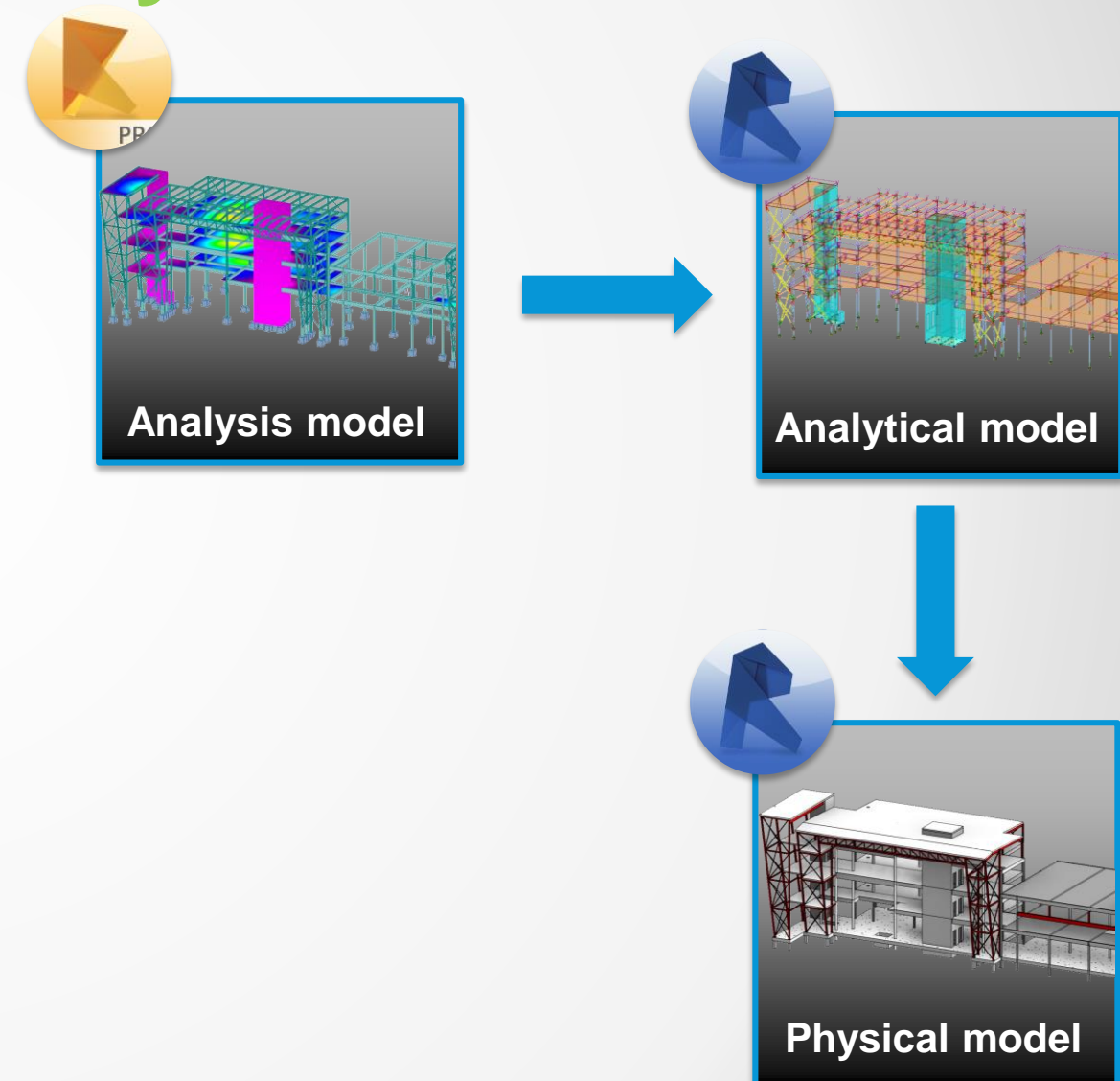
Structural Engineering Workflows

Design Focused Workflow



Revit ⇒ RSA ⇒ Revit

Analysis Focused Workflow



RSA ⇒ Revit

Structural Engineering Workflows

Design Focused Workflow

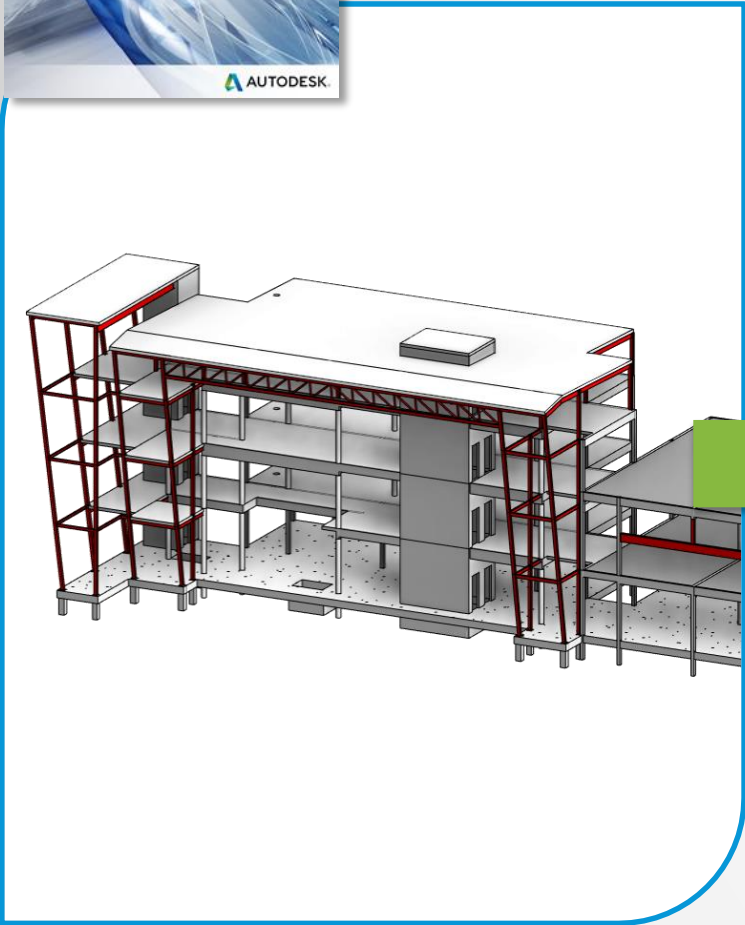
- Initial model by designer
- Reduce modelling costs
- Use BIM Protocol
- Engineer reviews analytical model
- Gravity analysis on the BIM model !
- Digital communication of changes

Analysis Focused Workflow

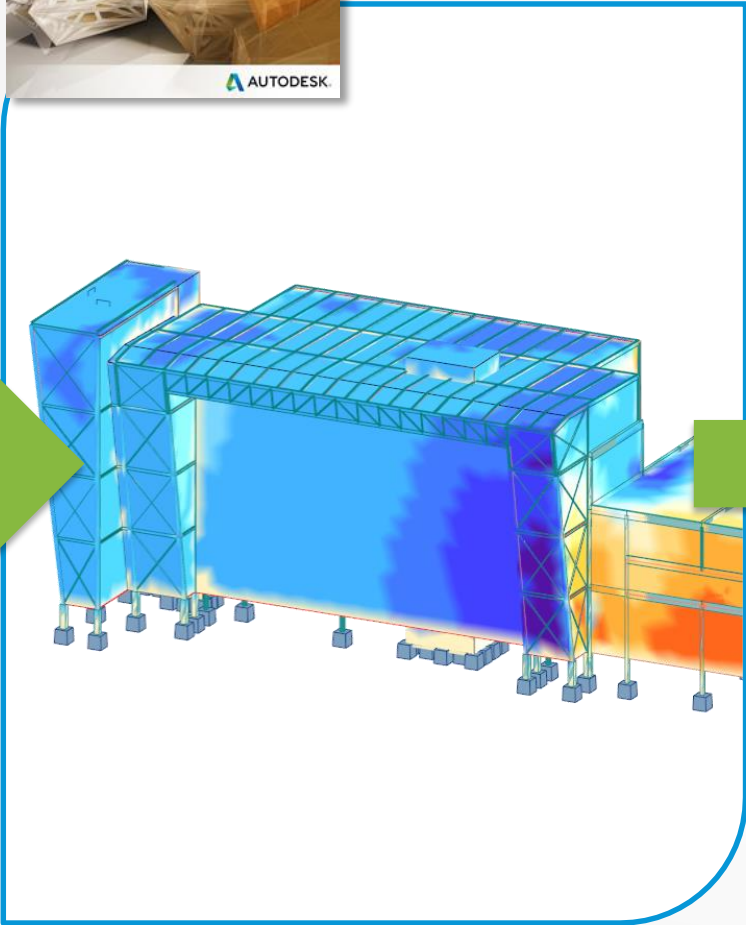
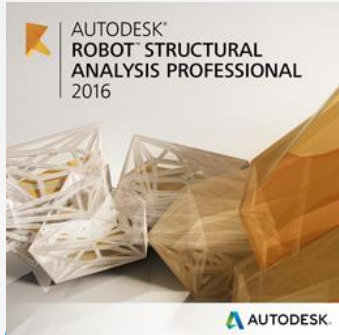
- Initial model by engineer
- Risk on simplified models
- Non-integrated design with architect
- Send model to designer
- Digital communication of changes

Design Focused Workflow

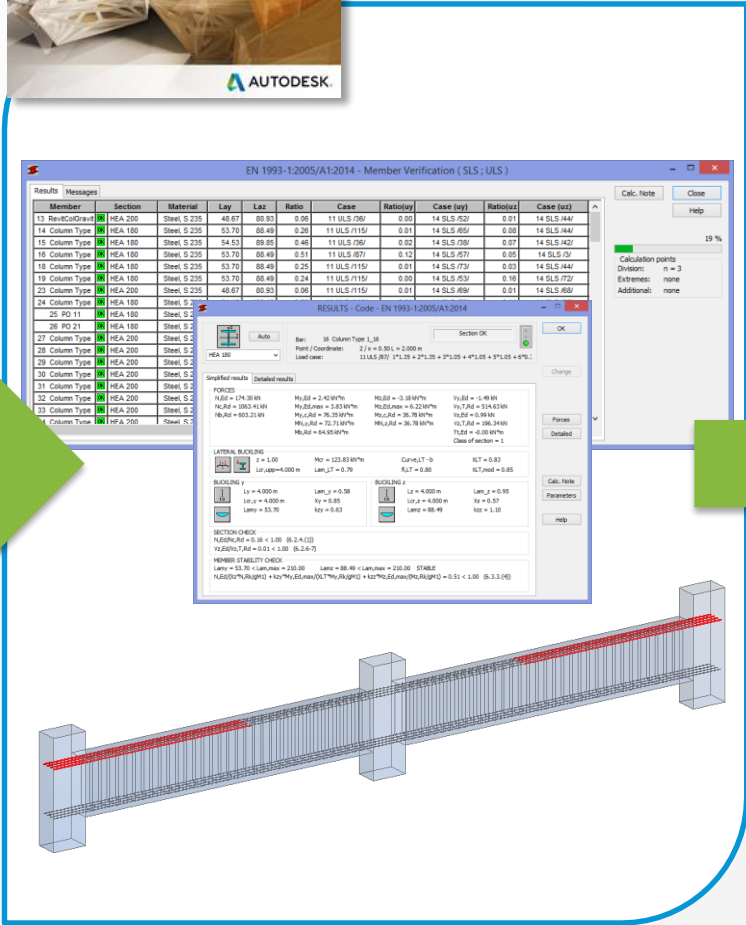
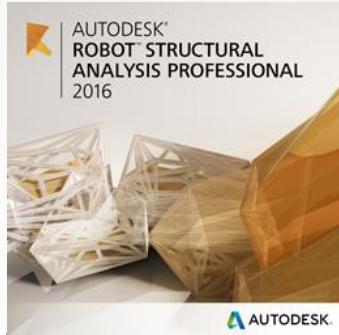
Design Focused Workflow



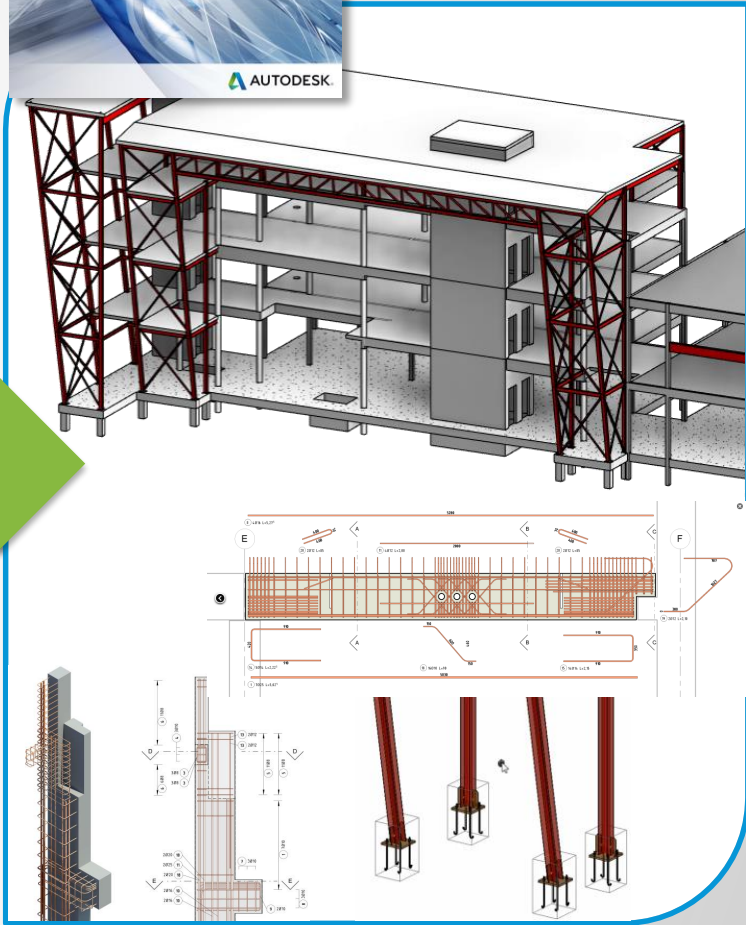
Structural Modelling



Structural Analysis



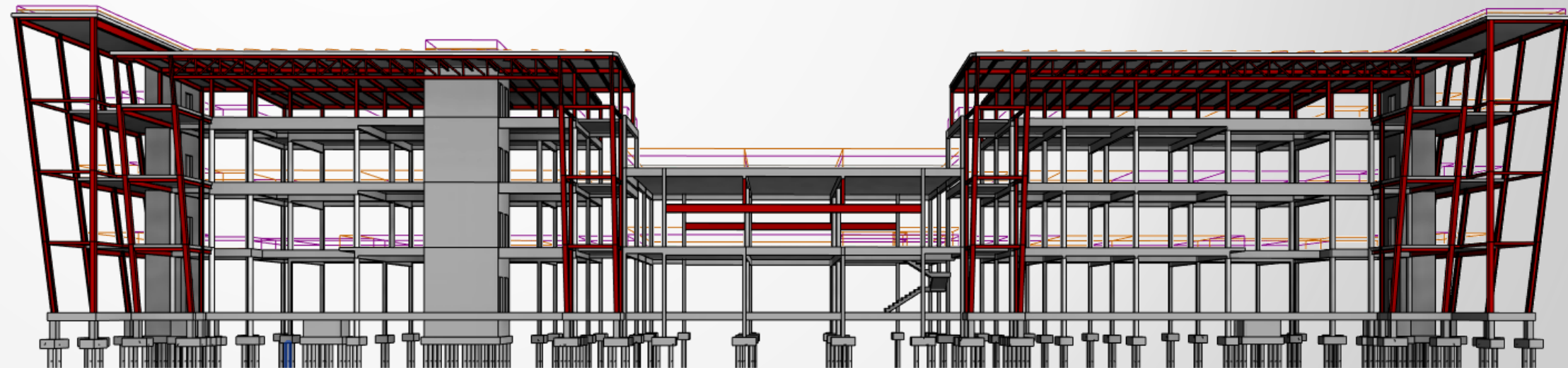
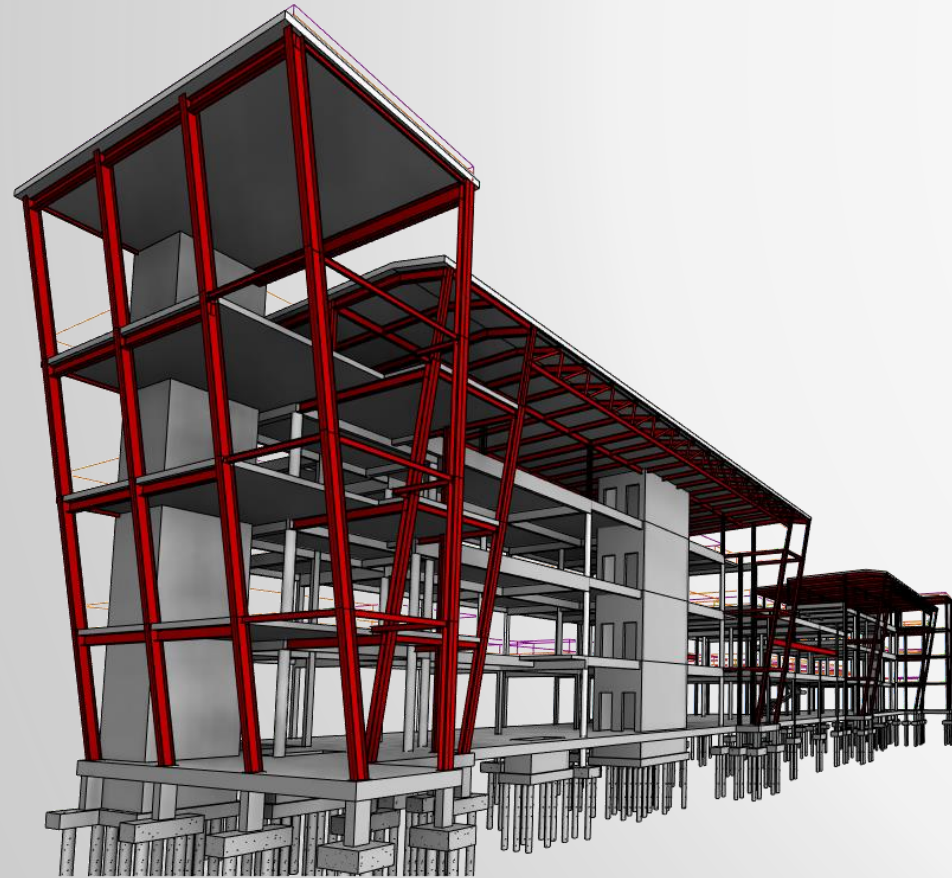
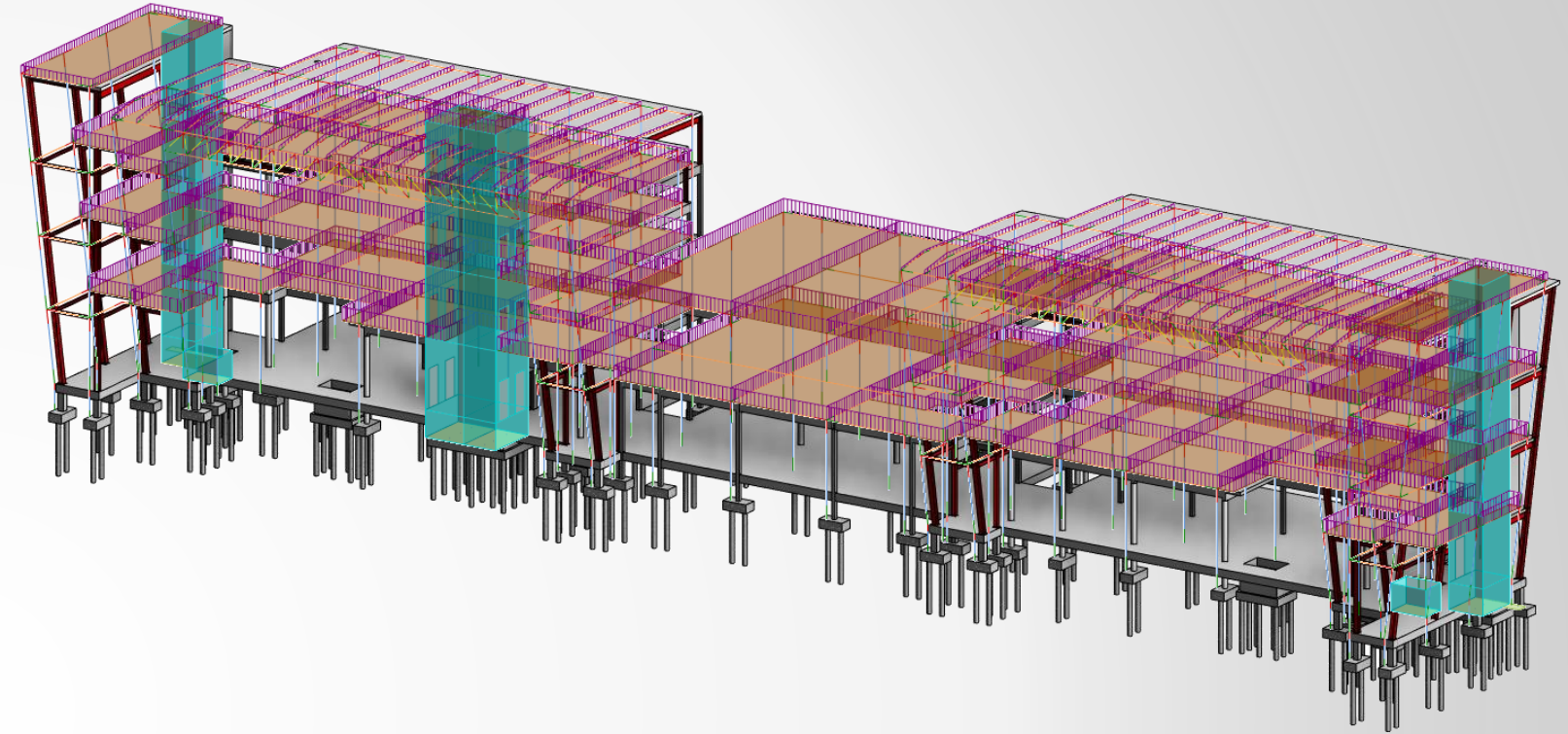
Code Check Design



Updated model & Detailing

Setting up the analytical model

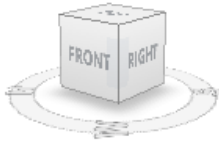
- Physical and analytical model in Revit
- Built up simultaneously
- Separate behaviour
- Analytical model used for analysis

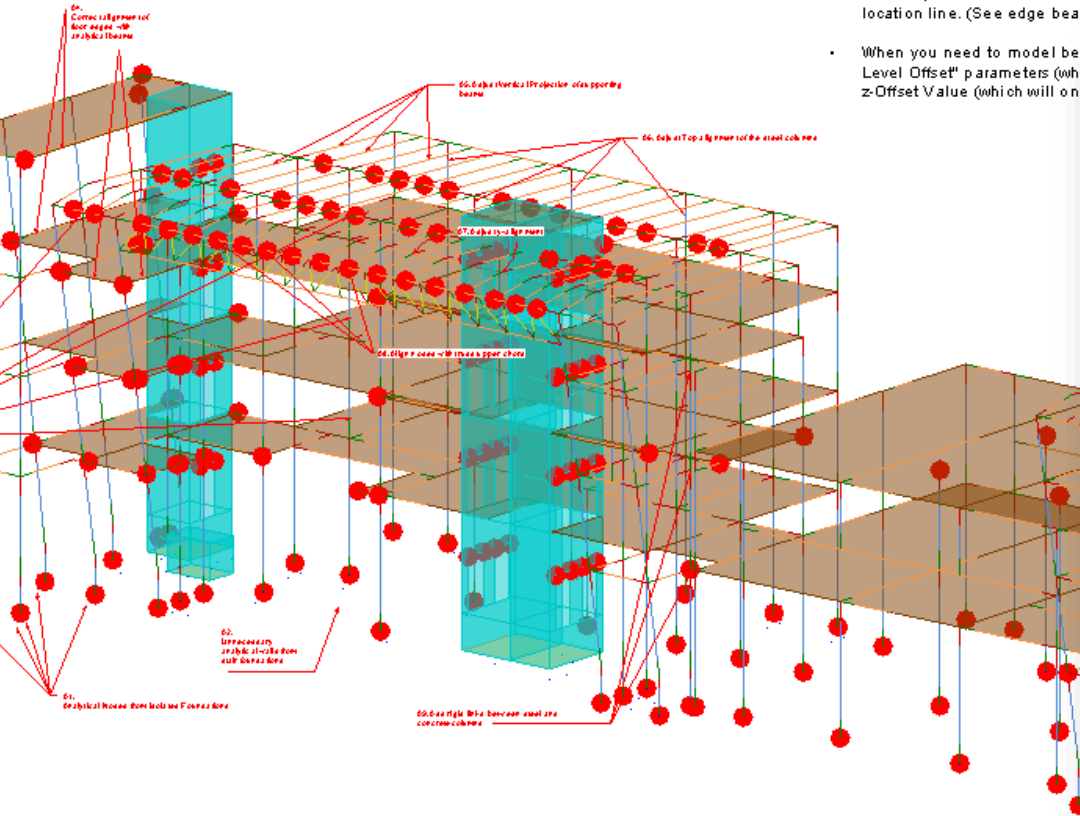


Setting up the analytical model

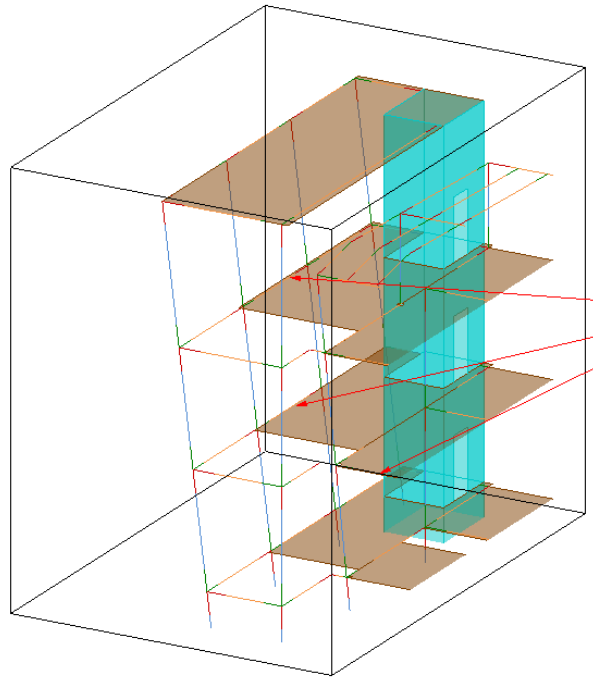
ADDITIONAL NOTES:

- The RED visible nodes represent the "Unconnected" state nodes. (View Filters are used for this representation). The ones at the corners of Floors and Slabs can be ignored if applicable.
- The unconnected nodes at the bottom of the columns are caused by lack of supporting boundary conditions. This will be done in the analysis software.
- When creating floors, use "Pick supports" method and Switch Join Order to obtain best result for analytical model alignment with the beams.
- Large horizontal displacements of beams should be done using the y-offset value, while the location line keeps the center to center of the columns. Then the AM can be set as to be positioned on the location line. (See edge beams at Level 1S of entrance building).
- When you need to model beam Level Offset" parameters (which will only





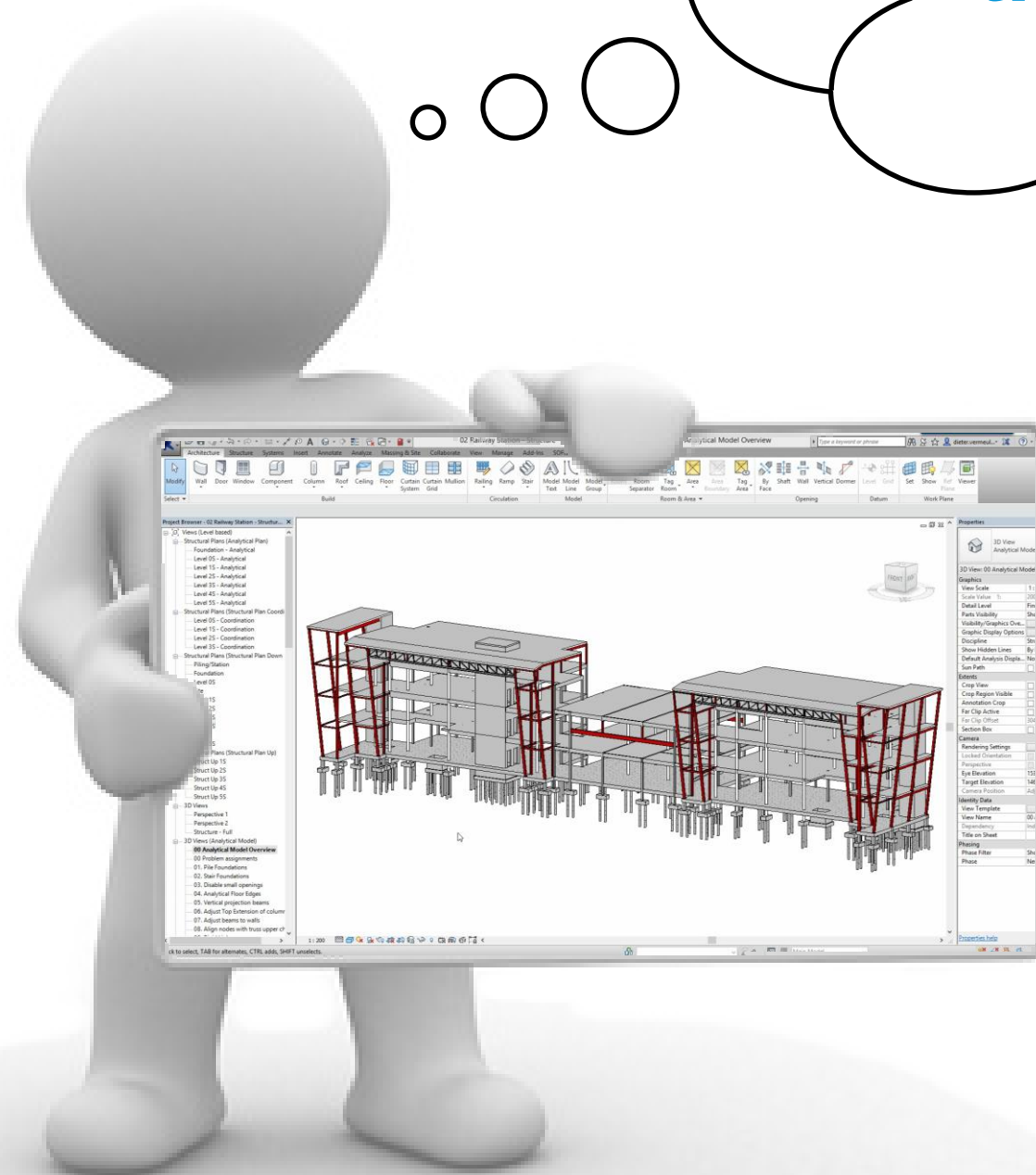
03. Correct alignment of floor edges with analytical beams



Analytical Floor edges need correction to avoid unexpected and unwanted behavior in simulation model due to overhanging floors effect.

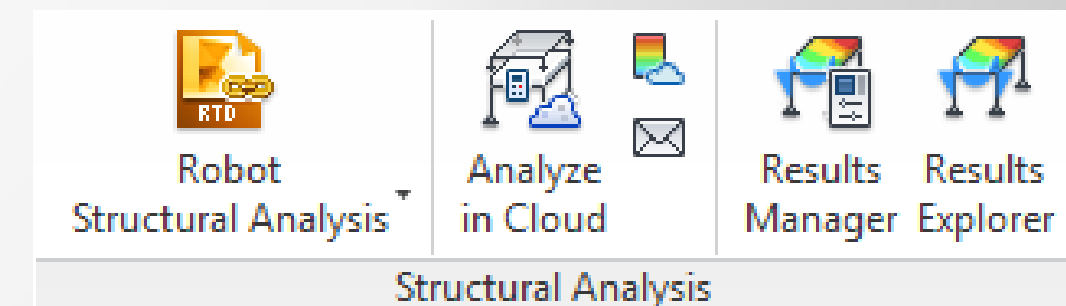
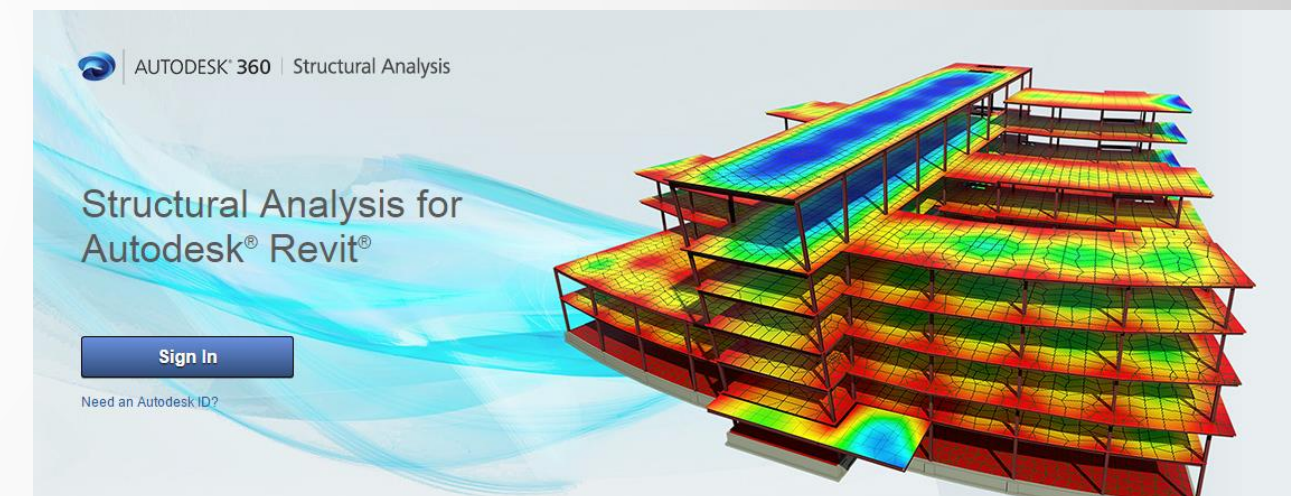
This can be achieved by using the "Align" command and select the analytical supporting beam as reference, then the analytical floor edge.

How do I handle
the analytical
model ?

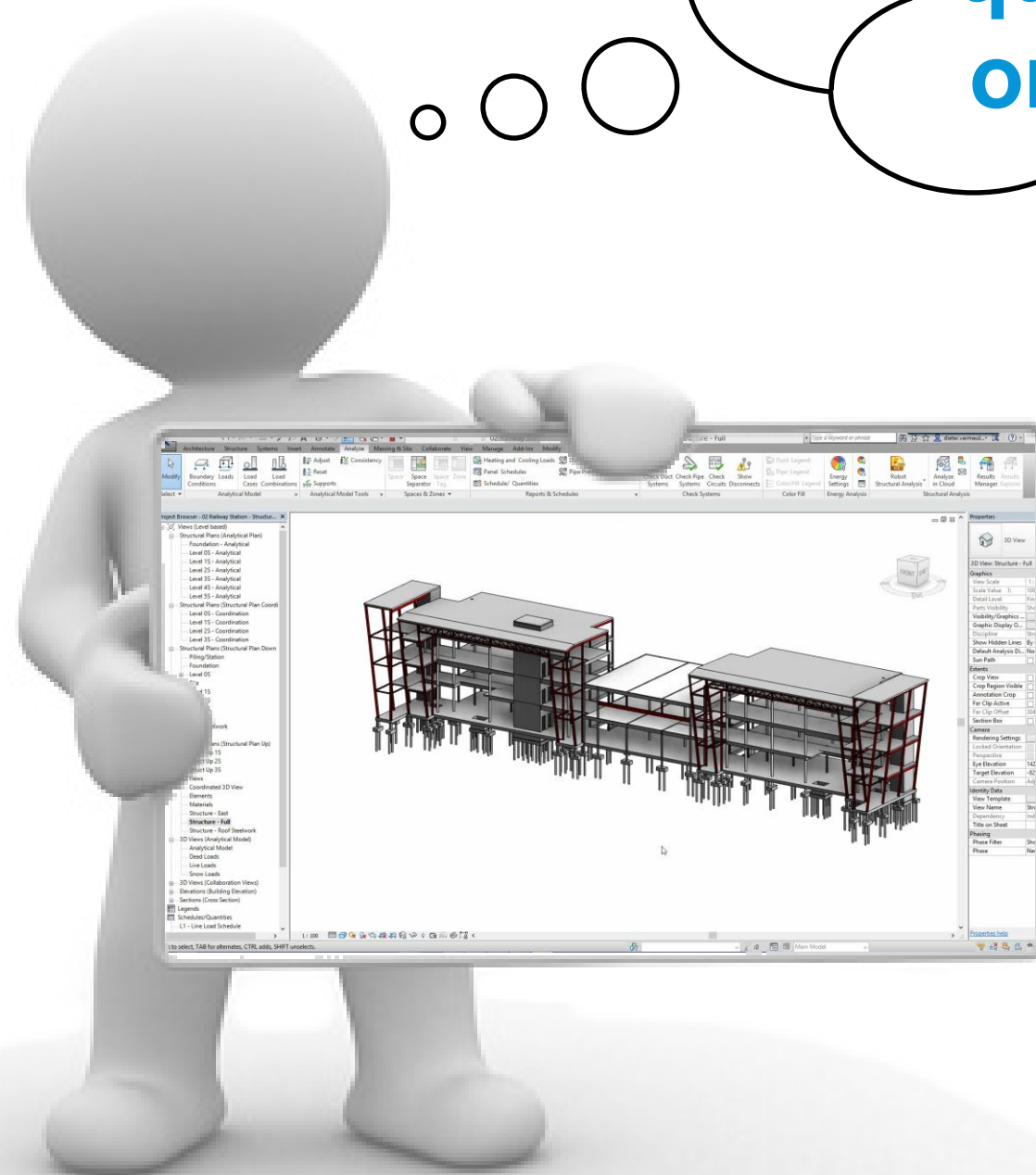


Early Stage Analysis and Design

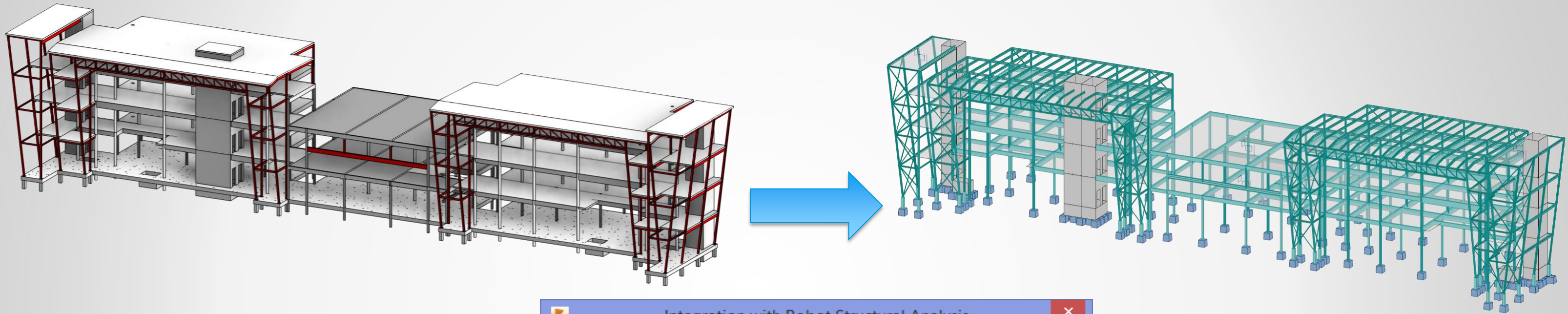
- Autodesk 360 Structural Analysis service
- Gravity and Static Analysis in the cloud
- RSA as calculation engine
- Result Packages in Revit
- Available on [Autodesk Exchange](#)



Let's make a
quick analysis
on this model



Exchange of analytical data from Revit to RSA



Integration with Robot Structural Analysis

Direction of integration with Autodesk Robot Structural Analysis

☒ Send model
☐ Update model
☐ Update model and results

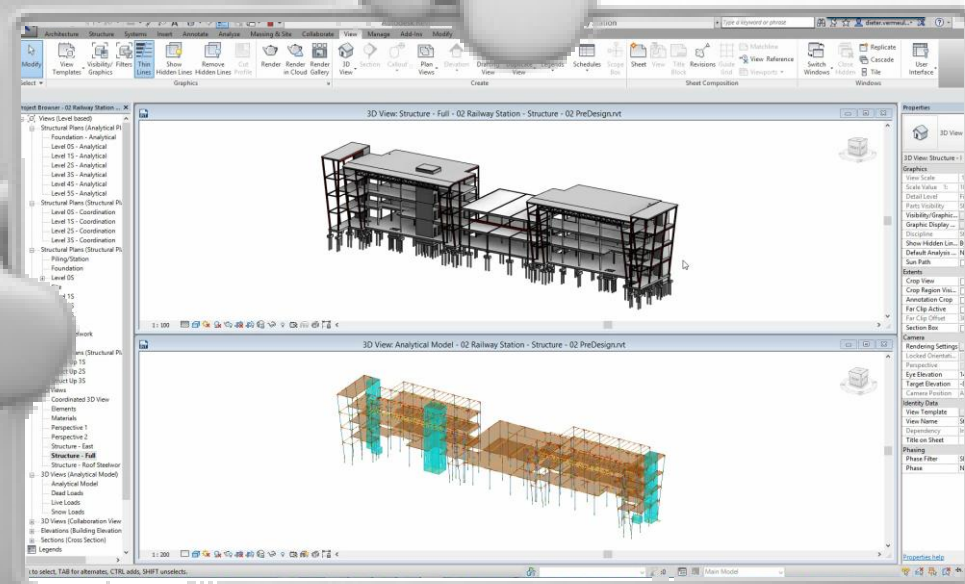
Type of integration

☒ Direct integration
☐ Send to the intermediate file (.smox)

Send options

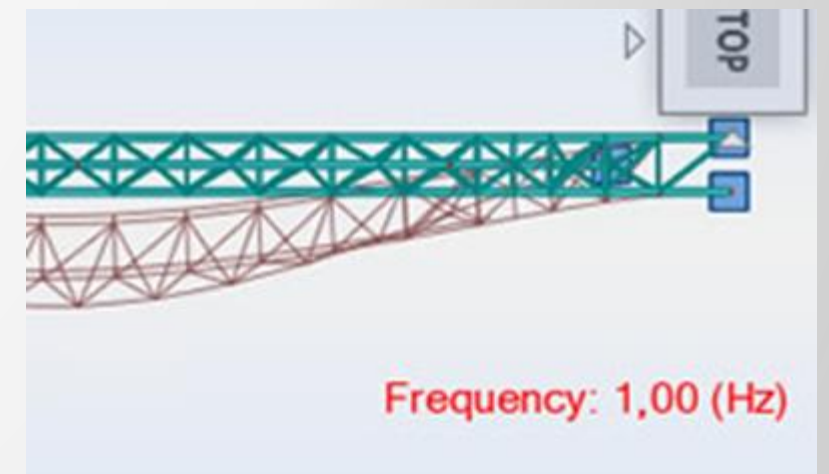
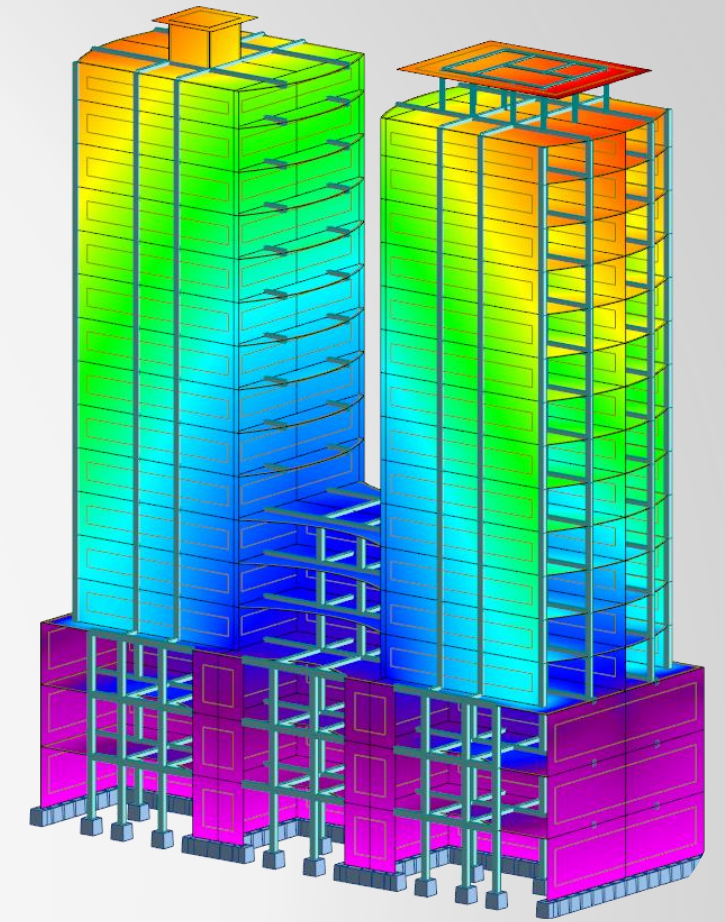
[Help](#) OK Cancel

I want this Revit
model in RSA

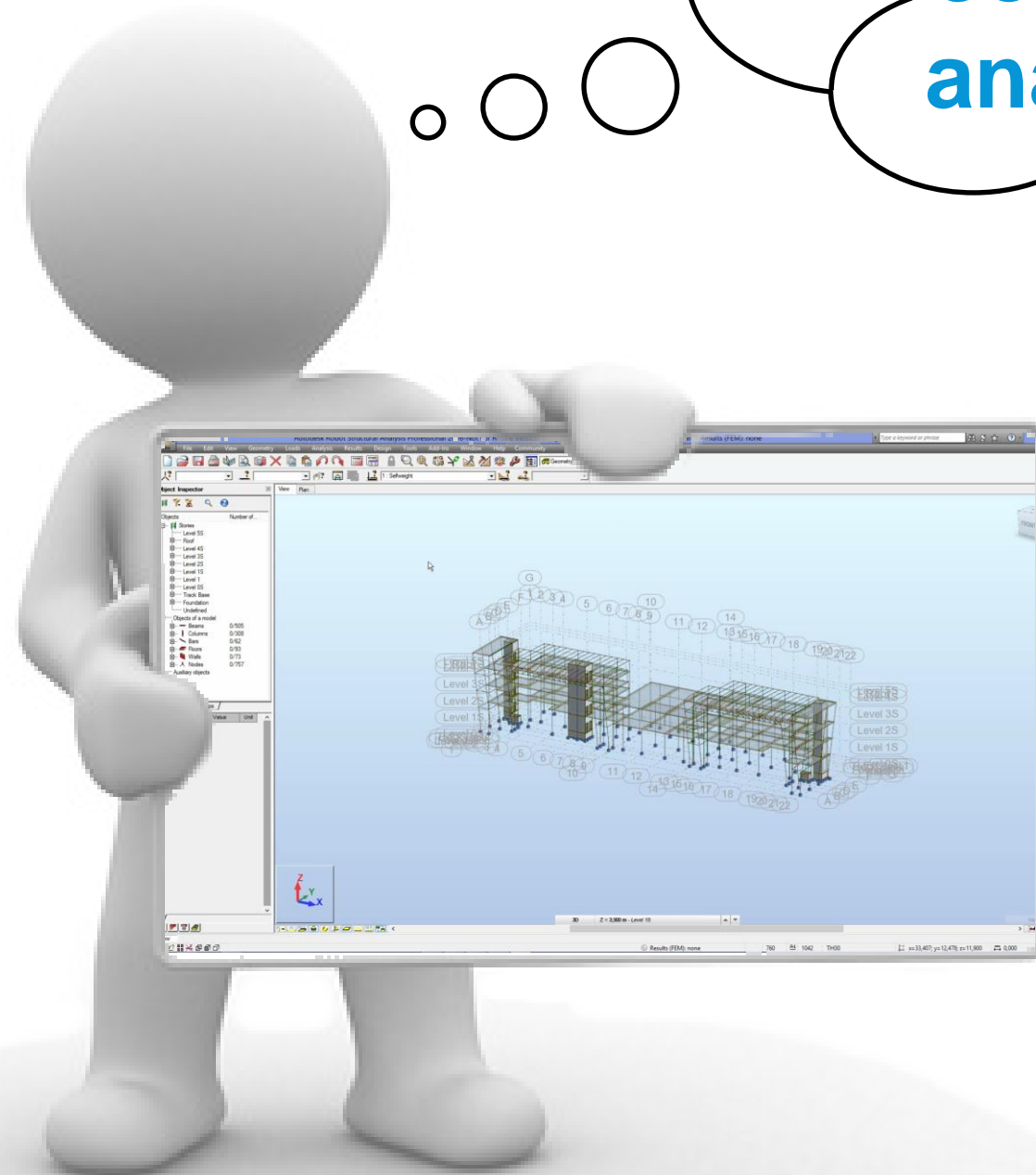


Comprehensive analysis with RSA

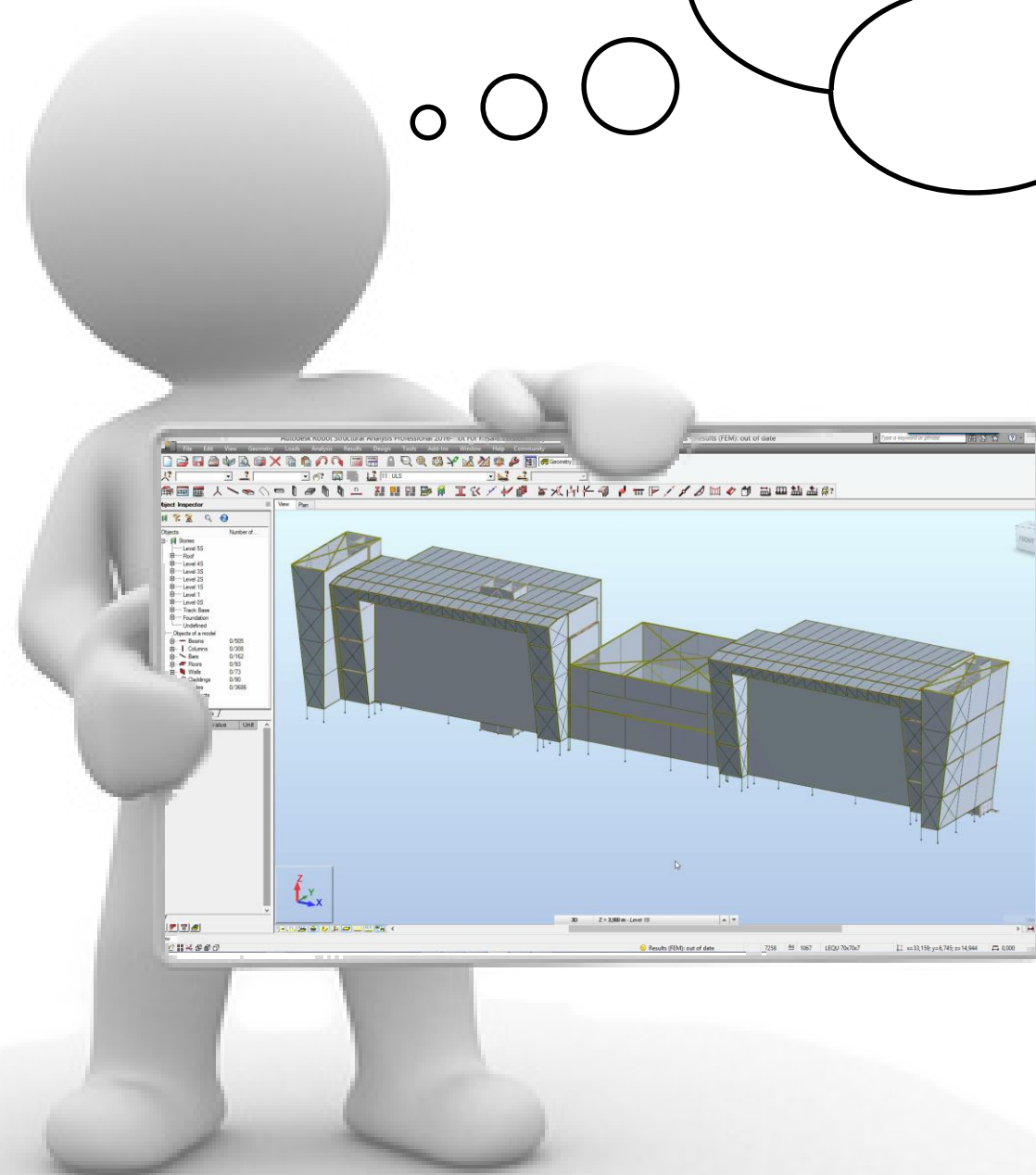
- Create an analytical model of a structure
 - Either from scratch, or by inputting structural elements from other models
 - Defines loads and load cases
 - Made of Beams and Shells, not solids
- Calculate forces, displacements, etc within the structure
- Validate those results against local codes
- Size and details structural elements
- Advanced non-linear and dynamic analysis modal, harmonic, seismic, FRF, footfall, ...



**Now do some
comprehensive
analysis in RSA**



**We need to
check the
results!**



Analyze Results in Excel

Read results from RSA into your custom Excel workbook

FILE

HOME

INSERT

PAGE LAYOUT

FORMULAS

DATA

REVIEW

VIEW

RESULTS CONNECT

fx

Formula wizard

Robot Structural Analysis

All

Bar forces - values

Formula definition

fx

Insert selected formula

fx

Modify formula

fx

Calculate all

fx

Calculate selection

fx

Units

?

Help

i

About

About

D5

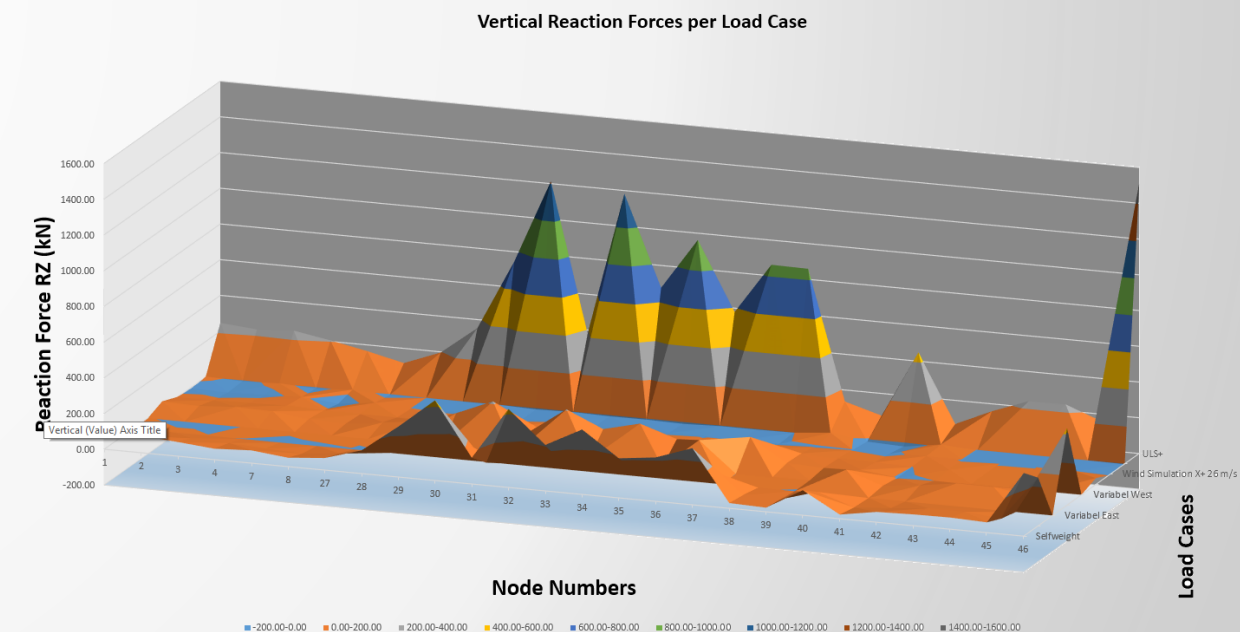
fx

=RSA_SUPPORT_REACTION("FZ",\$A5,D\$3,1)

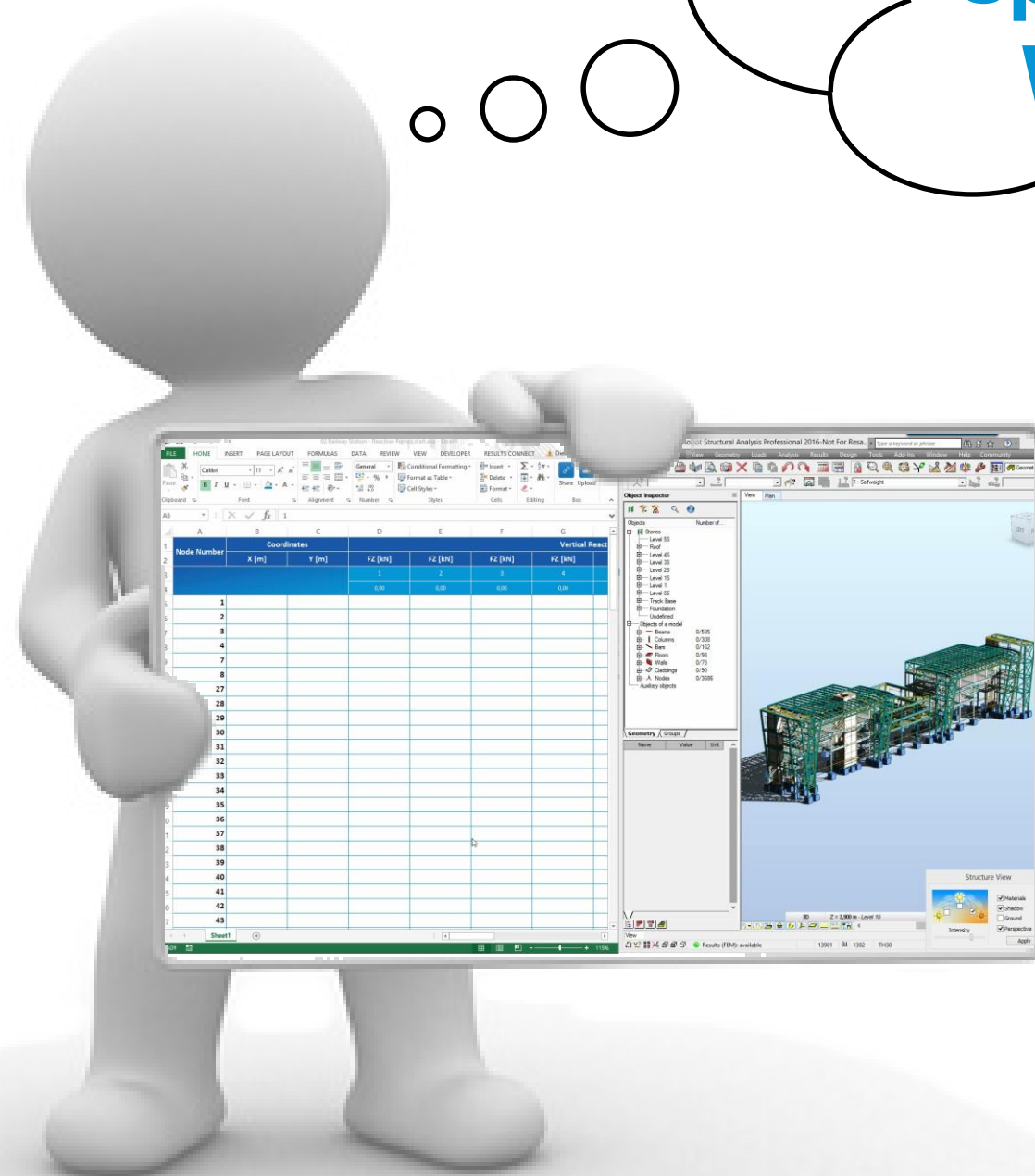
	A	B	C	D	E	F	G
1	Node Number	Coordinates		Vertical R			
2		X [m]	Y [m]	FZ [kN]	FZ [kN]	FZ [kN]	FZ [kN]
3				1	2	3	4
4				Selfweight	Permanent	Variabel East	Variabel Center
5	1	2.099	8.352	95.68	41.24	-0.08	0.09
6	2	2.099	4.176	94.81	37.39	0.24	-0.30

Install > Configure Installation

- ☒ **Autodesk® Robot™ Structural Analysis Professional**
Use advanced structural analysis tools to investigate linear and nonlinear behavior in large, complex structures.
- ☒ **Results Connect**
Use this MS Excel add-in to access data and results from an RSA model, and also to create custom calculations easily.



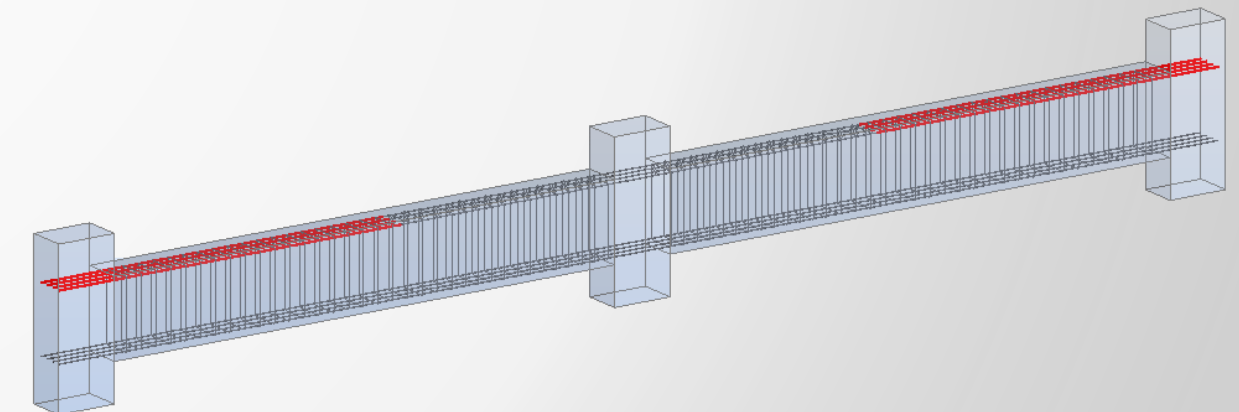
**I still use Excel
spreadsheets.
What now?**



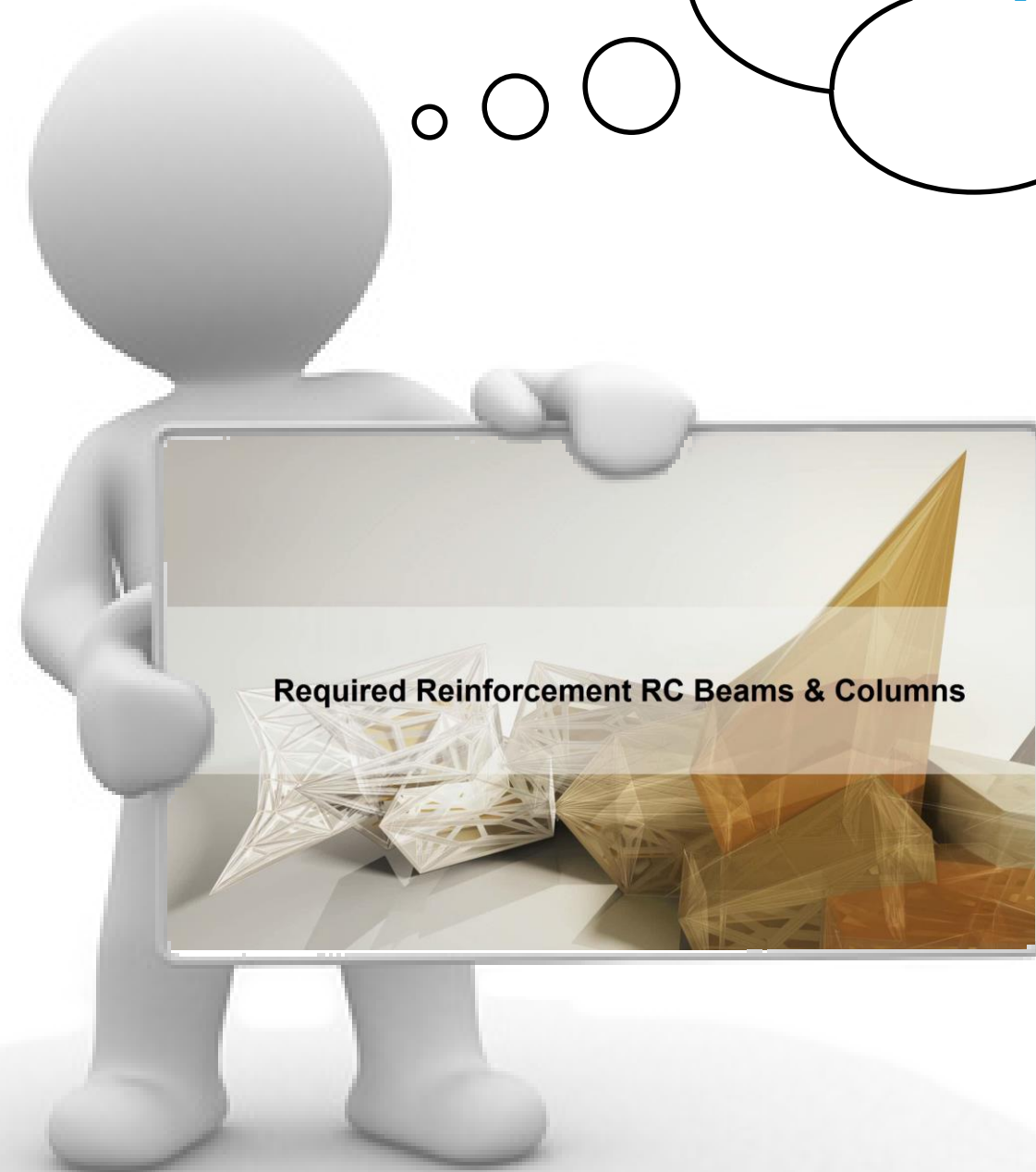
Code check design of Reinforced Concrete Elements

- Interpretation of results to RC code check design
- Calculation of required reinforcement $A_{s,req}$
- Design of provided reinforcement $A_{s,prov}$

Bar/Position (m)	Top required reinforcement (My) (cm2)	Top reinforcement - distribution (My)	Bottom required reinforcement (My) (cm2)	Bottom reinforcement - distribution (My)	Transversal reinforcement - type/distribution
275					2f8 55*10.0+37*15.0+55*10.0
275/ 0.400	0.06	2f18	3.32	2f18	
275/ 4.363	0.06	2f18	3.32	2f18	
275/ 8.326	0.06	2f18	4.03	2f18	
275/ 12.289	5.31	3f18	0.06	2f18	
275/ 16.252	0.06	2f18	3.32	2f18	
276					2f8 55*10.0+55*10.0+55*10.0
276/ 0.400	0.06	2f18	3.32	2f18	
276/ 4.363	0.06	2f18	3.36	2f18	
276/ 8.326	0.06	2f18	3.95	2f18	
276/ 12.289	5.29	3f18	0.06	2f18	
276/ 16.252	0.06	2f18	3.32	2f18	
313					-
313/ 0.400	3.41	2f18	3.41	2f18	
313/ 4.363	19.54	8f18	0.15	2f18	

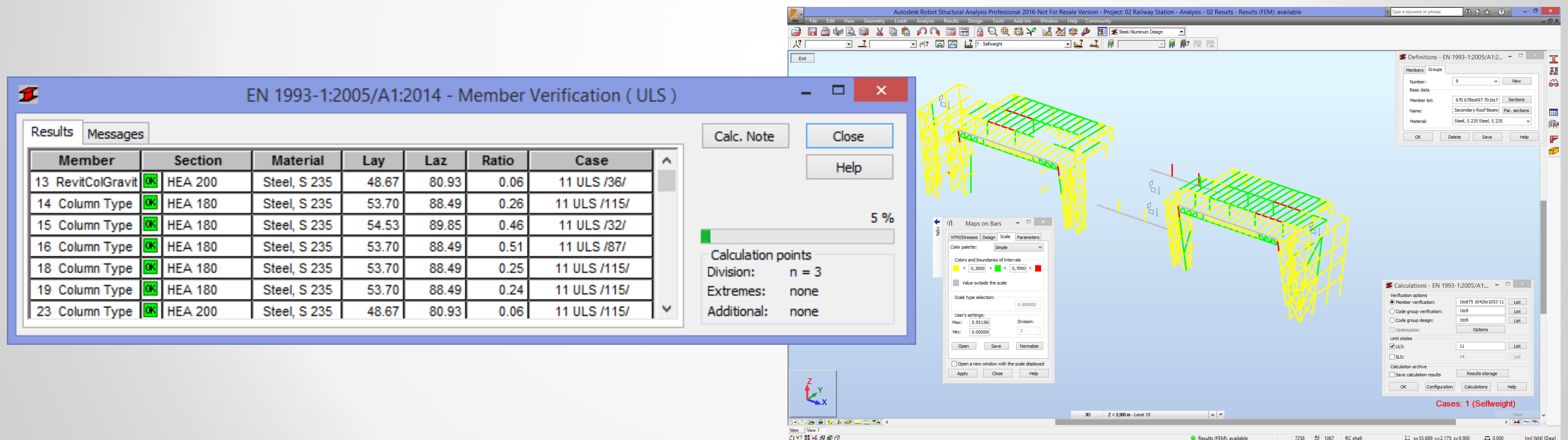


**Which kind of
rebar do we
need?**

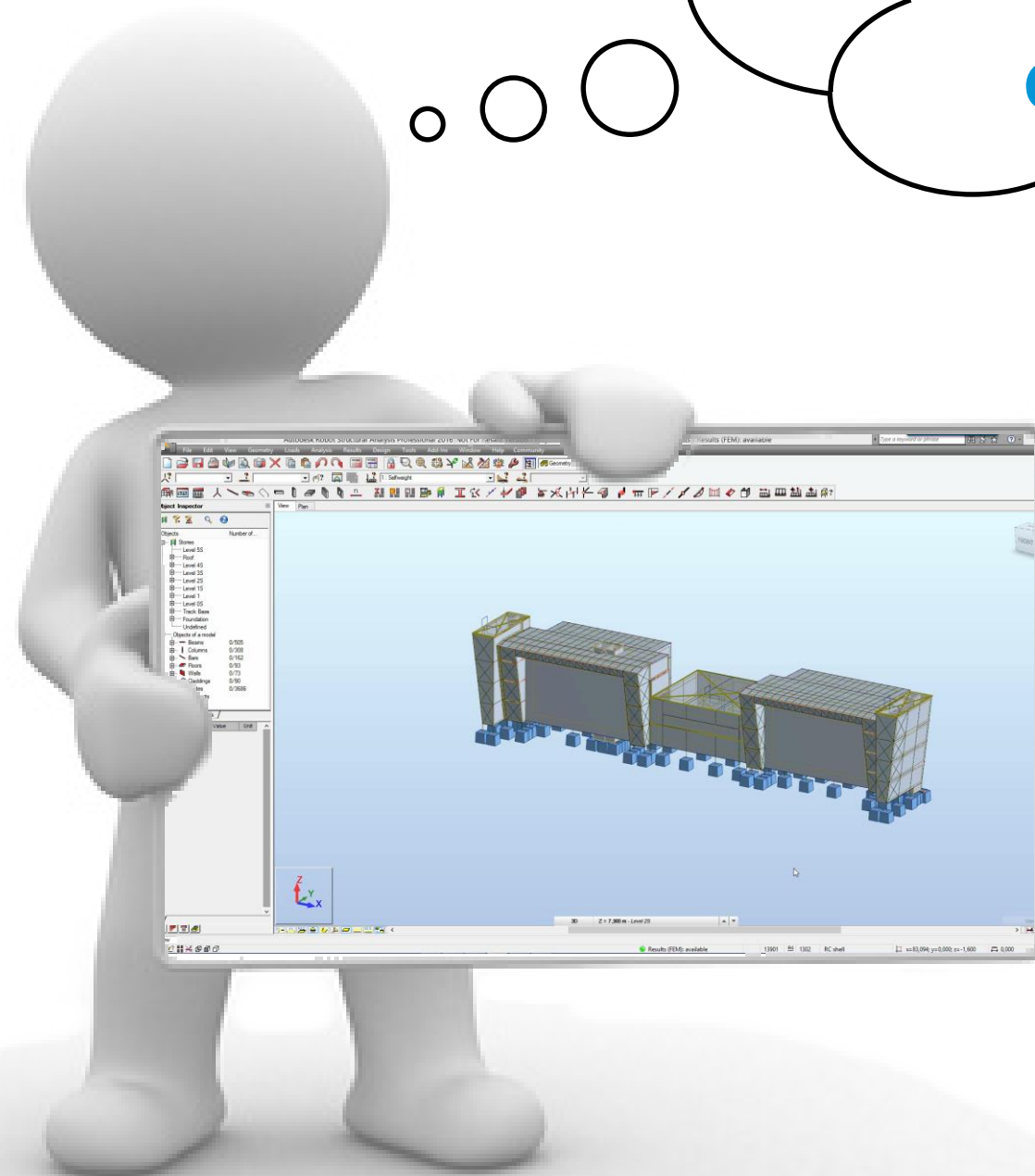


Code check design of Steel Structures

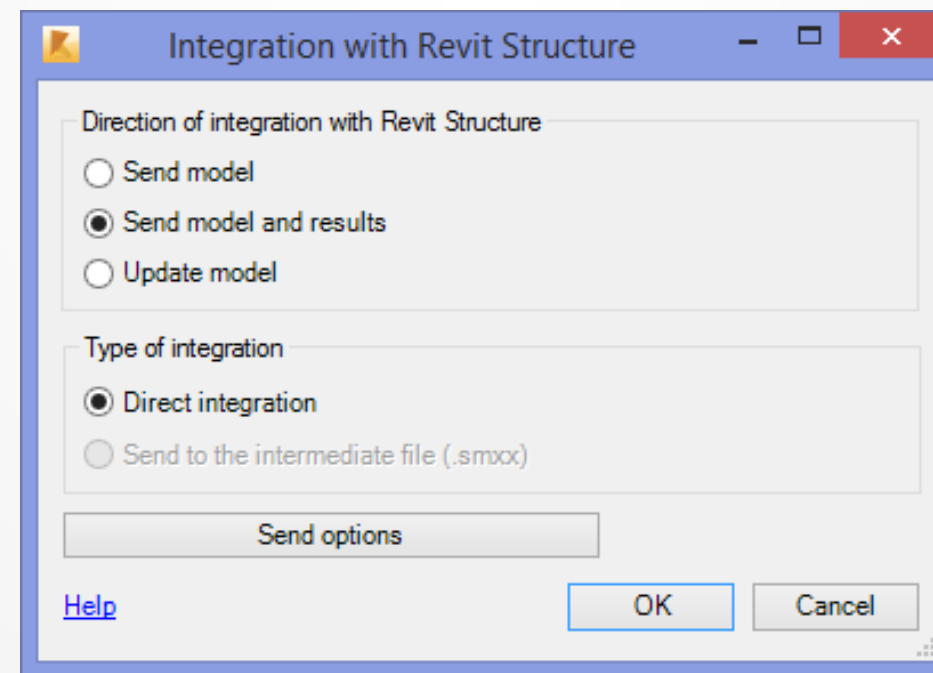
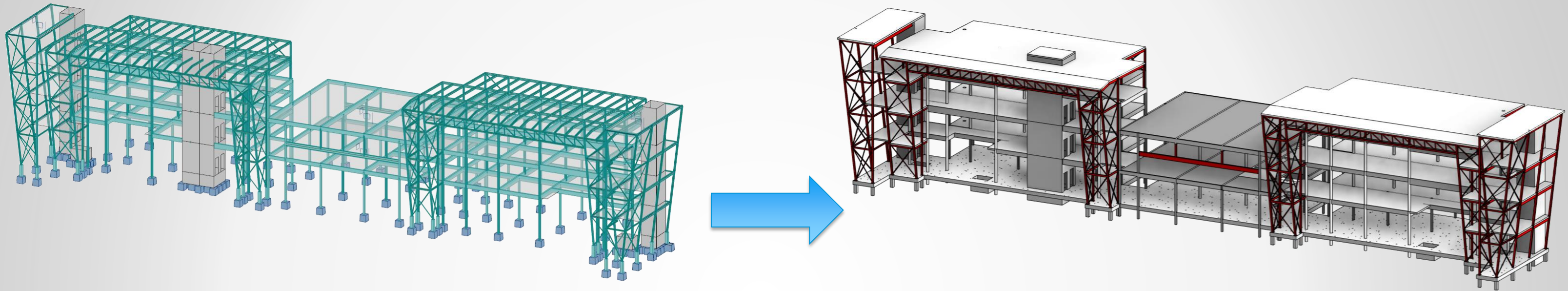
- Interpretation of results to steel code check design
- Member verification
- Steel section optimization



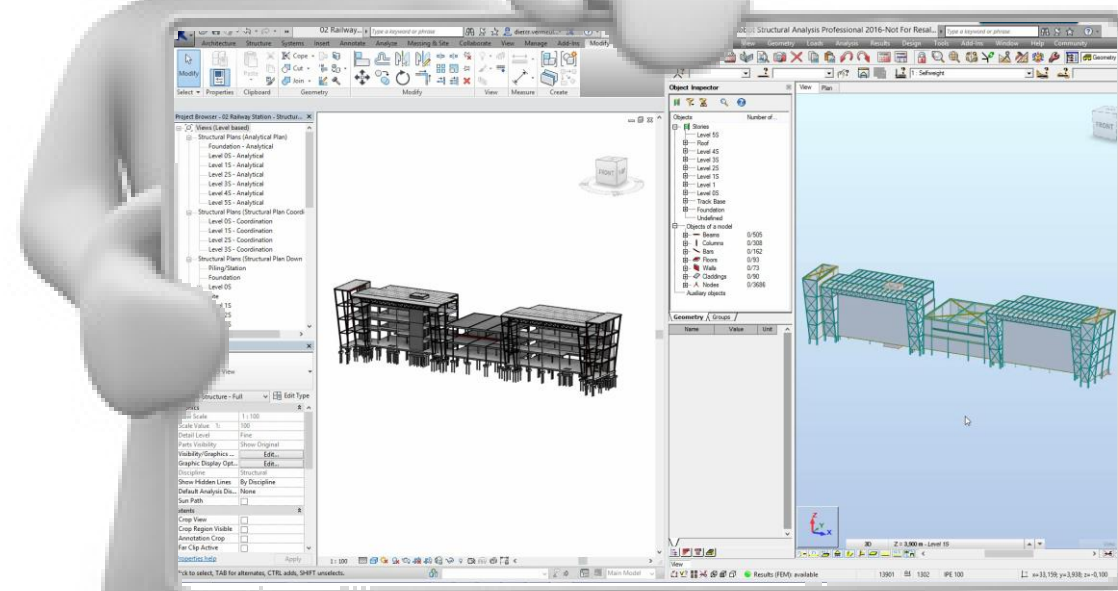
Is my steel
structure
optimized?



Update model changes from RSA to Revit

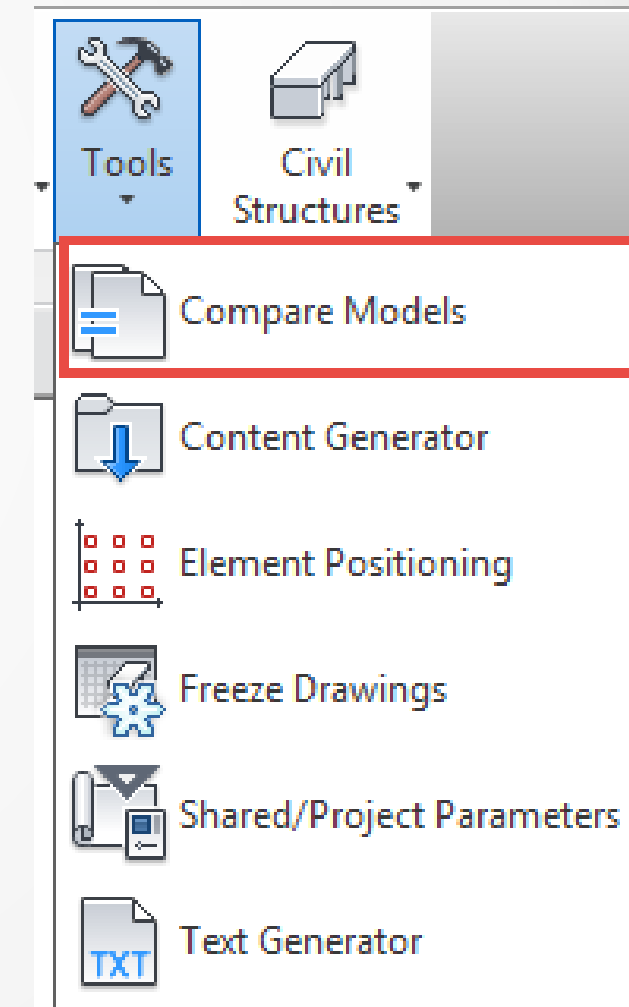
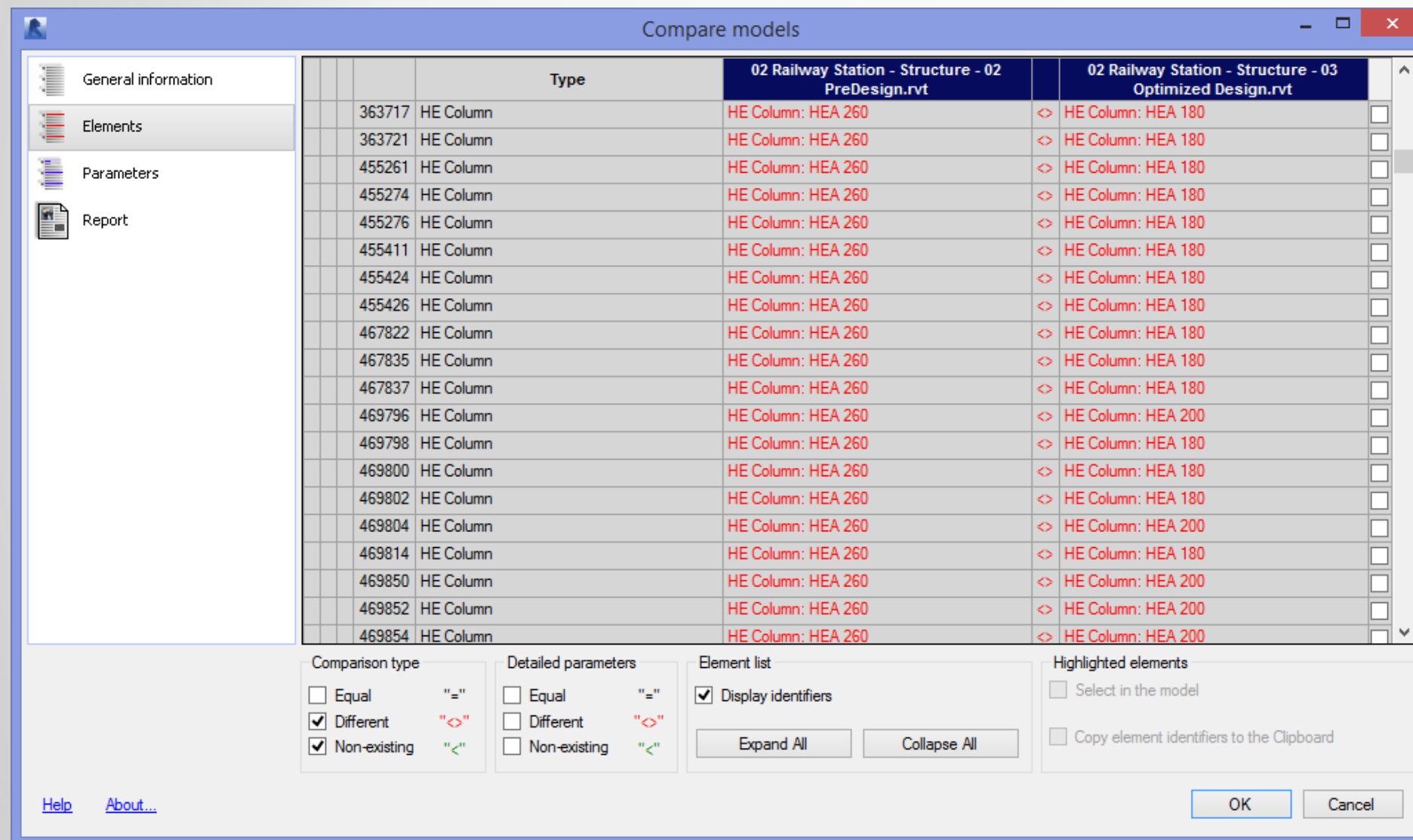


Can you send
me the changes
made to the
model?



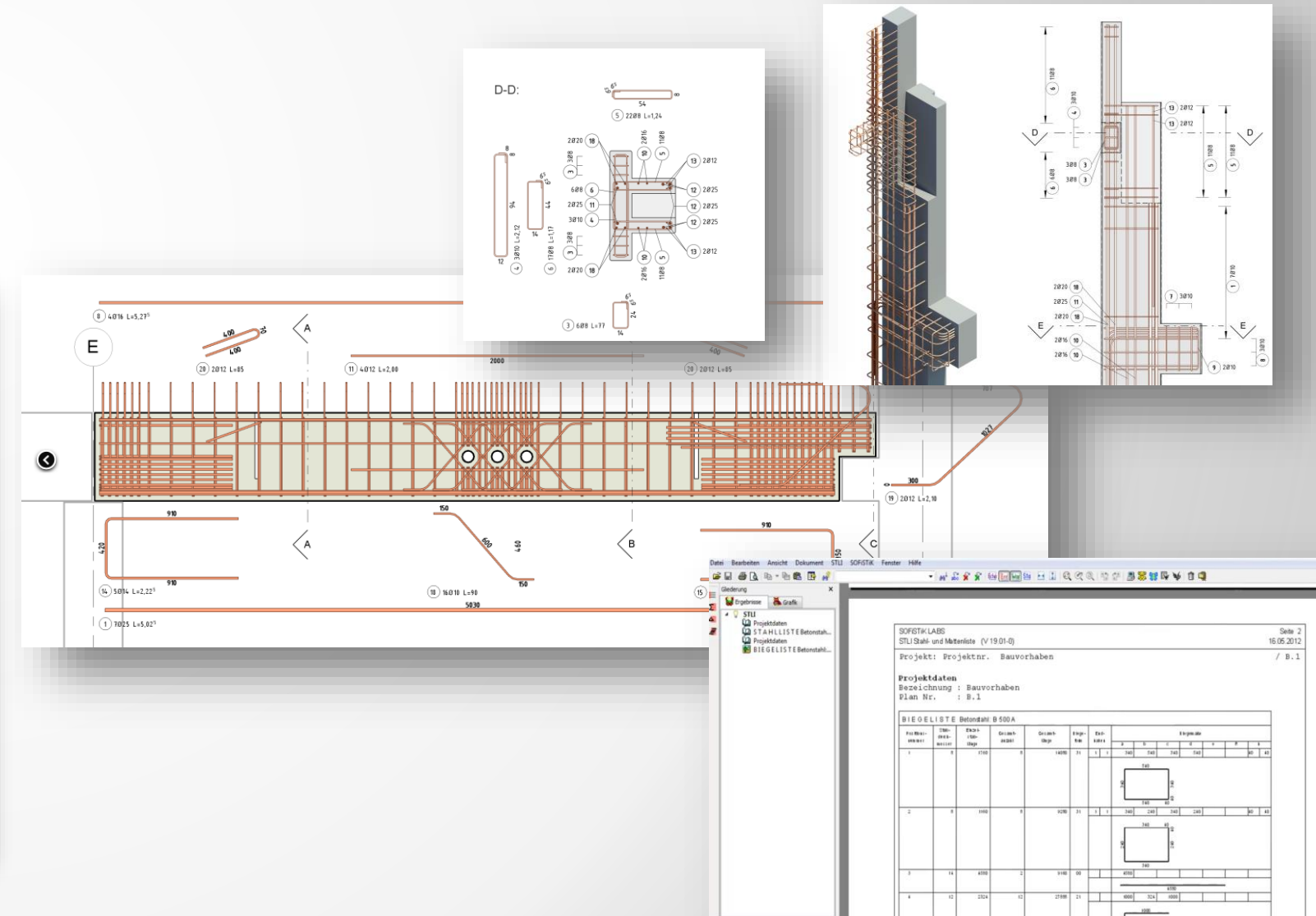
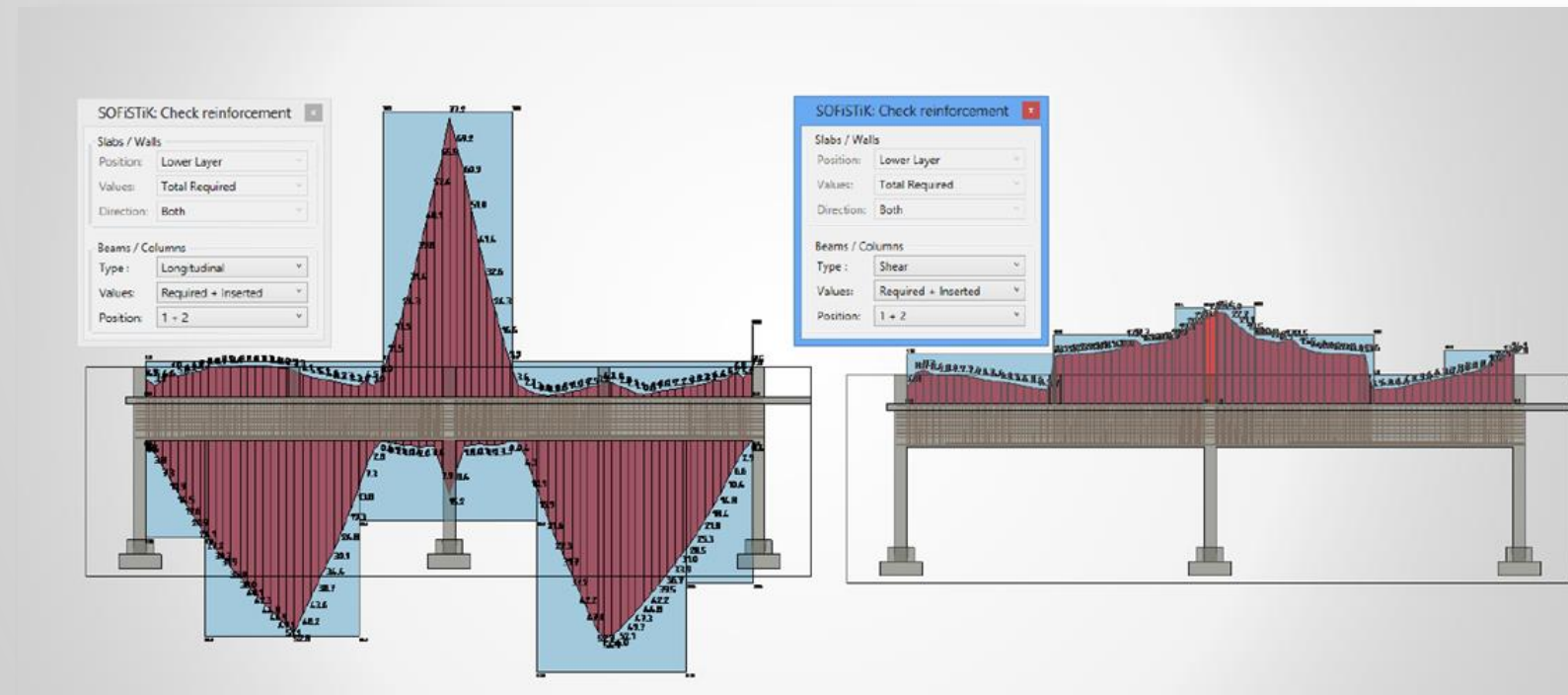
Track changes made to Revit model

Revit Extensions 2016 : Compare Models

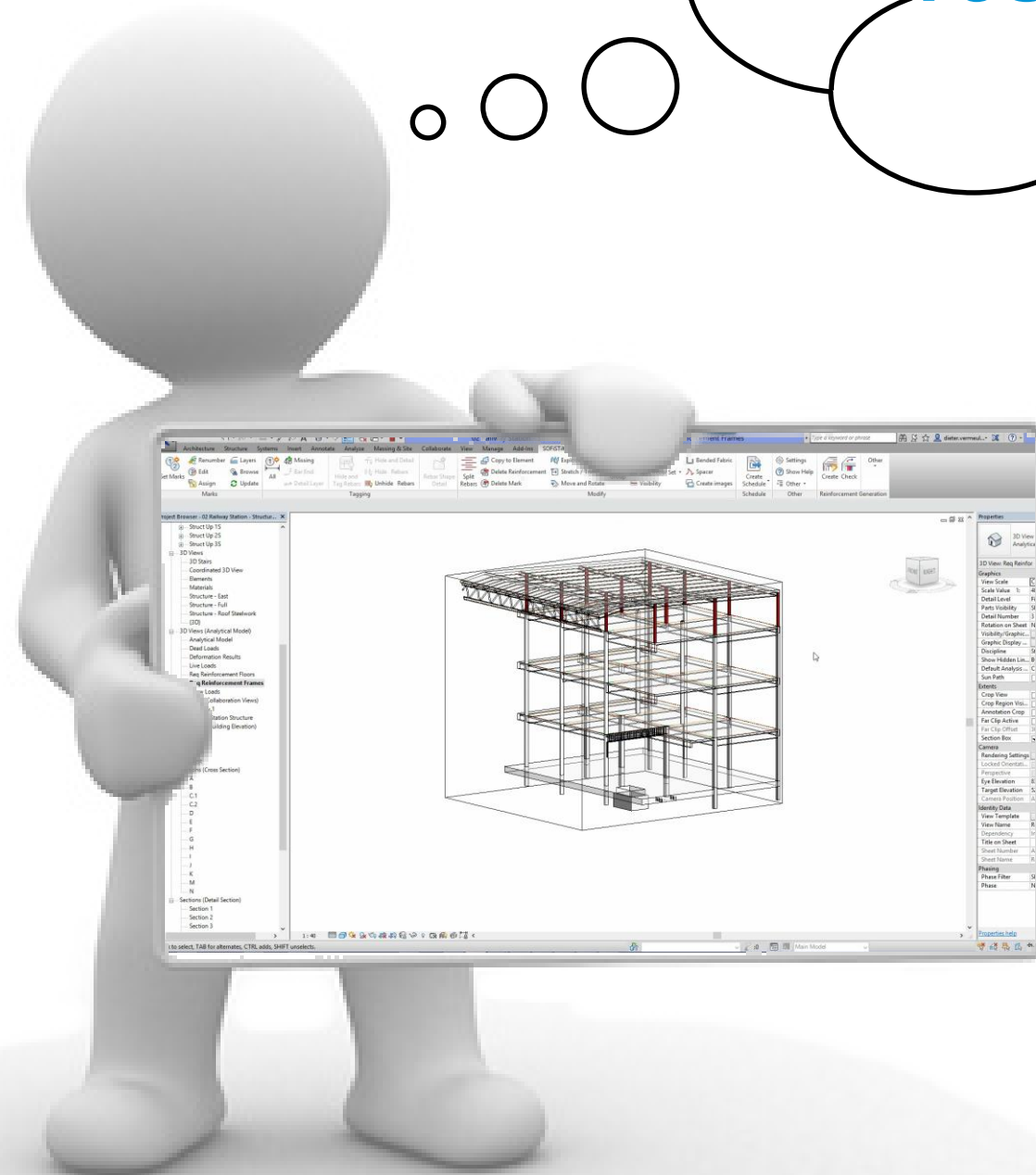


Reinforcement Detailing based on results

- Sofistik Reinforcement Generation
- Use Result Packages in Revit
- Available on [Autodesk Exchange](#)

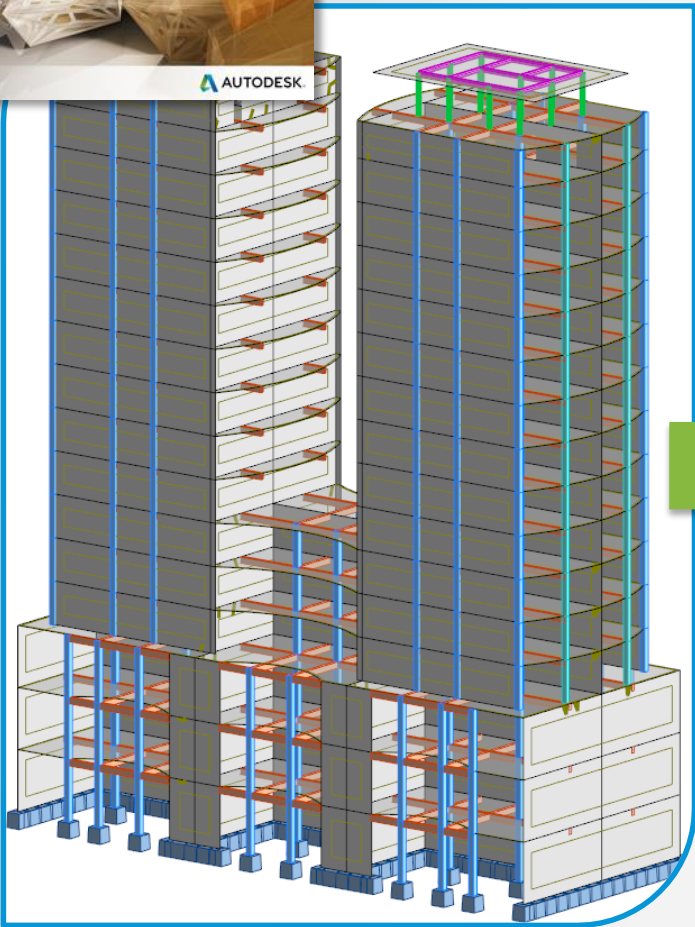
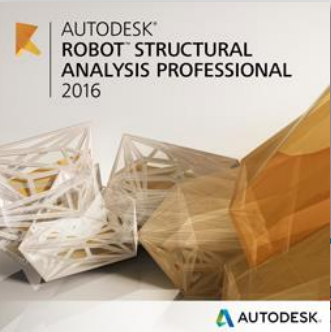


Can I reuse the
results for rebar
detailing ?

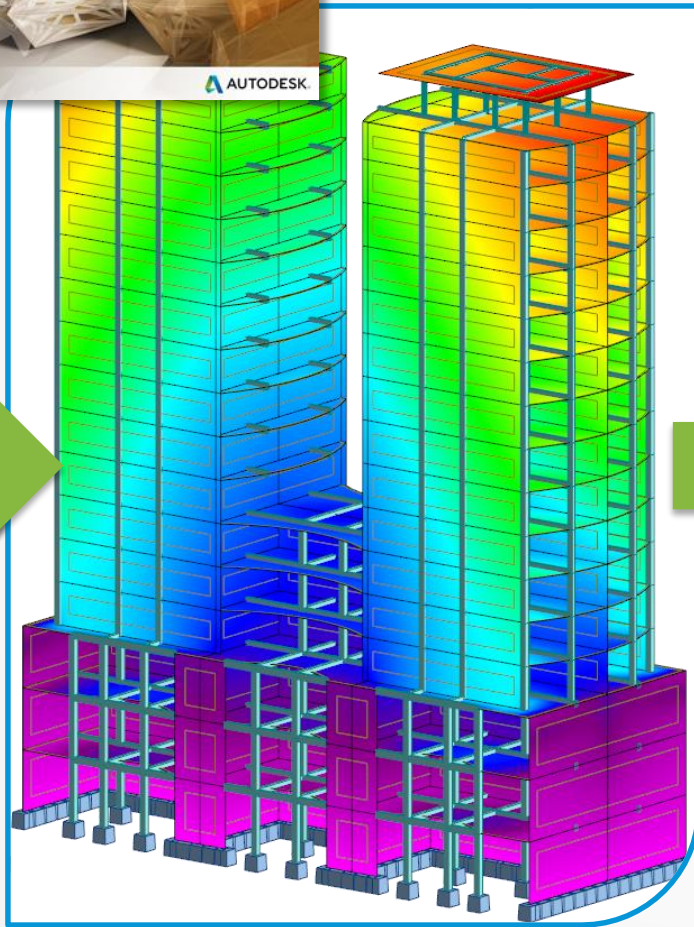
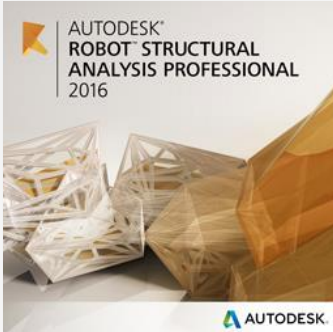


Analysis Focused Workflow

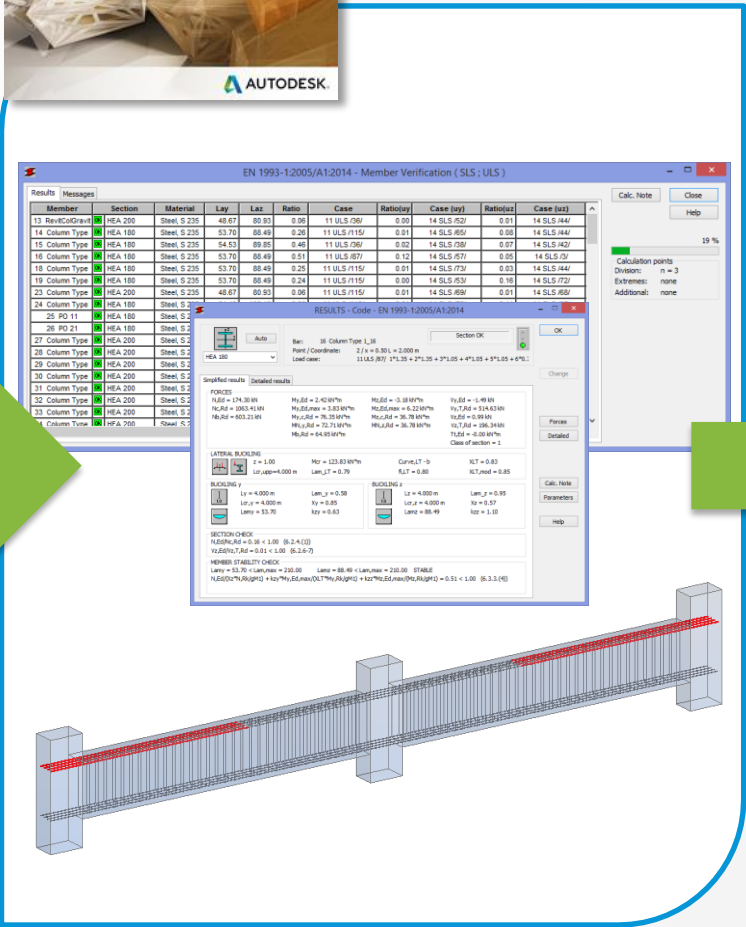
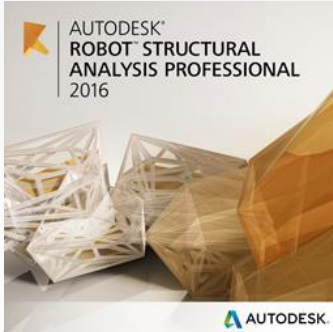
Analysis Focused Workflow



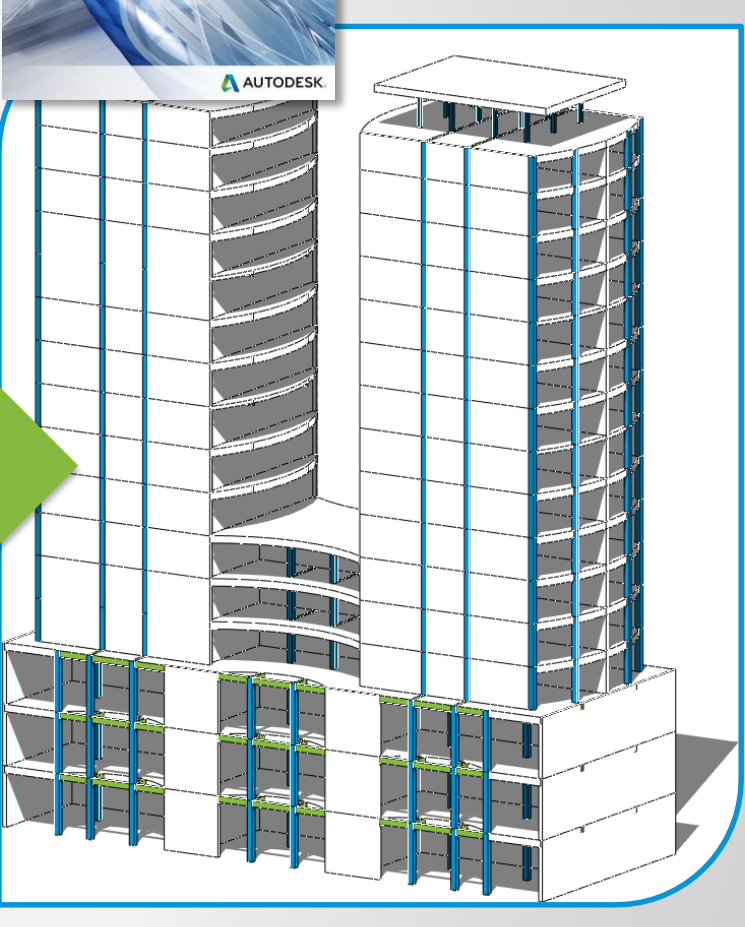
Analysis Model



Comprehensive Analysis

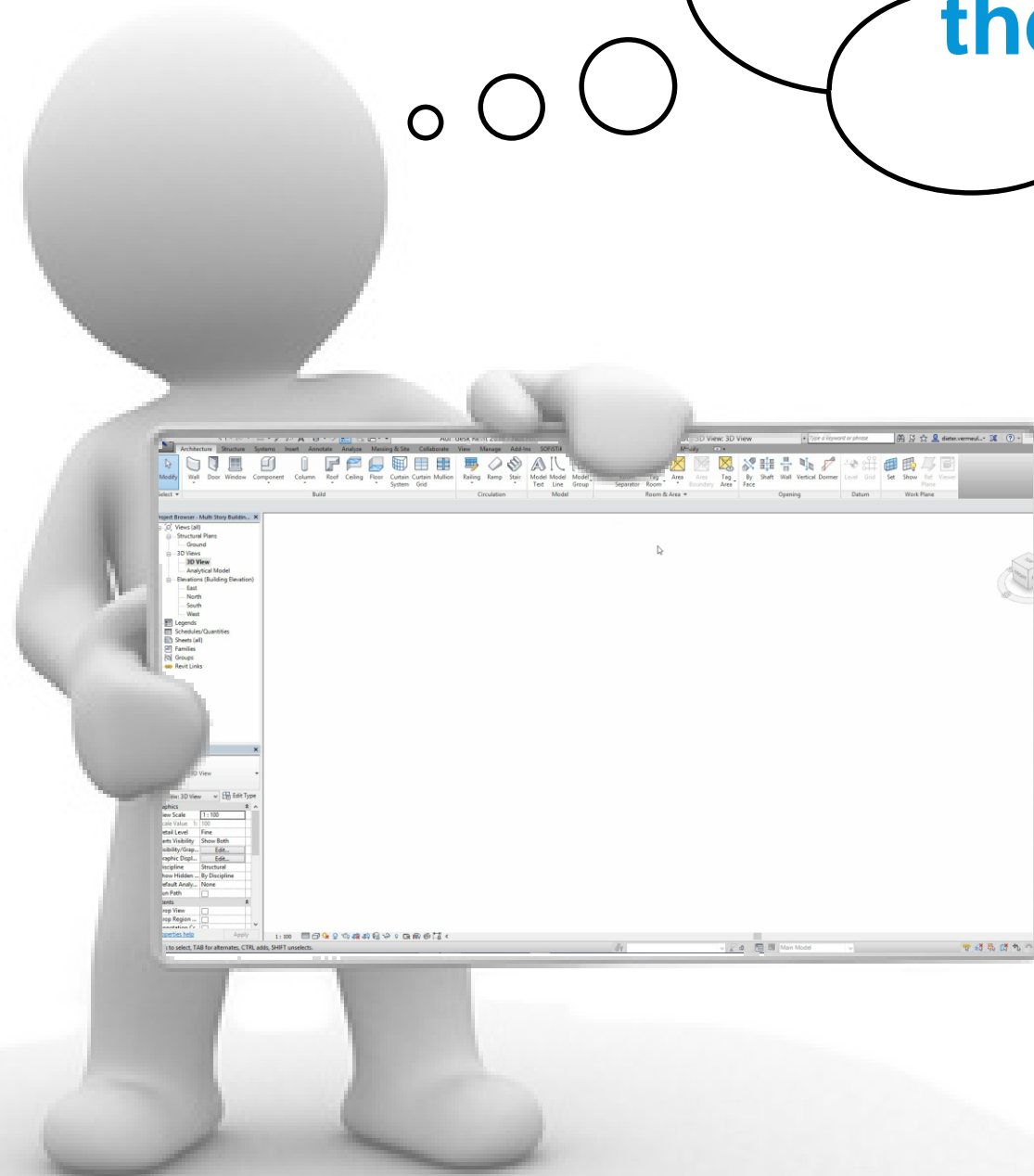


Code Check Design



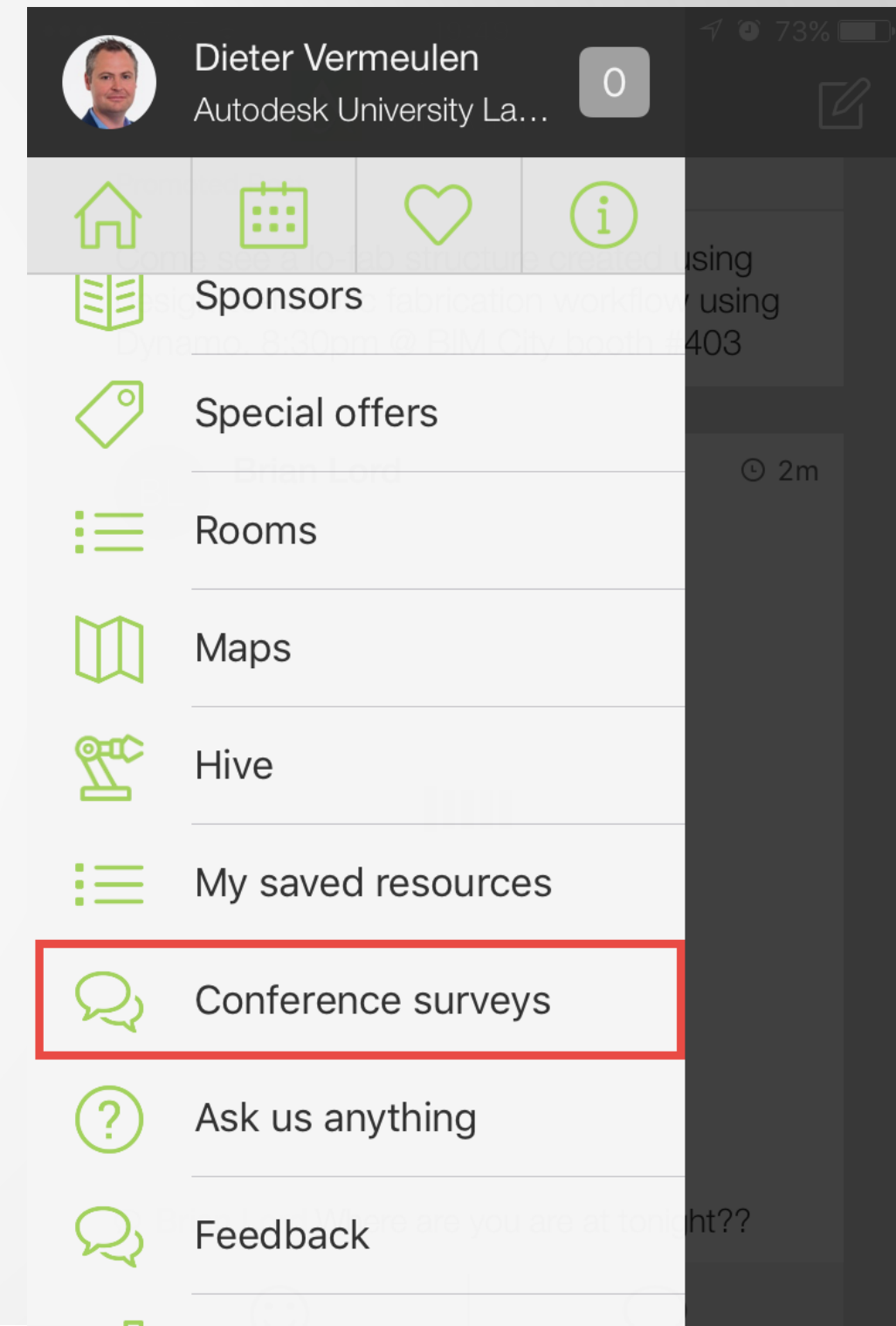
Design Model & Detailing

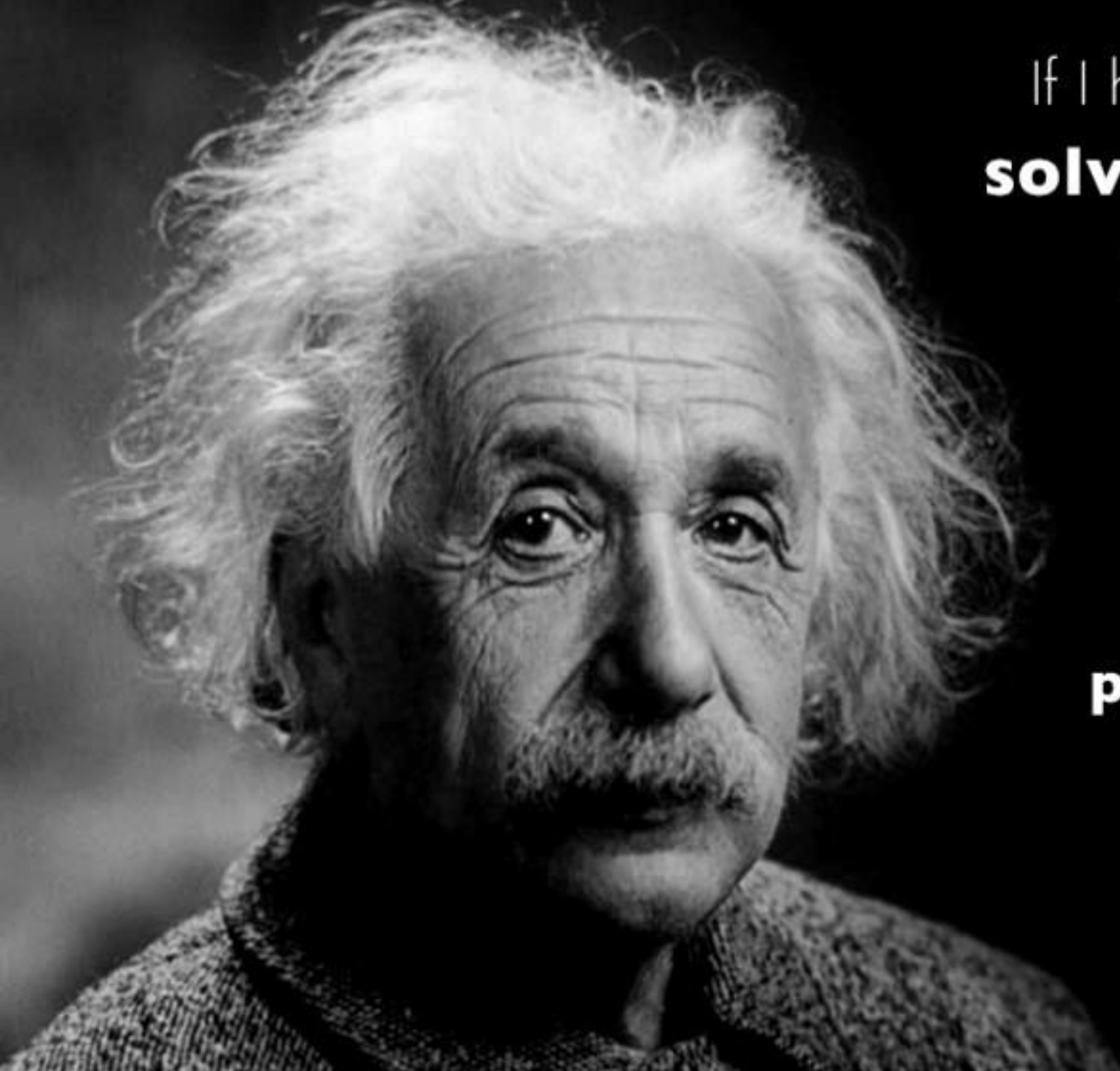
**I first model in
RSA and want
the model then
in Revit...**



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- AU 2016 passes awarded daily!
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- Give instructors feedback in real-time.





If I had an hour to
solve a problem and my
life depended on it,

I would use the
first 55 minutes
determining the
proper questions to ask.

Albert Einstein

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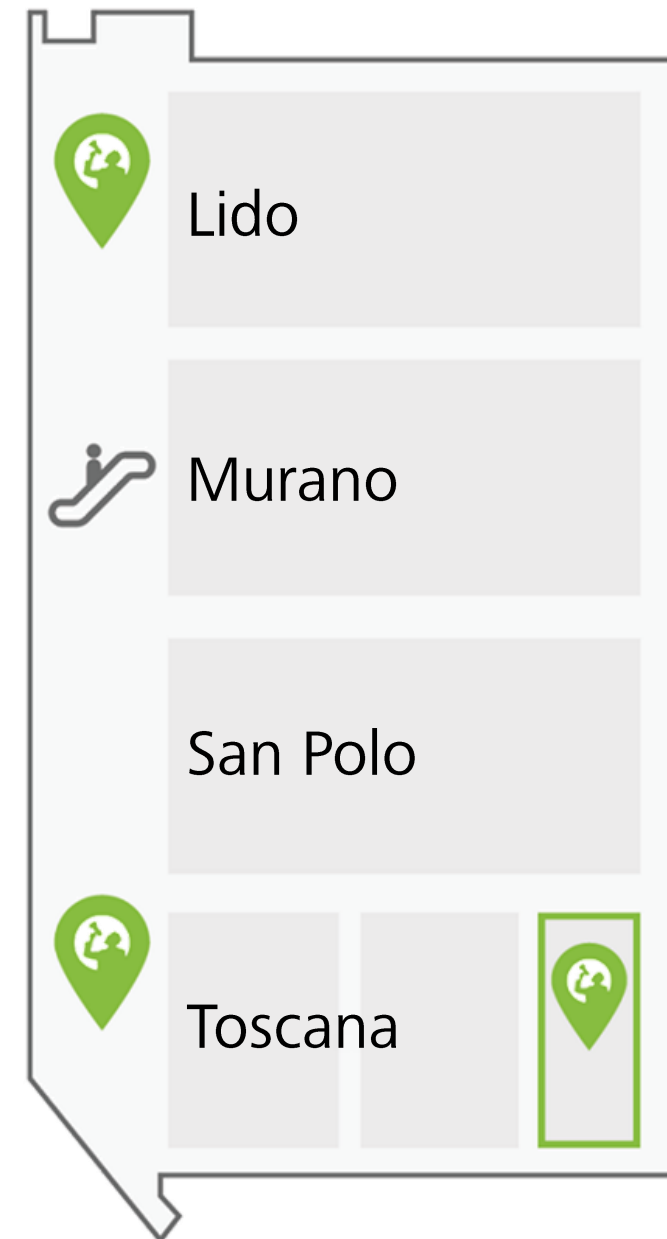
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