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SOFiSTiK Structural Analysis integrated in Revit – Workflow and Advantages

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Key Learnings

- See how the analytical model in Revit can be extended and used for structural analysis.
- Learn how multiple analysis models (main and sub-models) can be set up and organized within Revit.
- Learn how Dynamo can be used to access analysis results and to customize the process of results evaluation.
- Learn from customer success stories about the benefits of an integrated structural analysis process

Abstract

Analyze, Design, Evaluate, Repeat – the process of structural analysis is iterative. However, even in BIM-workflows, this cycle is often set out in dedicated software packages, where the analytical model is created and maintained independently from the BIM model. Redundant input and inconsistencies lead to an inefficient and costly process. As Revit automatically generates the analytical model along with the physical model, integrating structural analysis into a BIM-process gets reasonable and more critical, maintainable. The SOFiSTiK App, Analysis + Design for Revit, extends this concept and enriches the analytical model in Revit with additional properties, like design code specific materials, cross-sections or additional analysis elements. The entire analysis of buildings - from the definition of properties to the design of members and the visualization of results - can be conducted entirely within Revit.

Authors

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After receiving his PhD in Structural Engineering at the Technical University of Munich, Andreas is working in software development for SOFiSTiK AG, a leading European supplier of software for analysis, design and detailing.
Currently, he is leading a team which integrates structural analysis into Revit, allowing the user to keep within this platform for all structural work from analysis to detailing.

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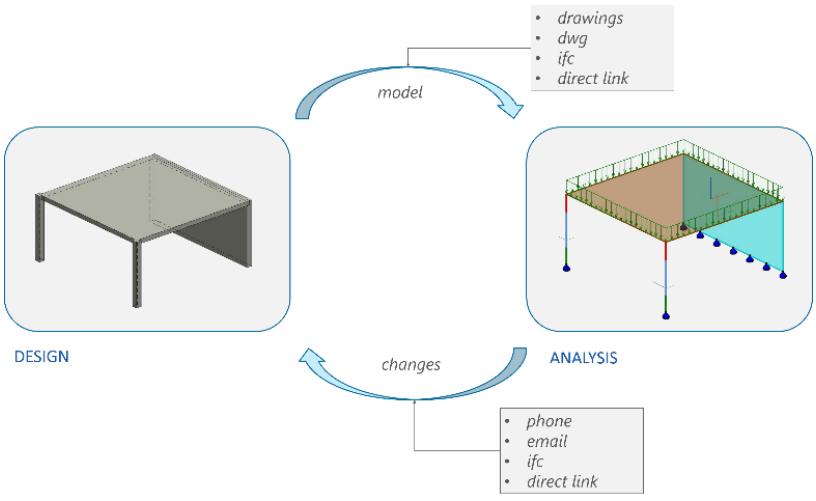
Noëlie Magnière is a product manager at SOFiSTiK AG, a leading European supplier of software for analysis, design and detailing in structural engineering. There, her primary focus are solutions for a seamless integration of structural analysis in BIM workflows.
She has Master of Science degrees from Ecole Centrale de Lyon and from Bern University of Applied Sciences. After a few years leading academical R&D projects in Switzerland, Noëlie moved to Germany and is working since then at the interface between software users and the development team.

Workflow in structural analysis

Structural analysis plays an important role when planning a building project. Analysis and member design checks ensure the feasibility of the designed structural concept. This is not only valid for the final phase where the design is already set but also – more and more important - in early project phases when different variants need to be explored and changes are less costly.

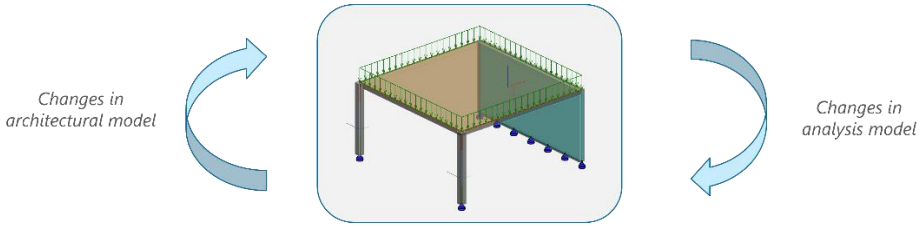
While the adoption of Building Information Modeling is increasingly commonplace in architectural design and formwork layout, the structural analysis is often de-coupled from a general BIM-workflow. Structural analysis and member design is usually performed in separate, dedicated applications. There, the structural model is entered separately often based on printed drawings or file-formats like pdf or dwg used as underlay. Results are propagated back to the initial model through different means ranging from simple e-mail to automatic model updates. However, especially when modifications occur on the initial BIM model, these changes need to be passed manually, which not only leads to additional re-work but may also poses the risk of inconsistencies. Following picture displays schematically the classical workflow.



Classical, de-coupled workflow in structural analysis.

This workflow in structural analysis contradicts the general concept of Building Information Modelling of having a central model being the ‘single source of truth’. Even if Revit is used as authoring tool for the structural model, the analytical model in Revit is usually ‘exported’ to third party applications where it will be enriched with additional data (loads, analysis control data) and often further modified. Though this workflow is automatized to a certain extends, the central problem of having a separate possibly inconsistent database for the analytical information remains. The structural analysis is decoupled and no longer part of the central model.

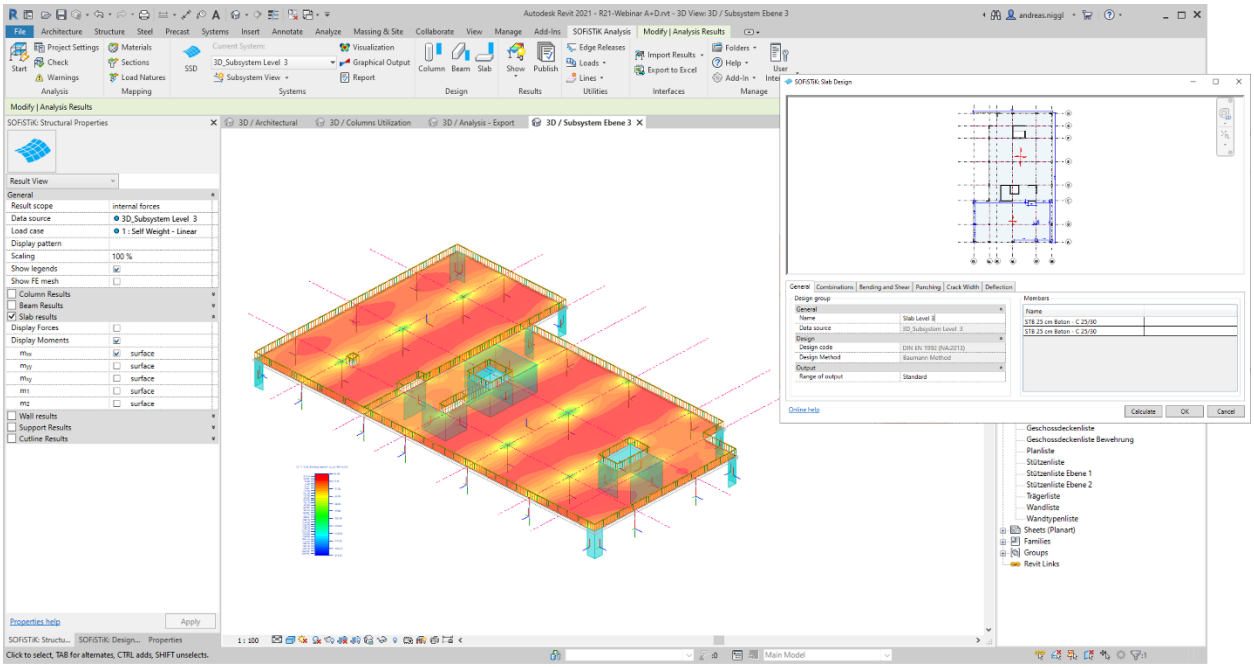
To overcome that contradistinction, it would be much more beneficial to integrate the structural analysis into the central BIM mode – which is indeed what Revit already provides! See the following picture:



Ideal workflow in structural analysis.

SOFiSTiK Analysis + Design for Revit

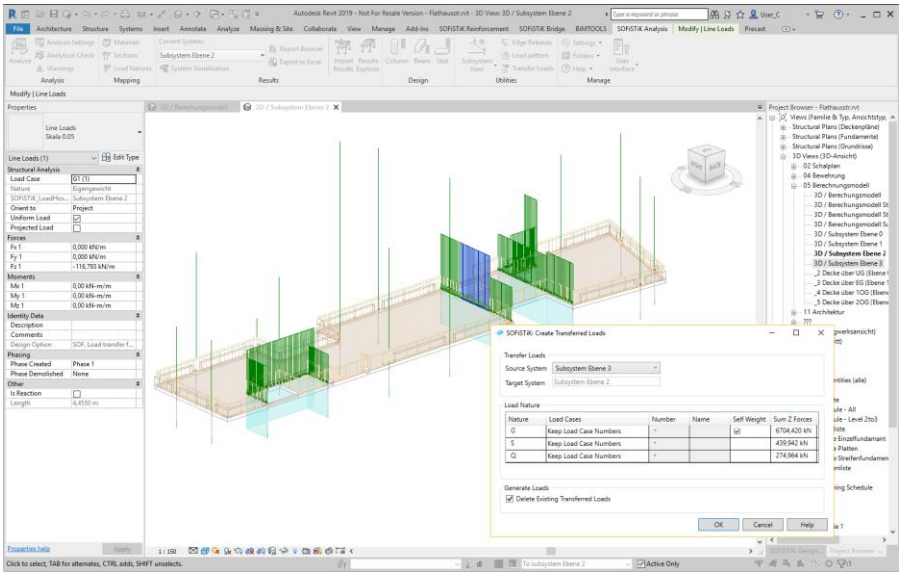
SOFiSTiK as a provider of software for analysis and design in structural engineering resolves this issue by providing a solution where the analysis and the design of buildings is entirely based within Revit. This class will present the application “SOFiSTiK Analysis + Design for Revit” which is an extension to Revit through the Autodesk App-Store or directly. The application provides functionality allowing to extend the analytical model in Revit with additional properties like slab/wall hinges or meshing properties and to perform analysis of the model and the design of members directly within Revit. Analysis results can be directly displayed within Revit. As all added information is consistently stored within the Revit database, the information can be shared with others using the standard collaboration features. Following picture shows a screenshot of the app:



The aim of this class is to discuss the advantages of this approach, the advantages when analysis is no longer decoupled from the BIM model but integrated within Revit. The benefits will be highlighted through three different live demos:

Organization of multiple analysis models derived from central building model

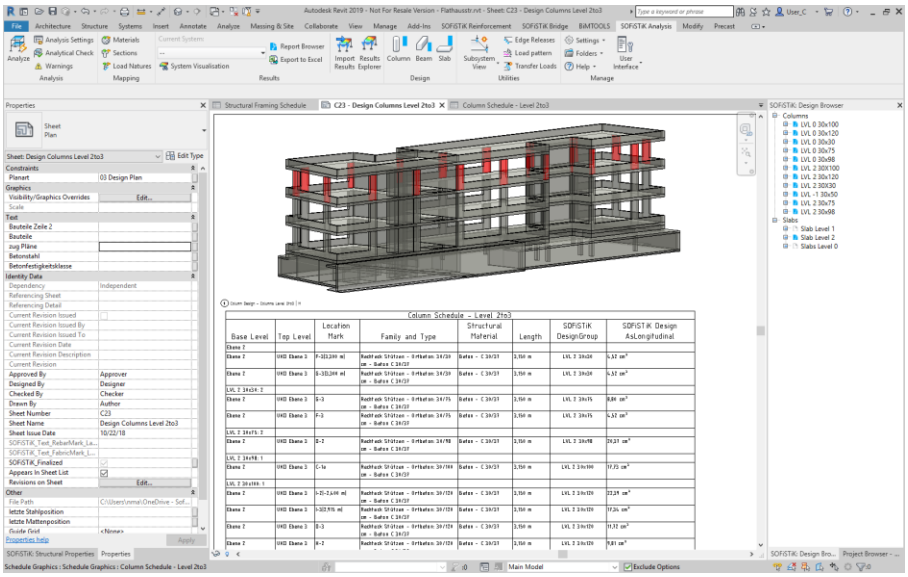
The analysis of a structure usually involves multiple analysis models of different fidelity. A global (often simplified) model of the 3D-structure is being used for global load take down or dynamic analysis. Local models are used for detailed analysis or member design. For example, the design of a column is carried out on a separated model by usually taking geometric and material nonlinear effects into regard. Similarly, the reinforcement design of slab members is often performed by separating the slabs from the global model. This class will show a workflow, where analysis variants can be set up within different views from which they can be analysed by the SOFiSTiK Extension. It will also be shown, how local modifications being subject to only one single model can be set up using Design Options within Revit. This will be demonstrated by loads being transferred from one sub-model to another.



Extracted slab sub-system with loads transferred from upper sub-system.

Organization of member design within Revit

When designing members, especially columns, elements of similar properties and loading are often collected into groups to reduce the number of different items to be designed and printed in the reports and also the number of variations which need to be built on site. A sensible grouping requires information from the BIM-model (shape, location) as well as information from the analysis (loading, required reinforcement). The class will show, how column members will be organized into groups within a standard column schedule by physical as well as analytical properties. Member check as well as reporting will be carried out within Revit.



Design Check of selected column members, results displayed in column schedule.

Collaboration through Revit Cloud Worksharing

As the Revit App “SOFiSTiK Analysis + Design” stores all analysis information within the Revit database, this information can automatically be shared with others through Revit Cloud Worksharing like any other member or element property.

This sharing of structural information allows for fully collaborative workflow for structural engineers. Structural engineers and structural detailers can share their structural model and their results through the central model stored on BIM 360, allowing e.g. for following workflows:

- Support the collaborative work of structural engineers in different offices
- Exchange data between structural engineer and reinforcement detailer
- Publish design document on BIM 360
- Display selected design results in BIM 360 Viewer

Figure 3 and Figure 4 shows one example. After analysing the structural model in Revit and designing members, selected design results, like e.g. the utilization of members can be uploaded to BIM 360 and e.g. graphically displayed in the Viewer.

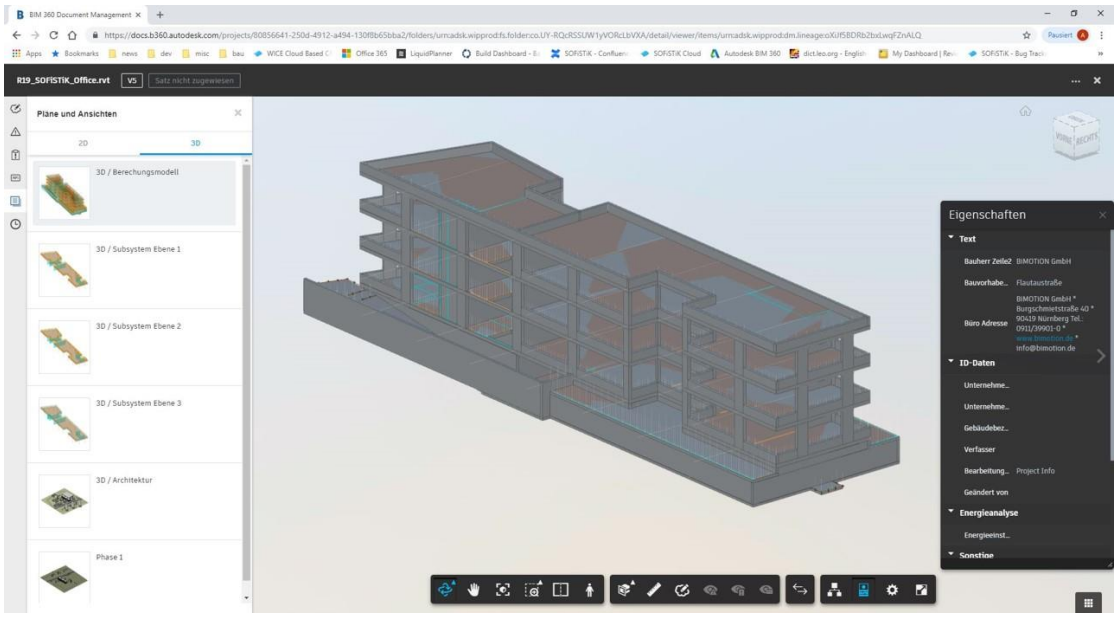


Figure 3: Structural model and subsystems in BIM 360 Design

With the design results available in the central model on BIM 360 this data can also be shared with detailers to support the generation and detailing of reinforcement. Without having to create and share drawings, the structural engineer can directly share design results like required reinforcement on the member level with the drafting department. The reinforcement designer can use that information to automatically create 3D rebars and plots. This workflow has been

demonstrated in a live presentation by SOFiSTiK on Autodesk University 2018 (see Reference [1]).

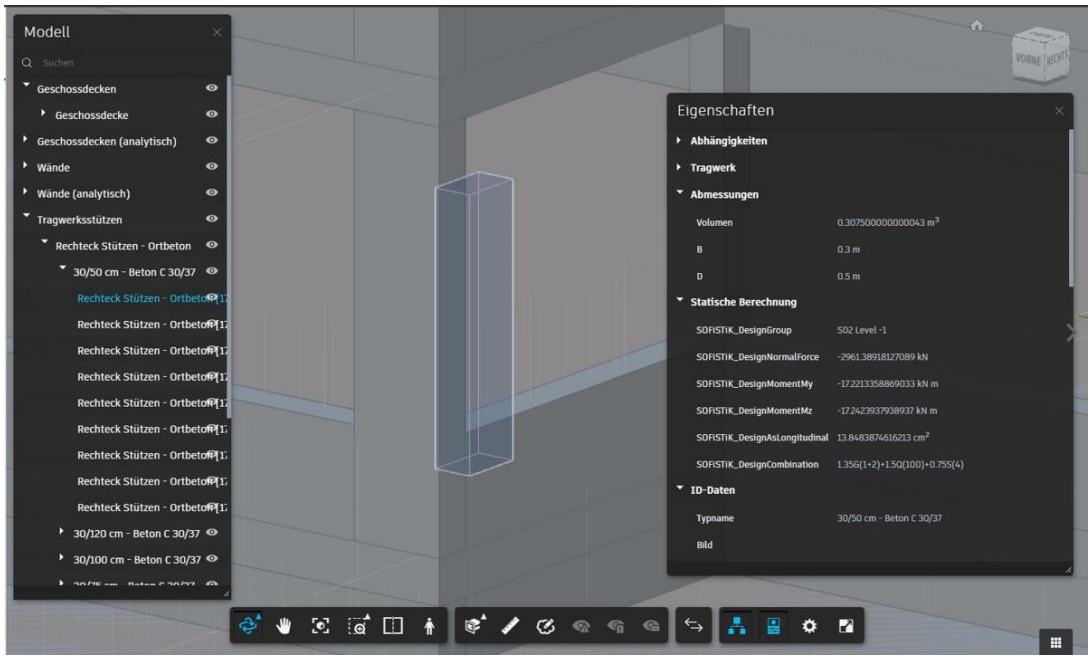


Figure 4: Selected structural analysis and design results displayed in BIM 360 Viewer

References:

[1] Andreas Niggl, Thomas Fink: Revit: The Hub for Structural Engineering in a Collaborative Environment, Autodesk University 2018, Las Vegas

[2] Björn Teutriene, Thomas Rastätter: Kollaboration statt Konfrontation: Effiziente Zusammenarbeit in der Statik, Autodesk University 2020