



Student Report

Building a 10-story hotel with SOFiSTiK

The Project

The building is a 10-story hotel located in Lod, Israel. It was designed as part of a final project in structural engineering by a bachelor's student in the Faculty of Civil and Environmental Engineering at the Technion - Israel Institute of Technology.

This is a special and challenging project that is unusual, especially in its cantilever elements. The whole structure “floats” and rests on two structural cores and on only 6 columns in the center of the structure. Also, between the columns, there is a 12 meters span that allows passage of a road below the first floor.

A typical floor area in the building is about 690 square meters, the gross height of each floor is 4 meters and the building has a foundation system that includes rafts under the structural cores and isolated foundations at the bottom of the columns that go down to the ground according to the geotechnician's recommendation.

Design challenges

Given the fact that this is such a special structure with cantilevers of about 4.5 meters, the global design was very challenging.

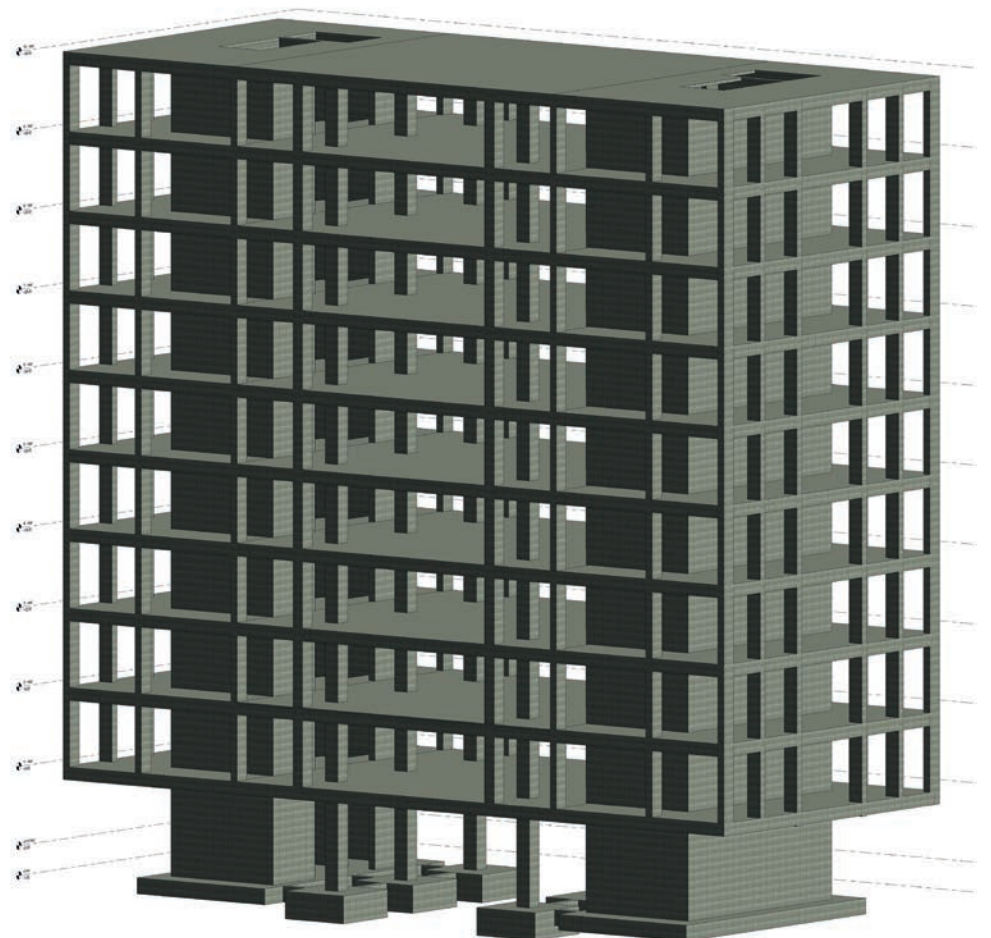
Initially, an attempt was made to effectively use the geometry of the structure through Vierendeel design, but too massive loads and deformations were obtained.

Later, an attempt was made to think about “hanging” the building and even designing a transformation floor at the bottom of the building, but these are

expensive solutions, not very effective, and very detrimental to the original architectural appearance and general aesthetics.

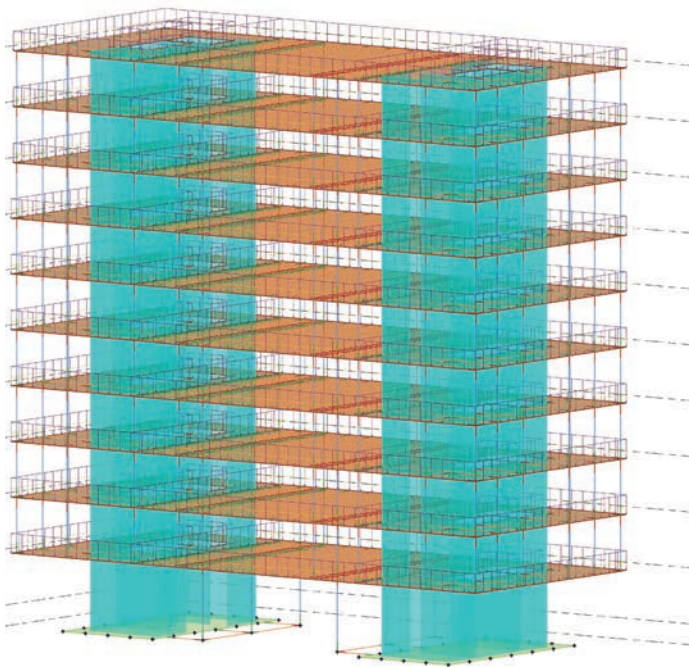
Finally, a design of the floor in the problematic field (in the area without the columns) was obtained in three different alternatives and an efficient design of the frames around the cantilevers.

In the first alternative, a ribbed slab was proposed in the problematic field, in the second alternative, a cast-in-place concrete slab without beams was proposed and in the third alternative, a hollow-core slab was proposed.



The power of BIM

Through the use of building information modeling (BIM), the project has become smarter and more efficient. Each element in the structure is represented by smart parameters and not by simple lines, which allows the production of design alternatives, views, sections, and schedules easily and very quickly.



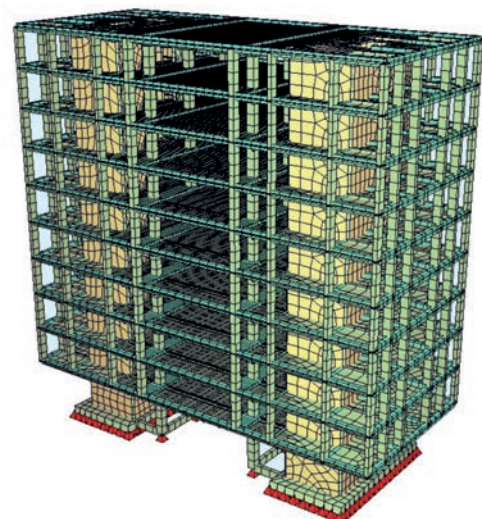
In addition, any change in elements is automatically updated on all sheets, which again saves time but, more importantly, prevents unnecessary human errors. This advantage is very important in a student project following the presentation of various design alternatives and performing many iterations to improve each alternative, which is done under the guidance of an experienced engineer.

Moreover, when building elements are modeled in a BIM software, the whole structure is more accurate from the level of display of connection details of elements to even the analysis in finite elements software performed on the analytical model.

Why SOFiSTiK?

To fully benefit from the power of BIM, analysis and design software that interfaces optimally with the BIM model is needed. SOFiSTiK does this wonderfully through built-in applications within Revit, which is a common software in the Israeli market. Unlike competing software commonly used in Israel, SOFiSTiK receives all the information from the ready-made model and performs all the required analyses, allows the design of elements according to standards and even provides convenient and advanced tools for creating and detailing reinforcements in various elements. All this, without compromising on any stage in the design, including advanced analyses such as long-term deformations and seismic analysis.

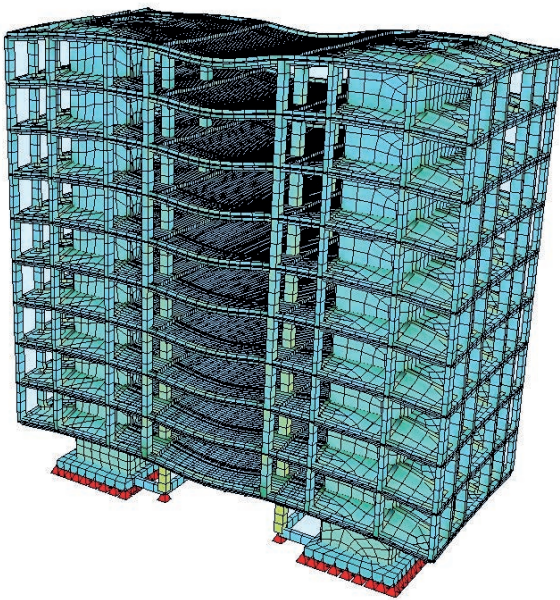
Another thing that influenced the choice is the availability and support. SOFiSTiK allows engineering students to obtain a license that contains everything the company has to offer and for the entire degree period, unlike competing companies in Israel. In addition, there is an excellent support team, both in Israel and at the headquarters in Germany, that provides answers quickly and professionally. Lastly, there is even a local SOFiSTiK website full of helpful content like guides, tutorial videos and more.



Analysis and design

After modeling the geometry of the structure, a process of analysis and design was carried out as part of the project with the help of the SOFiSTiK Analysis & Design application. The analysis is immediate and receives all the necessary parameters directly from the analytical model.

The advantage of creating sub-systems automatically through the application is evident so that the analysis can be performed for the global model and for each floor separately and includes a calculation of the rigidity of the boundary conditions and the transfer of forces from columns and walls. Further to the analysis, it is possible to view customized simulations of the structure, including deformations and earthquakes, in a particularly convenient interface.



In addition, the application provides tools for designing columns, slabs and beams while selecting the desired physical elements and in accordance with the required code. Here, the customization is reflected in the choice of load cases for the design and in the selection of parameters for the various tests, such as

crack width, penetration, bending, shear, and compressive loads.

All of this is done without exiting Revit and with maximum speed and efficiency, given the fact that there was no need to remodel a constructive model or redefine loads, boundary conditions, sections and/or materials. This advantage is extremely important when making changes.

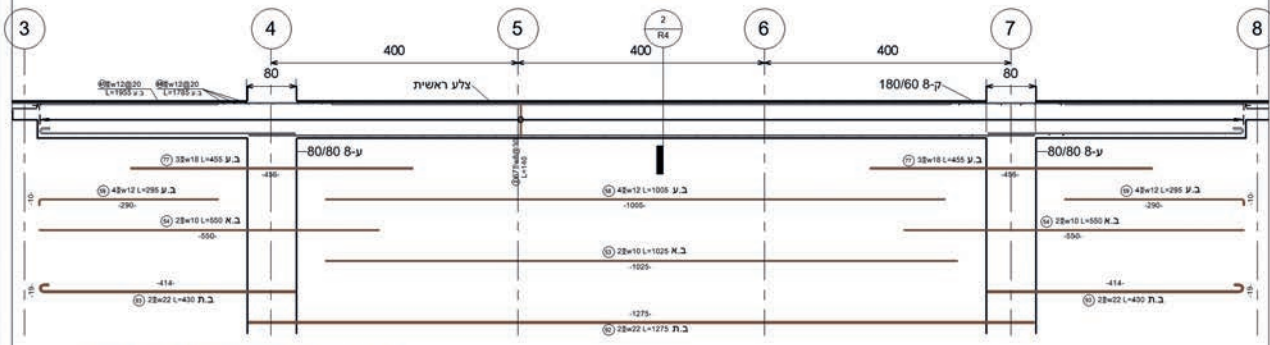
Reinforcements modelling and detailing

Perhaps the highlight of using BIM for the design of buildings is in the creation and detail of rebars. Here, the advantage of smart steel bar elements is huge because the changes are many and the number of occurrences of each rebar type is large. Thus, for example, we could see the same rebar in several different views, in sections, in schedules and in unique details. Without the BIM model, the action of changes, even of the elements containing the rebars, is unbearable and time-consuming. Beyond that and even worse, the probability of making mistakes in plans with the old method is almost certain when changes are needed.

All this is solved by modeling reinforcements with the help of the SOFiSTiK Reinforcement Detailing app. Once the design has been performed according to the required code, it is possible with the help of the app to create the rebar elements automatically based on the loads on the element and based on the selected standard. Then, also in reinforcement detailing in sheets, SOFiSTiK makes it easier to work with advanced tools that allow you to almost instantly switch from the default view of the rebar in Revit to detailed plans as are customary in the construction industry.

As engineers, we are required to verify the results and make slight changes after receiving the output from the software, but here, too, the tools are simple and convenient and of course - the changes are automatically updated in all sheets.

Alternative 1 - Ribbed Slab Reinforcement



1 Main Rib - Longitudinal Section
1 : 50

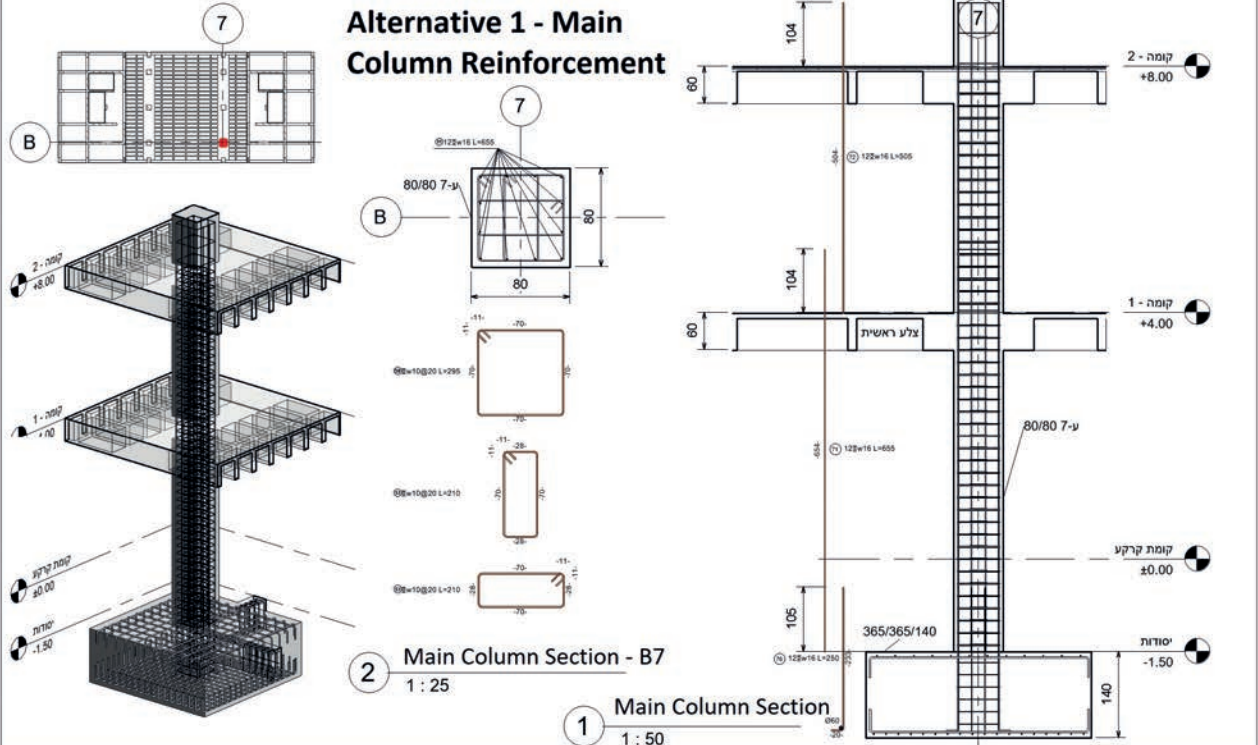


2 Main Rib - Width Section
1 : 25



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Alternative 1 - Main Column Reinforcement



2 Main Column Section - B7
1 : 25

1 Main Column Section
1 : 50

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Showing results

In light of the fact that this is a challenging project that contains special details such as the cantilever frame, it was decided to present the results of the forces and moments of these details in the project framework. Here, too, SOFiSTiK stands out exceptionally with its new tool for displaying built-in results in Revit 2021 on the physical model itself. It is a revolutionary tool that allows the display of results of both loads and reinforcement on the 3D views in Revit, a tool that includes settings that can be changed by the user and an eye-catching interface.

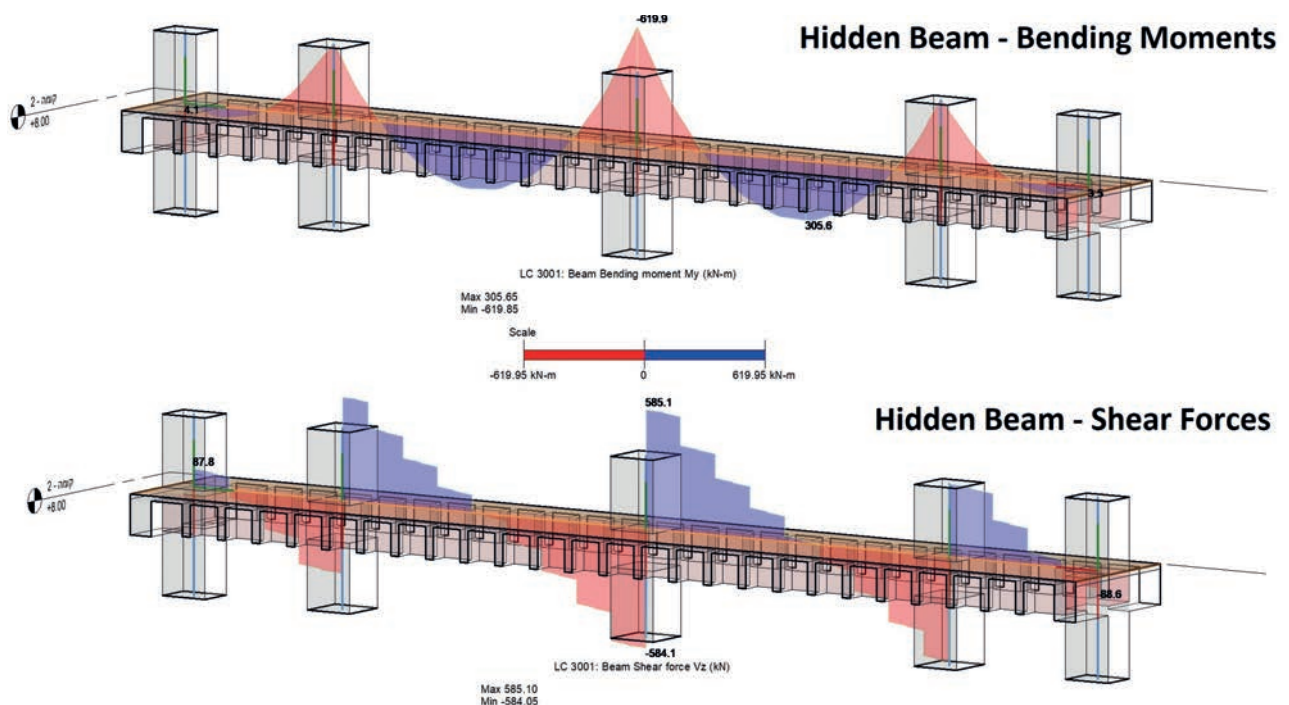
It is also possible to export complete design reports for each element previously designed as common file extensions such as word and pdf, and to view in an orderly manner the various details of the planned element including the element geometry, load tables and required reinforcement.

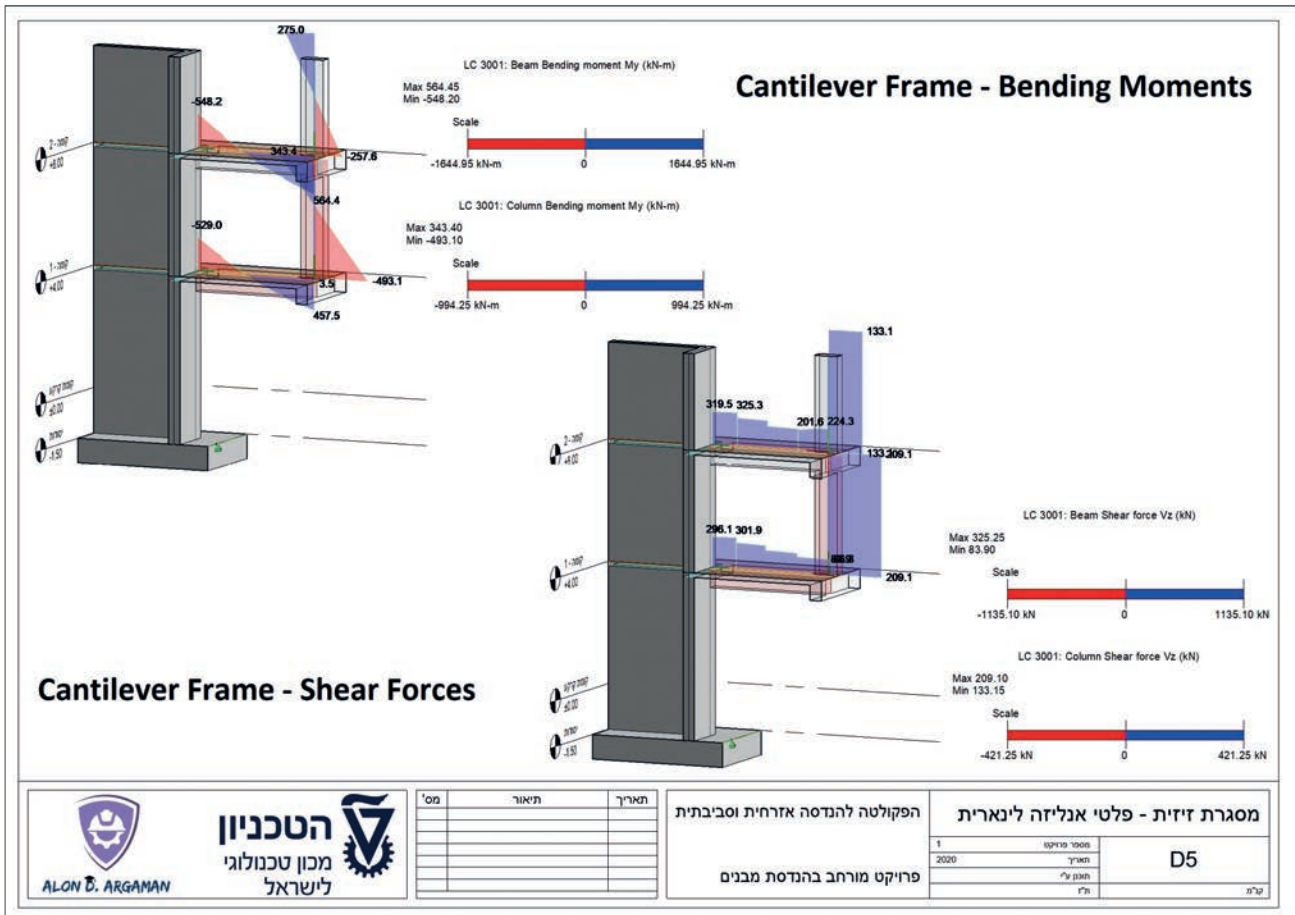
The future of BIM in academy and industry

Exposure to such advanced tools raises the question: Why do we, in the construction industry, insist on working with outdated tools and are willing to waste time and money on design errors, inaccuracies and inefficient work? Is it the academy that does not provide us with the tools or is it perhaps the industry that chooses to work with the tools to which it has become accustomed?

We must understand that lack of technological progress has a high price and BIM software is here to stay. Our world is three-dimensional and therefore it is more intuitive to work in this way through the use of models and the neglect of two-dimensional blueprints.

Today we are witnessing an increase in the use of BIM software, both on site using tablets and in engineers' offices, and for even more revolutionary BIM integrations such as the use of machine learning, laser scans and drones. As we adopt such approaches and keep an open mind for continuous learning, we will elevate the construction industry from low-tech to hi-tech.





הטכניון
מכון טכנולוגי
לישראל

מס'	תאור	תאריך

הפקולטה להנדסה אזרחית וסביבתית
פרויקט מורחב בהנדסת מבנים

מסגרת זיזית - פלטי אנליזה לינארית		D5	ק"מ
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	תאריך ע"י		
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About the Author

ALON D. ARGAMAN

I, Alon D. Argaman, a Master of Science student in structural engineering at the Technion - Israel Institute of Technology, am currently researching a new way to perform the initial design of structures using advanced algorithms, especially in the field of machine learning. I am fascinated by the field of BIM in particular, and by computing in construction in general. The project presented in this report is my final project in Structural Engineering as part of my undergraduate degree and it is noteworthy that this project won the highest grade in the current school year and is even nominated for an award.





SOFiSTiK Educational Version

Your future is important to us. For this reason, we offer the SOFiSTiK Educational version (single user) free of charge with full functionality for all students and faculty from the field of civil engineering, environmental engineering, geotechnology, architecture or mechanical engineering.

It contains all the actual FEA and design programs, SOFiCAD, the Rhinoceros® interface as well as the BIM Products for Autodesk® Revit®.

Simply register, download & start up.

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