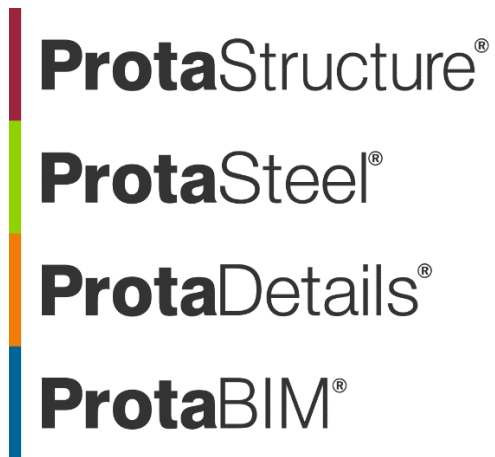




ProtaStructure Design Guide

IFC and DXF Import

Version 1.6

25 Sep 2020

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Table of Contents

Introduction	5
Shaping Your IFC & DXF Models.....	5
General Modelling Tips	5
Specific Tips for IFC.....	8
Revit IFC File.....	8
Importing IFC Files	10
Storey Information.....	10
Foundation Depth.....	10
Connectivity Tolerance	11
Profile Management	11
External Reference Drawing Management.....	12
Add	12
Active	12
Unit	12
Storey No	12
Use Colors.....	12
Opacity.....	13
Scale Factor.....	13
Move & Offset	13
Import.....	13
Importing DXF Files.....	14
Importing Floor Plans.....	14
Layers.....	15
Add/Replace	16
Unit of File	16
Connectivity Tolerance	16
Storey Information.....	16
Min Beam Length.....	17
Max.Beam Width	17
Default Beam Height.....	17
Default Slab Thickness	17
Default Pile Length.....	17
Importing 3D Physical DXF Models	18

Supported Entities	18
Add/Replace	18
Unit of File	18
Connectivity Tolerance	19
Importing 3D Analytical Models.....	20
Add/Replace	20
Unit of File	20
Thank You	22

Introduction

This guide shows how you can take advantage of importing IFC, 2D, and 3D DXF and analytical data into **ProtaStructure** to start or enhance your project models quickly. Procedures and scope are discussed.

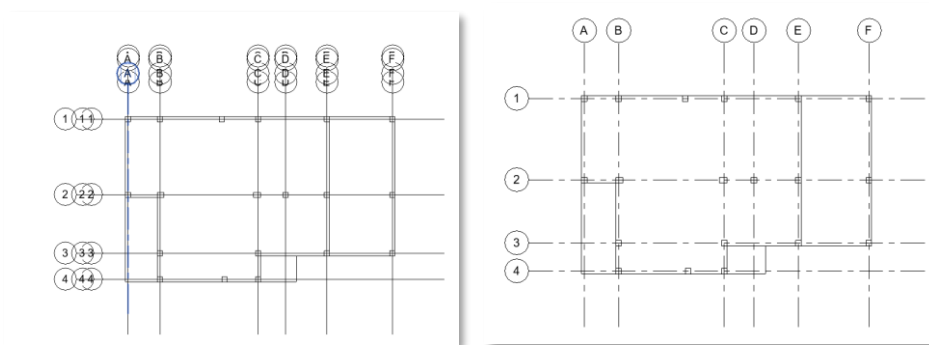
Please also refer to our ProtaBIM guide for integration with Revit.

Shaping Your IFC & DXF Models

General Modelling Tips

We recommend the following 'best practice approach' for importing IFC and DXF data into ProtaStructure to help establish valid models.

- Overlapping grids must be avoided to ensure the analytical model can be properly prepared.

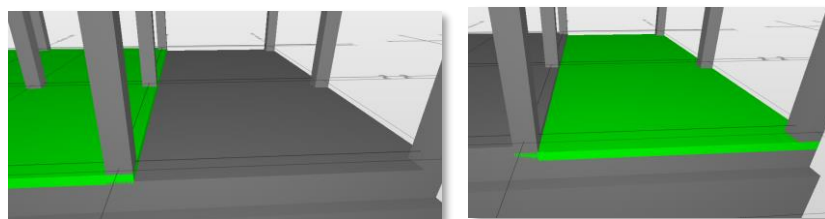


Example for Grids (Inappropriate at the Left – Appropriate at the Right)

While preparing the finite element models, **ProtaStructure** uses grids to form the nodes, which are derived from the grid intersections.

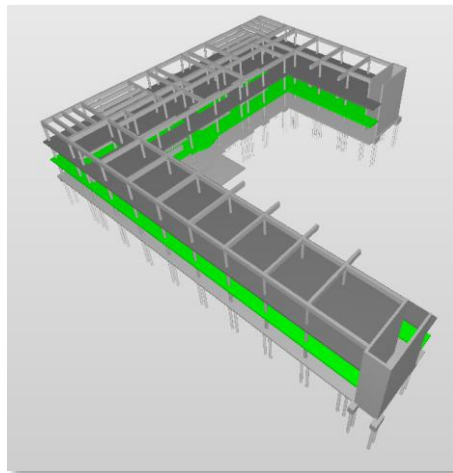
If grids to define elements do not exist, they can be generated automatically. However for best results we would recommend that grids are pre-defined to locate every element.

- Overlapping slabs must be avoided. They may touch at the edges for flat slab models, and they may either be defined at the beam edges or the grid boundaries for frame system models.



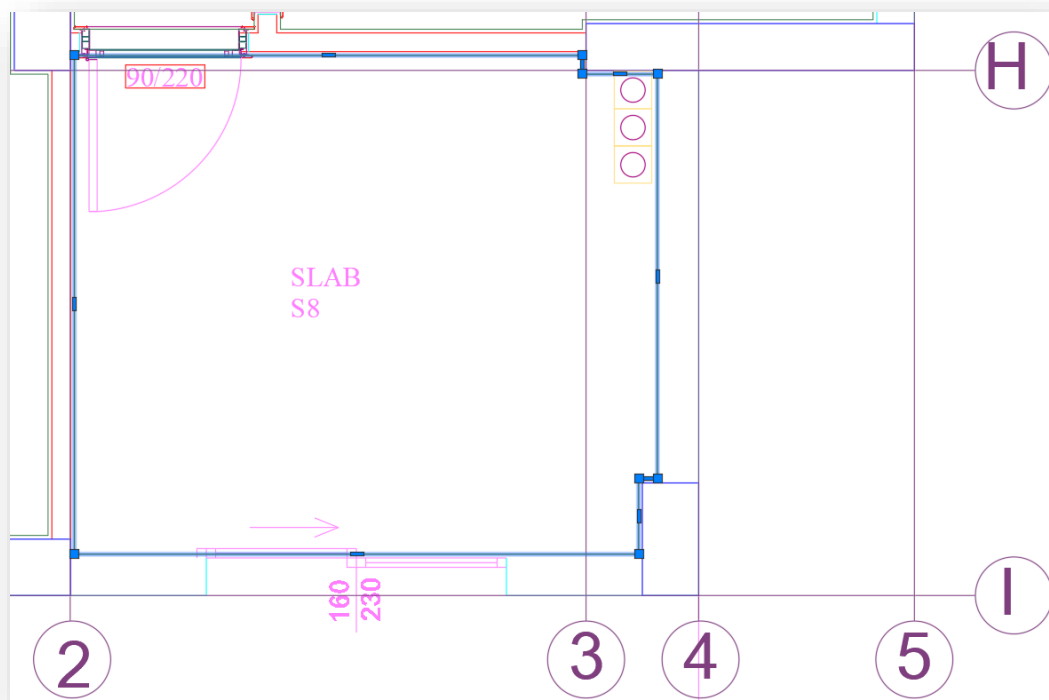
Structural Elements Such as Slabs and Footings Shall be Modeled Appropriately for Analysis

- Defining the slab as a single piece is geometrically correct but creates problems when creating the analytical model. We would not recommend this approach.

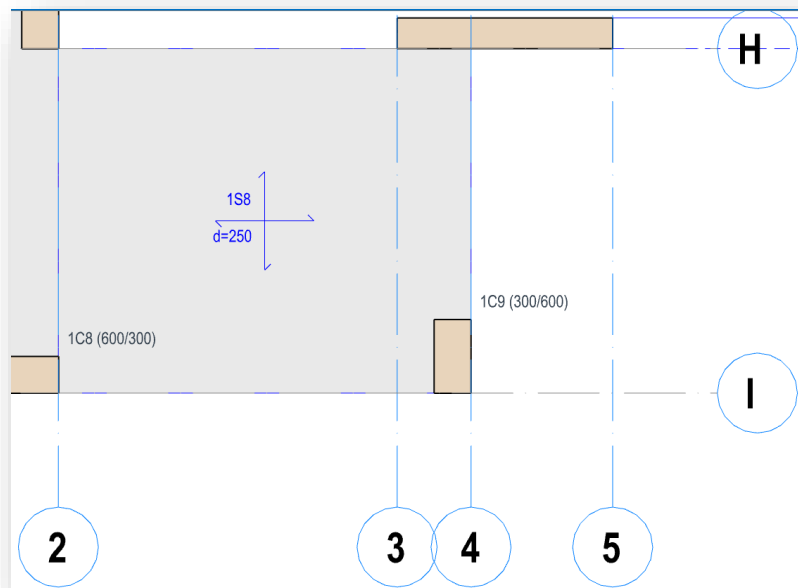


- Slab edges should lie on axis grid lines. A slab edge may consist of multiple points as long as those points are close to a grid line. These points will be removed and this edge will be considered to lie on that related grid line.

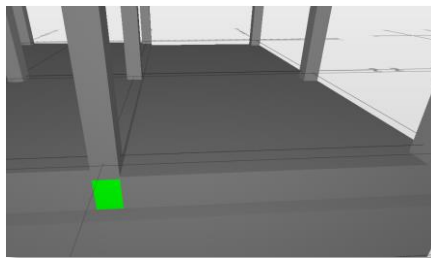
Below you can find an image of a slab from an architectural dxf file. Please note that the grids and polyline edges are not overlapping at axis 4 and H.



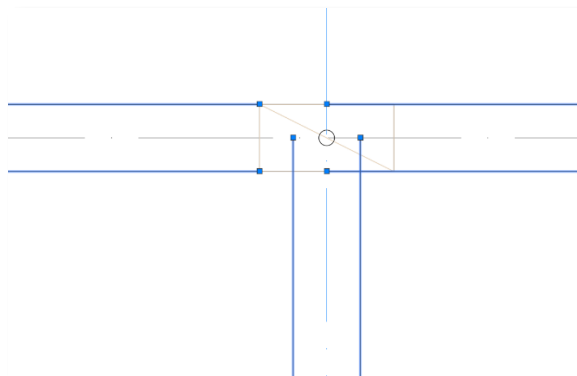
Above slab will be imported into ProtaStructure as a flattened rectangular slab as shown below.



- Columns should **not** extended and overlap into other vertical members (walls or columns for example) above or below there position. However, it is ok to overlap with beams or slabs at the joints where they are defined.



- Beams joining at intersections on the plan can be overlapped at the joints. All highlighted lines are valid for beam definitions in the below image.



Specific Tips for IFC

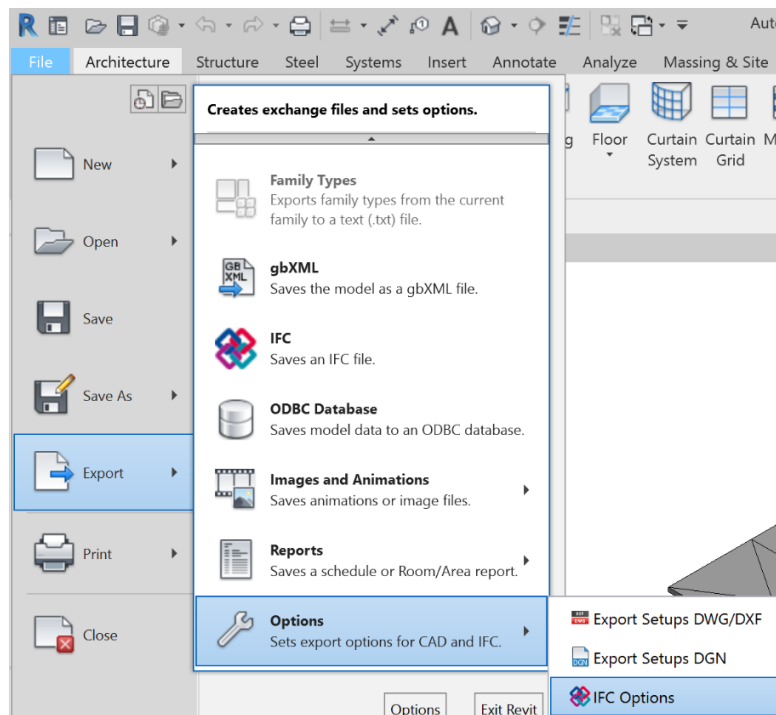
As each software exports IFC files according to its implementation, we recommend you to take a look at the export options of your software.

ProtaStructure works with stories and grids. Hence, it is essential to define and export these entities while preparing the project and IFC file.

Using **Brep** representations should be avoided in IFC models as much as possible since the complex geometry of **Brep** elements can cause errors in creating an effective structural model. For extrusion elements, however, IFC offers a variety of profile types that can be used to import into ProtaStructure.

Revit IFC File

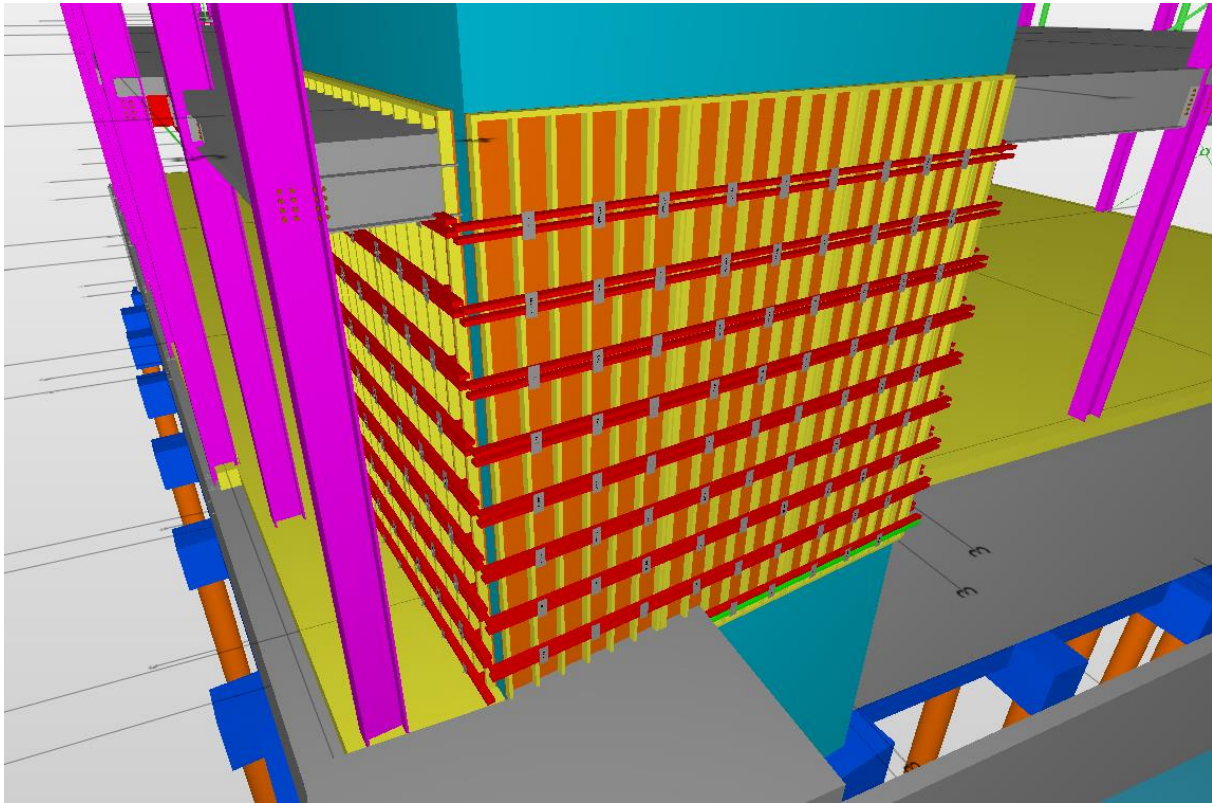
By default, Autodesk Revit does not export the **IfcGrid** entity, which is used to define the axes in Prota Structure. You can alter the export options in Revit to export the **IfcGrid** entities. Go to **File > Export > Options > IFC Options**. From **Revit Category**, go to **Grids**. Set IFC Class Name of Grids to **IfcGrid** so that Revit will export grids.



IFC Export Classes: C:\ProgramData\Autodesk\RVT 2020\exportlayers-ifc-IAI.txt		
Revit Category	IFC Class Name	IFC Type
Grids	IfcGrid	

Assembly Elements

IfcElementAssembly represents several element types. These elements consists columns, beams, frame members and so on. In order to prepare the finite element model appropriately, these elements shall have proper grid definitions. The screenshot below shows element assemblies which include several column members without grids.



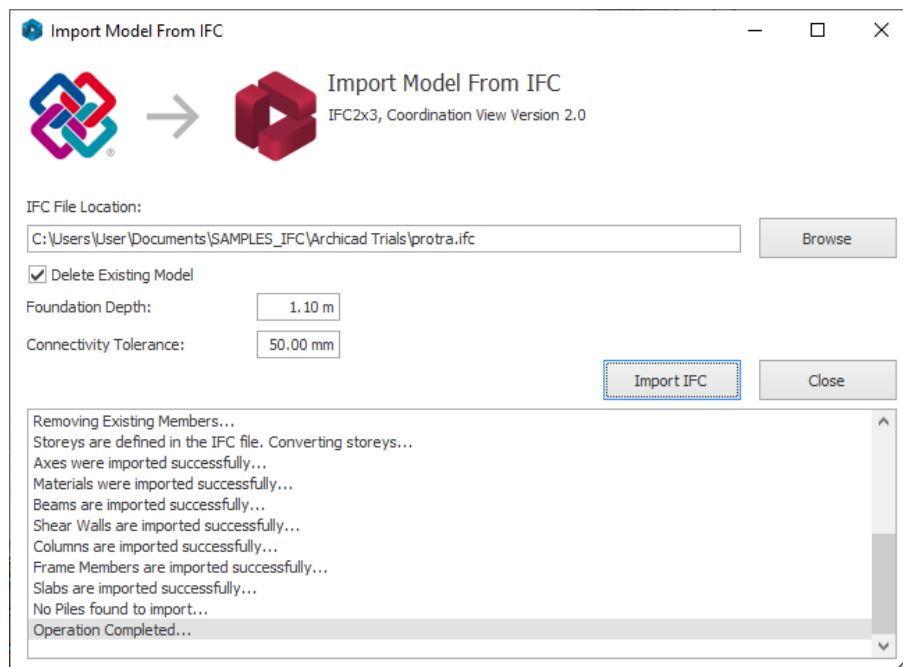
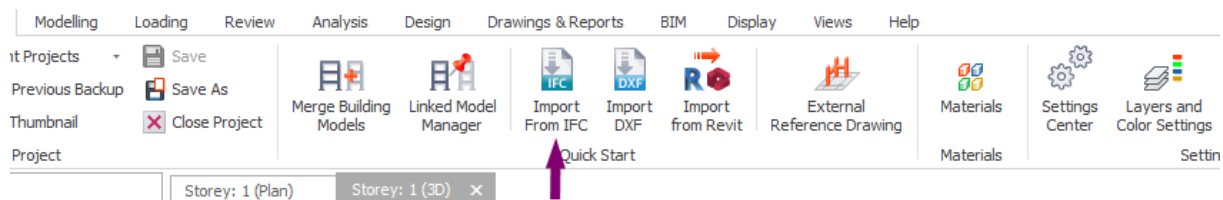
Although the non-existing axes will be generated automatically, this type of situation causes the finite element model to include many different nodes for each column in the assembly, thus the model is not correct. This problem can be easily solved by using some diagonal axes during the modeling phase and the import will be more accurate.

Importing IFC Files

IFC 2x3 Coordination View data can be imported into **ProtaStructure**. Supported member types are column, shearwall, beam, slab, mat foundation, pad footing, pile, and frame members.

Tip: If the type of a member is not explicitly defined in the IFC file, this member is imported as a general Frame Member, which can be converted to trusses and other macro members later.

IFC import can be accessed from the QuickStart Menu



Storey Information

Level information can be defined in an IFC file. However, existing architectural or structural software on the market may not export the level information as a part of their IFC implementation. If the level information exists and members are assigned to their relative levels, the import function will prepare stories according to the given levels.

If levels are not exported, **ProtaStructure** will automatically prepare the stories using the structural member elevations defined in the model.

Foundation Depth

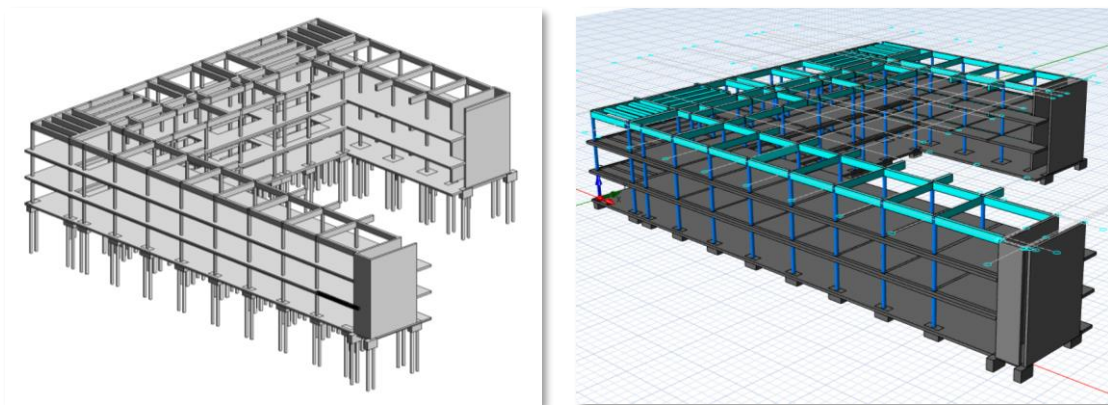
The foundation depth parameter is specific to **ProtaStructure** and is used for more accurate detailing. Hence you will not be able to find any foundation depth parameter called 'Foundation depth' in an IFC file. You can provide the foundation depth value here for a quick setup.

This tolerance helps **ProtaStructure** to properly assign grids to shearwalls, beams, and columns, even if appropriate nodes of the grid system are outside the borders of those members' geometrical existence.

DXF > ProtaStructure

If the IFC file includes pre-defined IFC profiles, a dialog is displayed at the end of the import process to match these profiles with the **ProtaStructure** database.

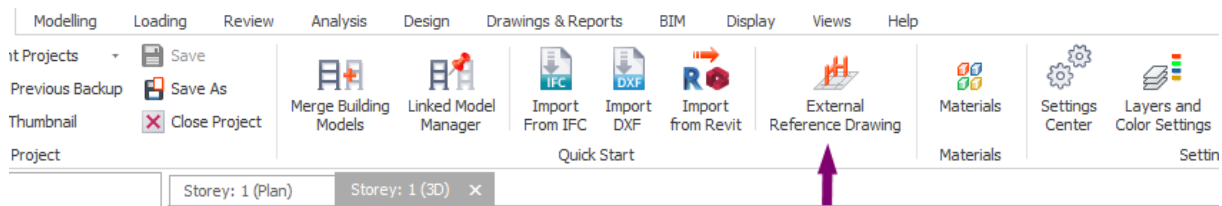
Section Label	Shape Type	Width:	Height:	Area	Search in DB	DB Profile Label	DB Width:	DB Height:	DB Area
527	_U	50 mm	100 mm	1265 mm ²	►	LKPCF100X50X10	50 mm	100 mm	1300 mm ²
443	_I	300 mm	300 mm	11700 mm ²	►	LKC30 SX30SX97	305 mm	308 mm	12300 mm ²
446	_I	165 mm	303 mm	5064 mm ²	►	LKB30 SX16SX40	165 mm	303 mm	5130 mm ²



Model Defined in IFC File and imported into ProtaStructure

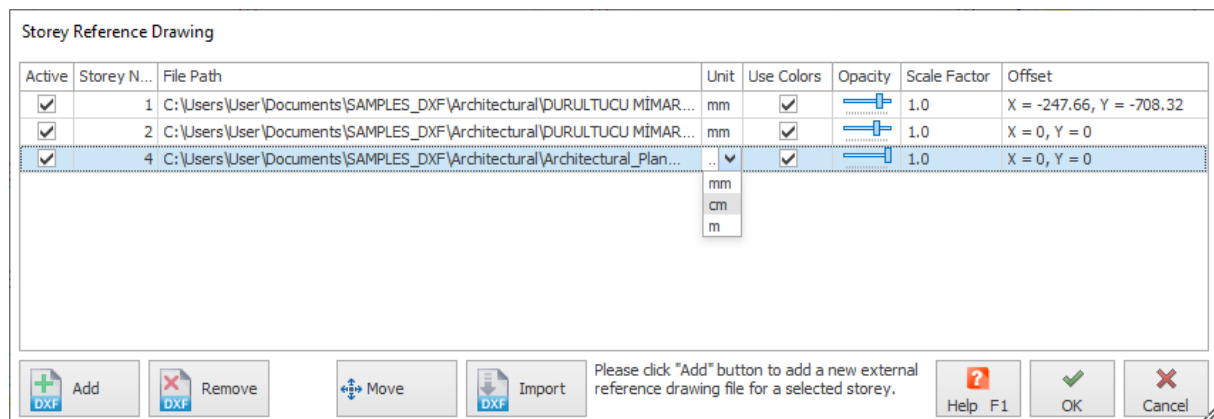
External Reference Drawing Management

ProtaStructure allows you to load external DXF drawings and show them as ghost reference layers under your model. *External Reference Drawing* button can be found under the *Quick Start* menu.



This tool allows you to assign DXF drawings to different stories. Properties like unit, opacity, scale factor, and offset can be set individually for each imported file. The whole state will be saved along with the project data and can be restored; the next time project gets opened.

The referenced DXF files should be intact to restore the external drawing layer next time the project gets loaded.



Add

Click *Add* to select and load a DXF file. The file will be converted into 2D drawing entities inside **ProtaStructure** directly upon loading. However, it will not be visible until the *Active* box is checked.

Active

This checkbox controls the visibility status of the external drawing.

Unit

Please select the correct unit of the DXF file from the unit column of the table right after the loading of the file. The drawing will be scaled immediately.

Storey No

The imported file will be assigned to the active story initially. You can use the 'Storey No' column to assign it to any other story. Only one drawing can be attached to a specific story.

Use Colors

If this field is checked, colors defined in the file will be used, if unchecked, a grayscale drawing is displayed.

Opacity

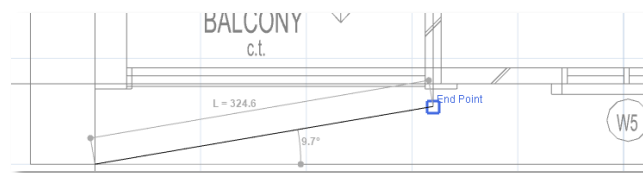
This parameter controls the opacity of the colors. This field applies only if drawing colors are selected to be used.

Scale Factor

This factor scales the whole drawing.

Move & Offset

Click the 'Move' button and pick two points on the plan view to move the external drawing. Dynamic Input functionality (hit F2) can be used here as well. The offset value between the two picked points will be shown at the 'Offset' column of the table.



Import

The selected reference drawing can be imported into the assigned story. 'Import DXF' interface will be loaded with pre-defined Storey and file unit values in this case. The drawing can be imported on top of the existing model in this mode.

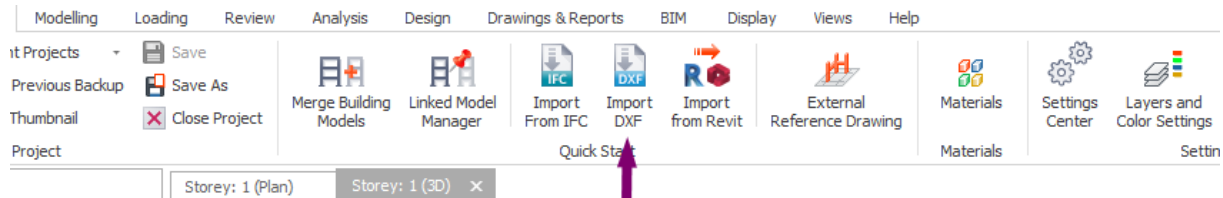
A full model can be developed from scratch in a controlled environment using the 'External Reference Drawing' interface and Import option.

Please see *Importing Floor Plans* for further details.

Importing DXF Files

Three options are available for DXF import into **ProtaStructure** which can be accessed from the *QuickStart* Menu, *Import DXF* button

1. *Floor Plan (a pre-defined structural floor-plan for example)*
2. *3D Physical Model*
3. *3D Analytical Model*

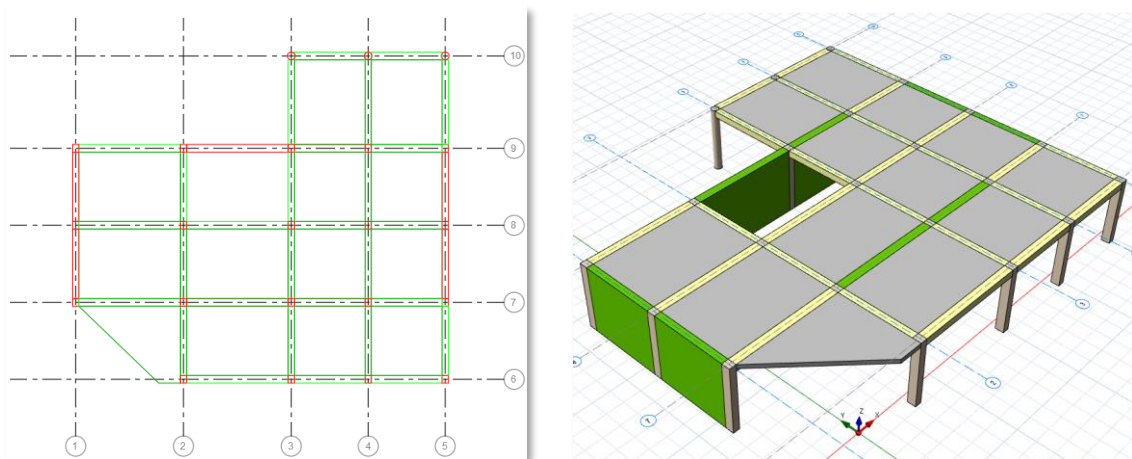


If you are importing a drawing which you also wish to use overlay against your model for coordination purpose, please use the '**External Reference Drawing**' option.

Please note that member definitions usually vary significantly from one software to another. **ProtaStructure** uses grid systems to be able to create a high-precision structural model out of physical members for analysis, design, and detailing purposes. Since DXF is not a data-rich format, its not always possible to capture all the modeling information such as connectivity and grid relations, sections, and eccentricities. We generate these from the primitive data read from the file. However, you may have to edit and refine information further once you have it in **ProtaStructure**.

Importing Floor Plans

Floor plans can be imported and transformed into 3D modeling elements.



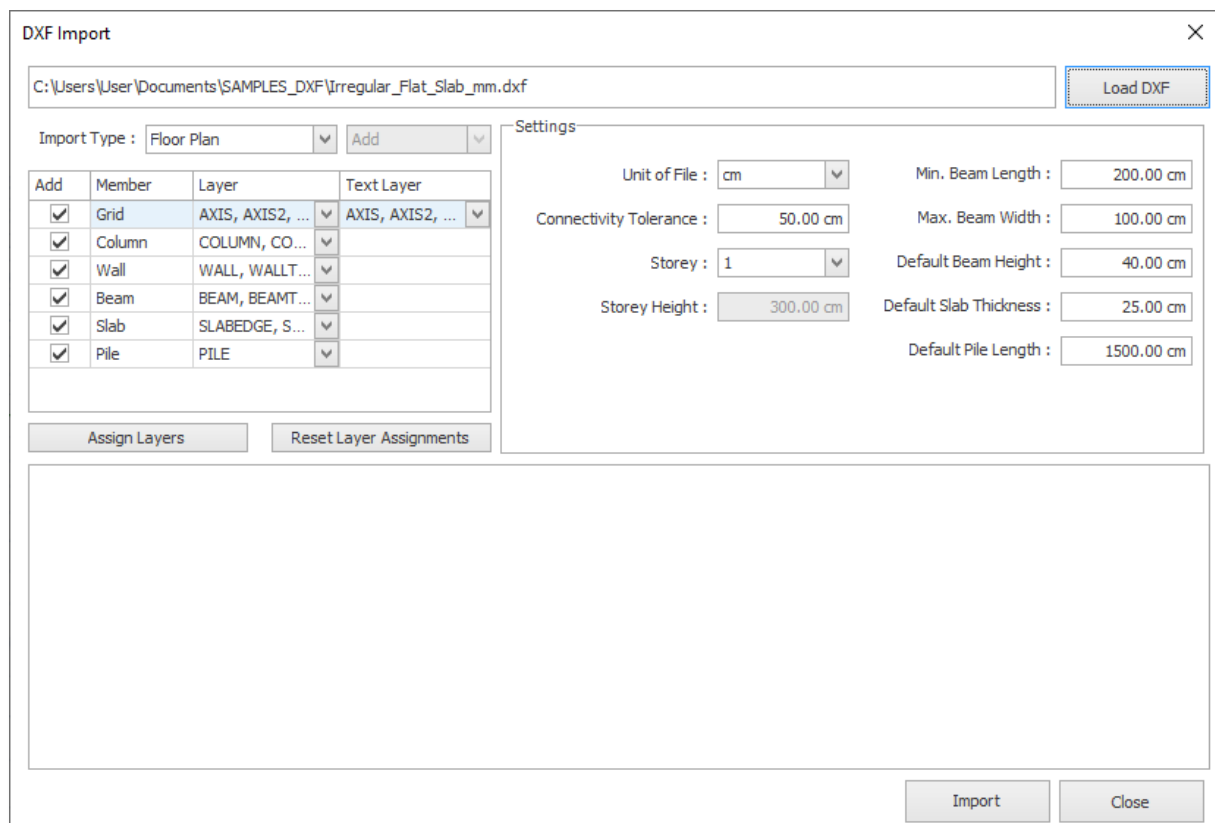
DXF > ProtaStructure

DXF import module reads primitive CAD objects and converts them to structural members as grids, columns, beam, shearwalls, slabs, and piles. The below table shows supported CAD entities for 2D drawings.

Structural Member	Supported CAD Entity Type
Grid	Polyline, line
Column	Polyline, line, circle, block
Shearwall	Polyline, line
Beam	Polyline, line
Slab	Polyline
Pile	Polyline, circle

Tip: Grid definitions are not a MUST. If they are not provided, they will be generated automatically, considering all the imported structural members.

Please select the DXF file using the “**Load DXF**” button. The file will be read immediately.



Layers

Each member type should be defined on different layers in the DXF file.

The layers in the file are scanned for keywords to spot possible layers that may be used for entities defining structural members in **ProtaStructure**.

The layer detection is done automatically upon the DXF file load.

If layers for a specific member type are not recognized, please use the dropdown list to assign the layers manually.

You can make multiple layer selection for each member type. At least one layer should be selected to enable that member type for import.

You can use the **“Assign Layers”** button anytime to reset all layers to the ones found by the program.

You can reset the assigned layers using **“Reset Layer Assignments”** button.

Text Layer is only necessary to relate grid labels with grids.

Add/Replace

To prevent discrepancies, Add/Replace functionality is disabled for *Floor Plan Import*. Members will be added to the existing model. Existing members in the model (if any) will not be removed.

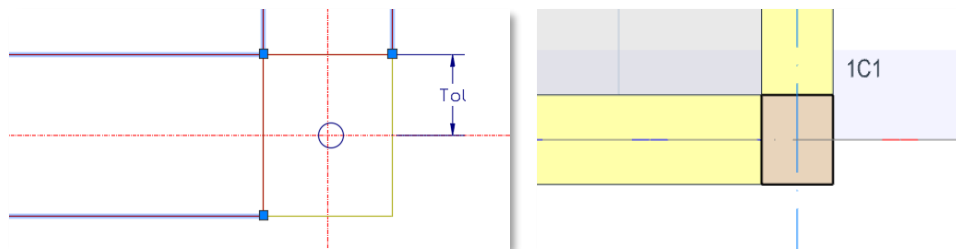
Unit of File

Please select the unit of the DXF file you load.

Connectivity Tolerance

This tolerance helps **ProtaStructure** to correctly assign grids to shearwalls, beams, and columns, even if nodes of the grids are outside the borders of those members’ geometrical definition.

Connectivity tolerance should be larger than the distance measured from the beam or shearwall boundary to the grid intersection.

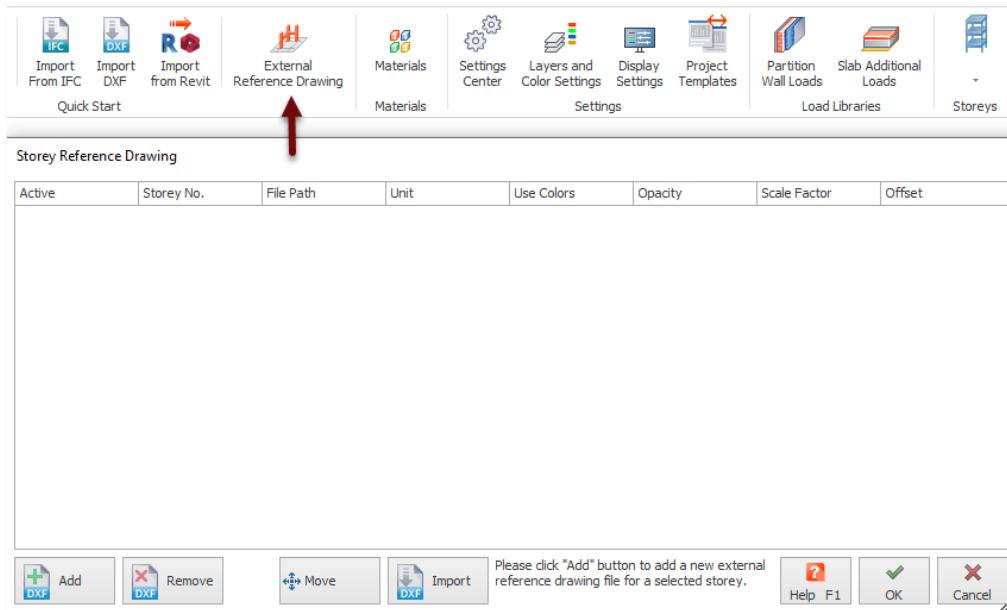


DXF > ProtaStructure

Storey Information

Select the Storey on which the model is to be generated. The current Storey will be selected upon the form opening.

If you are going to create a full model out of 2D floor plans, you’ll need to create the stories first. You may also find it easier to use the **External Reference Drawing import** command for this. It helps to manage all drawings from a single interface and links to the DXF import interface.



Min Beam Length

The length of a DXF line entity should be higher than this value to be eligible to form a beam.

Max.Beam Width

The import module checks all parallel lines against possible beam formation. Distance between two parallel lines should be less than this value to form a beam.

Default Beam Height

Beam sections will be generated using the measured beam width and this value.

Default Slab Thickness

This parameter can be used to assign the default thickness for the imported slabs.

Default Pile Length

This parameter can be used to assign default length for the imported piles.

Importing 3D Physical DXF Models

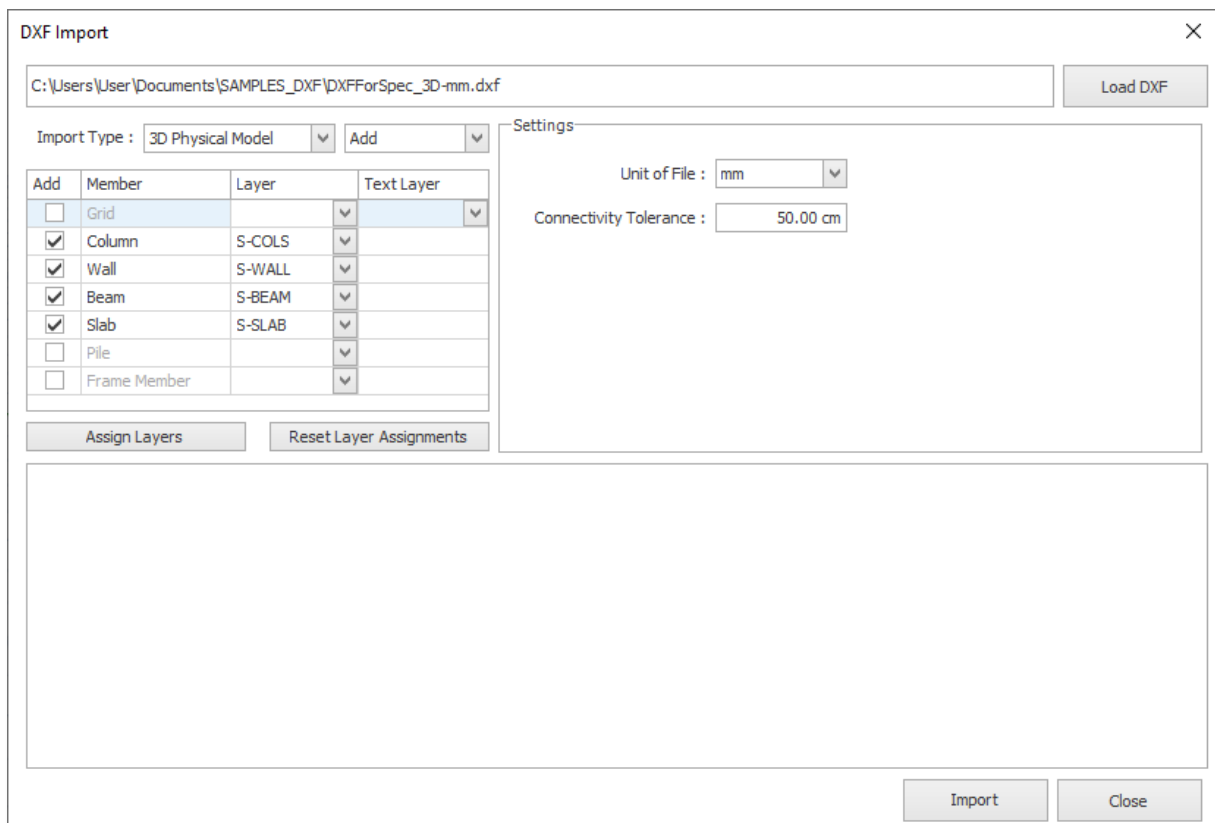
A structural model can be created or enhanced by directly importing a 3D DXF file. However, if an IFC file can be provided by a 3rd party software, we strongly recommend using it instead of a DXF file. IFC files are typically more data-rich, and **ProtaStructure**'s IFC support is far more extensive.

The 3D Model generation will not prompt for story selection. Instead, all the stories are generated automatically from the z-coordinates of the members.

Supported Entities

Members should be defined using **PolyfaceMesh Entities inside Blocks** in the DXF file to be imported into **ProtaStructure**.

Tip: Allplan exports 3D DXF files using Solid3D. This is not supported by **ProtaStructure** yet. Please use their IFC export instead.



The DXF Import dialog box is shown with the following details:

- Title Bar:** DXF Import
- File Path:** C:\Users\User\Documents\SAMPLES_DXF\DXFForSpec_3D-mm.dxf
- Load DXF:** Button
- Import Type:** 3D Physical Model (dropdown), Add (dropdown)
- Settings:**
 - Unit of File:** mm (dropdown)
 - Connectivity Tolerance:** 50.00 cm
- Table:**

Add	Member	Layer	Text Layer
☐	Grid		
☒	Column	S-COLS	
☒	Wall	S-WALL	
☒	Beam	S-BEAM	
☒	Slab	S-SLAB	
☐	Pile		
☐	Frame Member		
- Buttons:** Assign Layers, Reset Layer Assignments, Import, Close

Tip: Grid definitions will be generated automatically, considering all the imported structural members.

Add/Replace

Both Add and Replace options can be used for a 3D model import. Add option will merge the imported model with the existing one. Replace option will remove all the existing members and place the imported model.

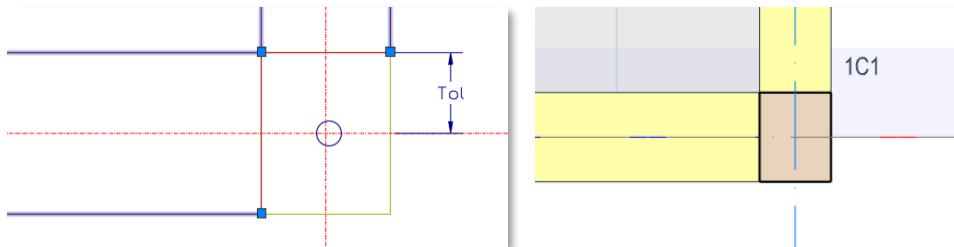
Unit of File

Please select the unit of the DXF file you wish to load.

Connectivity Tolerance

This tolerance helps **ProtaStructure** to correctly assign grids to shearwalls, beams, and columns, even if appropriate nodes of the grid system are outside the borders of those members' geometrical existence.

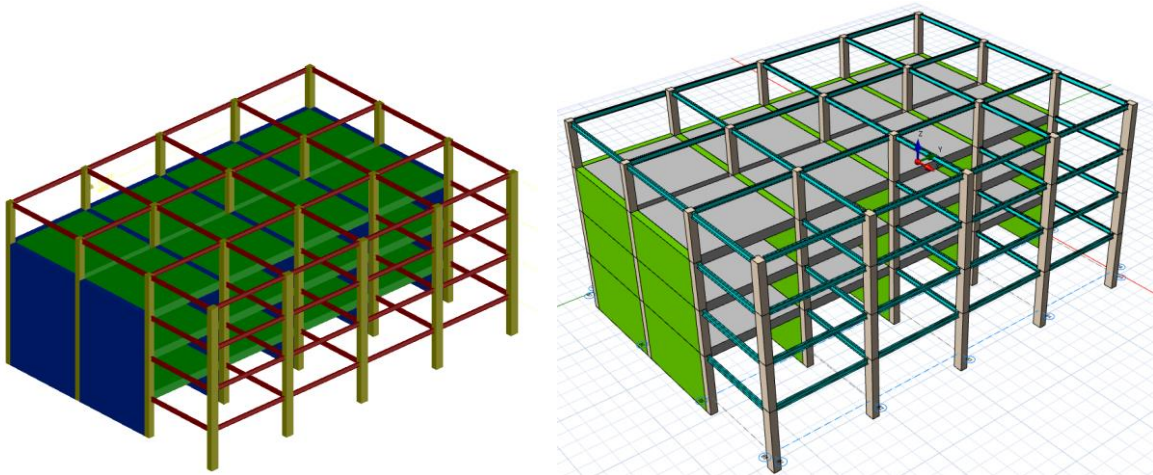
Connectivity tolerance should be higher than the distance measured from the beam or shearwall defining entity endpoints distance to a grid intersection



DXF > ProtaStructure

Storey Information

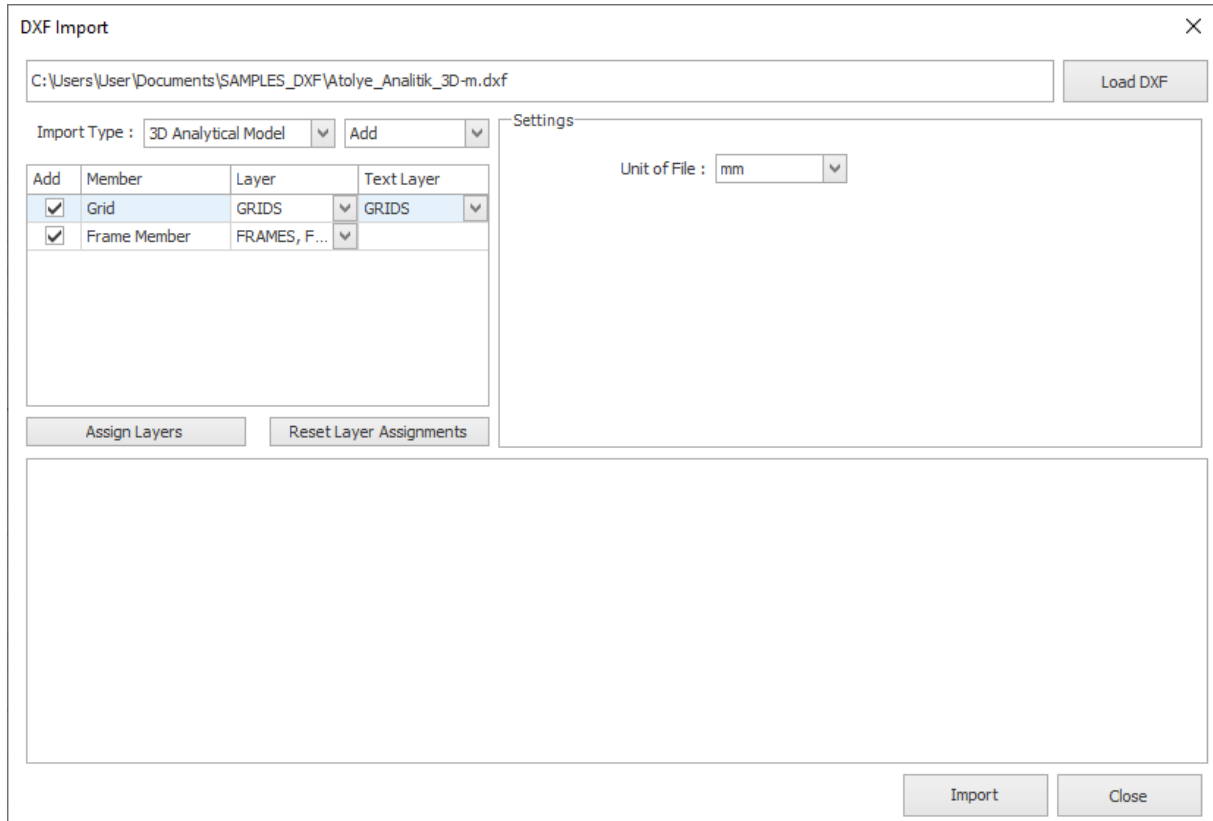
Storeys should have been defined in ProtaStructure to match with the storey scheme of the model in the DXF file. For example, if there are 3 shearwall panels on top of each other in 3D then at least 3 different stories with z coordinates closer to those panel top z coordinates should exist. No exact match is required. The difference between shearwall top and storey levels will be assigned as DelZ (offset) values to shearwalls. This applies for other member types as well.



3D DXF > ProtaStructure

Importing 3D Analytical Models

3D analytical members are imported as frame members where each line is assumed to be a frame element and imported accordingly. The layers shall be selected appropriately for accurate models. The sections are used as default and can be modified by the user after the import.



The DXF Import dialog box is shown with the following fields and controls:

- File Path:** C:\Users\User\Documents\SAMPLES_DXF\Atolye_Analitk_3D-m.dxf
- Load DXF:** Button
- Import Type:** 3D Analytical Model (dropdown), Add (dropdown)
- Settings:**
 - Unit of File:** mm (dropdown)
- Table:**

Add	Member	Layer	Text Layer
☒	Grid	GRIDS	GRIDS
☒	Frame Member	FRAMES, F...	
- Buttons:** Assign Layers, Reset Layer Assignments, Import, Close

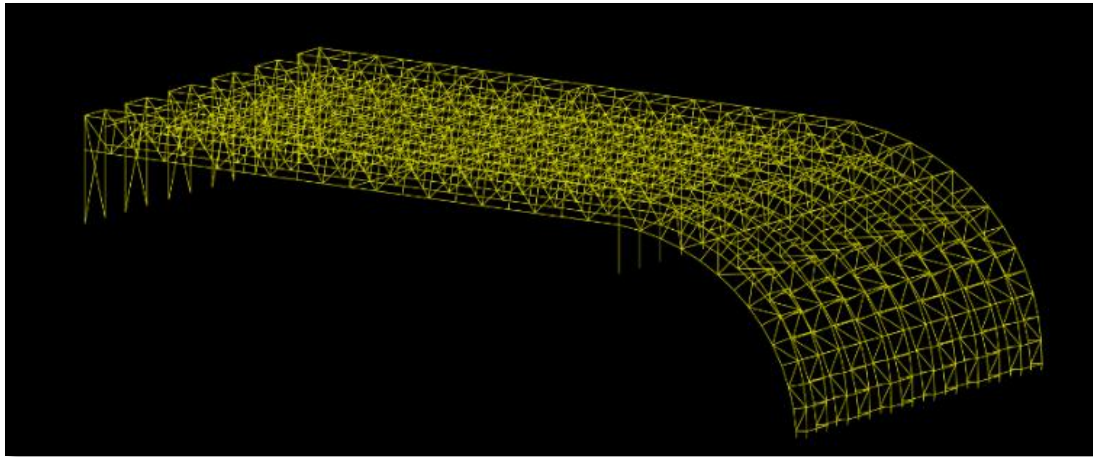
Tip: No grids will be defined for imported Analytical Models

Add/Replace

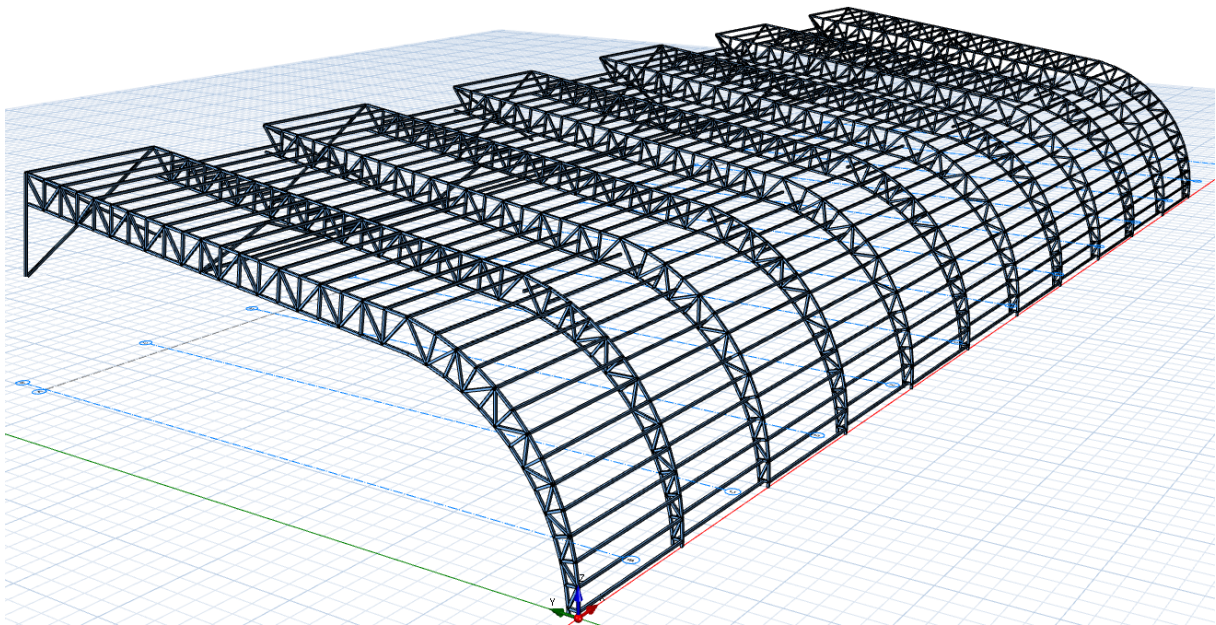
Both Add and Replace options can be used for a 3D model import. Add option will merge the imported model with the existing one. Replace option will remove all the existing members and place the imported model.

Unit of File

Please select the unit of the DXF file you load.



Analytical Model defined in DXF File



Imported ProtaStructure Model

Thank You

Thank you for choosing the **ProtaStructure** Suite product family.

It is our top priority to make your experience excellent with our software technology solutions.

Should you have any technical support requests or questions, please do not hesitate to contact us at all times through globalsupport@protasoftware.com and asiasupport@protasoftware.com

Our dedicated online support center together with our responsive technical support team is available to help you get the most out of Prota's technology solutions.

The Prota Team

