

Saimaa University of Applied Sciences
Technology, Lappeenranta
Double Degree Program in Civil and Construction Engineering

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Custom Components in Tekla Structures

Bachelor's Thesis 2011

ABSTRACT

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Custom Components in Tekla Structures, 128 pages, 3 appendices

Saimaa University of Applied Sciences, Lappeenranta

Technology

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Finnmap Consulting

Bachelor's Thesis 2011

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The purpose of the bachelor thesis was to determine the creation processes of Tekla Structures custom components for balcony slab and balcony jointing elements. As a result of work, 2 custom components for balcony slab and 6 custom components for jointing tube units were created. In addition the task was to create an excel sheet for the calculation of tube joint element for connection of balcony slab to the main frame of the building. An excel calculation file was designed. Also, the work consists of general information about Tekla Structures software and general information about balconies in Finland.

All designings were made under the guidance of Finnmap Consulting Oy Company in Lappeenranta department. All works were done using computers, equipment and software of Finnmap Consulting Oy.

This thesis is a guide for beginners in Tekla Structures software because the text includes general information about Tekla Structures and detailed information about creation of custom components as an important part of Tekla Structures software.

Keywords: Tekla Structures, Custom Component, Balcony.

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1 INTRODUCTION

The bachelor thesis was written during 4 month working period at the Finnmap Consulting Oy Company under the supervision of the leader of Lappeenranta department of Finnmap Consulting Oy Company Mr. Tommi Turunen and the instructor of the thesis working at the Saimaa University of Applied Sciences Timo Lehtoviita.

This thesis should ideally be used as a guide on how to create custom components in Tekla Structures software in balcony slab and jointing element examples. Custom components help to use one unit for creation of the same or the similar parts in the building model. For example, if the building has the same balcony type but different sizes then the designer does not have to make all balconies separately. It is easy to use one ready-made custom component for a balcony element with changeable parameters. By analogy the AutoCAD software uses “block” elements.

The thesis report also includes general information about Tekla Structures software. Tekla Structures is a modern designing software with plenty of features. Most works during practice in Finnmap Consulting Oy Company were made with Tekla Structures.

Some general and detailed information about balconies in Finland was evaluated as a base for the design features of custom components (balcony types, sizes, drainage, jointing elements, calculations, etc.).

This thesis report is anticipated to help and save time when the designers start working with Tekla Structures software.

2 TEKLA STRUCTURES SOFTWARE

2.1 Tekla Structures

Tekla Structures is a tool for structural engineers, detailers, and fabricators. It is an integrated model-based 3D solution for managing multi-material databases (steel, concrete, timber, etc.). Tekla Structures features interactive modeling, structural analysis and design, and automatic drawing creation (About Tekla Structures, Tekla Structures Help). Tekla Structure model example is in figure 2.1.

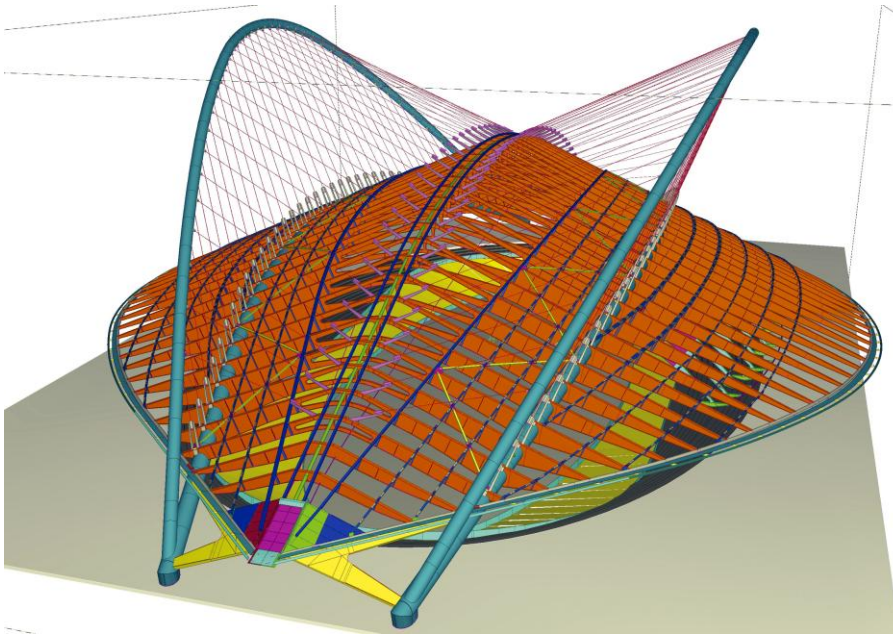


Figure 2.1 Tekla Structures Model

Tekla Structures is Building Information Modeling (BIM) software that enables the creation and management of accurately detailed, highly constructible 3D structural models regardless of material or structural complexity. Tekla models can be used to cover the entire building process from conceptual design to fabrication, erection and construction management.

Tekla Structures is one product available in different configurations (Figure 2.2 Tekla Structures configurations) and localized environments that provide specialized set of functionality to suit the segment and culture-specific needs of the construction industry (<http://www.tekla.com>).



Figure 2.2 Tekla Structures configurations

Tekla Structures, *Steel Detailing* is a standard configuration enhanced with relevant steel detailing functionality. Users can create detailed 3D models of any steel material and then generate corresponding fabrication and erection information shared by all project participants.

Tekla Structures, *Precast Concrete Detailing* is a standard configuration enhanced with relevant precast detailing functionality. Users can create detailed 3D models of concrete structures and then generate corresponding fabrication and erection information shared by all project participants.

Tekla Structures, *Reinforced Concrete Detailing* is a standard configuration enhanced with relevant cast-in-place detailing functionality. Users can create detailed 3D models of concrete structures and then generate corresponding fabrication and erection information shared by all project participants.

Tekla Structures, *Construction Management* software configuration includes functionality to manage and track project status. Users can communicate and manage information from supply to installation.

Tekla Structures, *Engineering* is a standard configuration that enables synchronised engineering. Professionals in structural engineering and design can collaborate with other project participants and stakeholders using the same shared model.

Tekla Structures, *Viewer* module includes full viewing and reporting functionality. This tool is ideal for consulting and presenting a modelled structure at any stage of the project lifecycle.

Tekla BIM sight is the free software for full viewing. There is the new BIM application for building information model-based project communication to everyone in the construction industry.

In Tekla Structures it is possible to automatically produce drawings and reports from the 3D model, at any time. Drawings and reports react to modifications in the model, and are always up-to-date.

Tekla Structures includes a wide range of standard drawing and report templates. Own templates can be made using the Template.

Tekla Structures supports multiple users working on the same project. Partners can work together on the same model, at the same time, even in different locations. This increases accuracy and quality, because you always use the most up-to-date information Editor (About Tekla Structures, Tekla Structures Help). This is very important in big companies like Finnmap Consulting Oy.

Tekla Structures includes the following features:

- Easy modeling of basic structures, such as beams, columns, and slabs.
- Useful modeling aids, such as 3D grids and an adjustable work area.
- Catalogs of available material grades, profiles, and bolts.
- Modeling tools to create complex structures, such as staircases and trusses.
- Intelligent connections, such as end plates and clip angles, to automatically connect main members.
- *A custom component editor that you can use to create your own parametric connections, details, and parts.*
- Links to transfer data between Tekla Structures and other software, such as AutoCAD, STAAD, and MicroStation.
- Drawing tools to create several drawings with one click.
- Data output for CNC machines.
- Capability to undo and redo changes you have made, so that you can test solutions, and revert to the original if needed.
- Tekla Structures is available in a wide range of languages, and adapted to local standards and requirements (Main features, Tekla Structures Help).

Tekla Structures also takes into account the region specifics the designer is working with. The environment means region-specific settings and information (Finnish, Russian and Swedish software included). It defines which profiles, material grades, default values, connections, wizards, variables, reports, and templates you use (Environment, Tekla Structures Help).

All designers and engineers familiar with CAD systems are used to work with the help of snap switches. It is a handy tool that has no alternative. Tekla Structures also has snap switches. Snap switches specify the exact locations of objects, for example, end points, midpoints, and intersections. Snap switches help to pick points

to position objects precisely without having to know the coordinates or create additional lines or points.

2.2 Custom components

Tekla Structures contains a set of tools for defining intelligent connections, parts, seams, and details, called custom components. It is possible to create own components, similar to Tekla Structures system components. Tekla Structures creates a dialog box for the custom component, which can be customized, if required.

Custom components can be used in the same way as any Tekla Structures system component. Tekla Structures contains a wide range of components that can be used to automate the process of creating a model. Tekla Structures contains large component base for different solutions and materials (Custom Component, Tekla Structures Help).

3 BALCONIES IN FINLAND

There are three different basic types of balconies in Finland:

3.1 Consol type

The support for balcony slab is at only one side. The plate is connected with bearing wall or flooring with some special connection units (Figure 3.1 Consol balcony slabs).

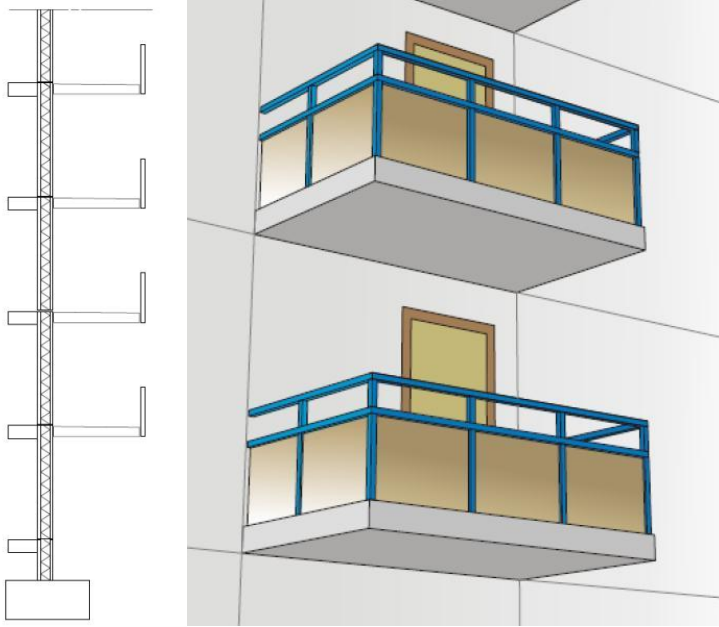


Figure 3.1 Consol balcony slab

3.2 Recessed balcony

The support of the balcony slab can be at 2 or 3 sides (rarely at 4 sides). The balcony is surrounded by wall (Figure 3.2 Recessed balcony).

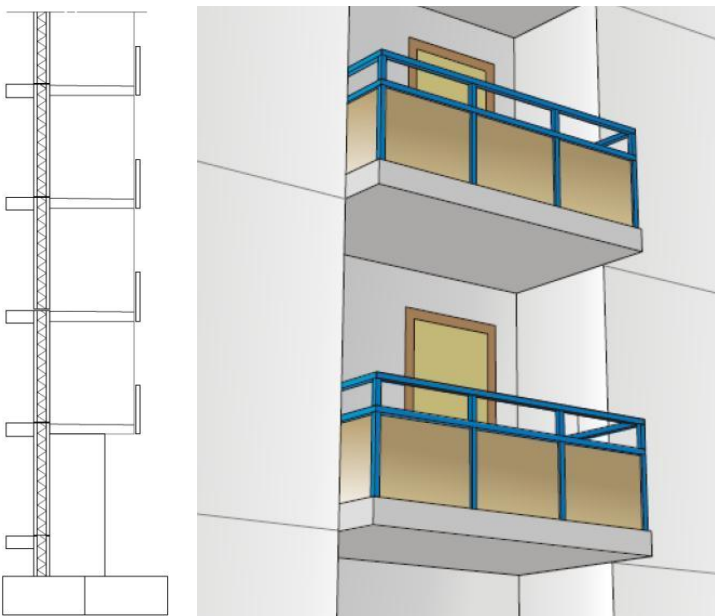


Figure 3.2 Recessed balcony

3.3 Balcony supported with columns or cables

There is an additional support of columns or cables at one or more points (Figure 3.3 Supported balcony).



Figure 3.3 Supported balcony

3.4 Choosing a balcony type

The main reason of choosing the balcony type is architectural appearance of the building. The designer making the architecture planning of the building has to decide which balcony type will be used in the building.

The cheapest type of balcony is usually consol type.

If the building already exists and some additional balconies are needed then the balconies are supported with columns or especially with cables can be installed.

In the industrial building the balcony structure can be more complicated.

3.5 Sizes of balcony slab

The width of balcony slab depends on the balcony structure, planning requirements and architecture. Usually it is 15M, 18M, 21M, 24M, 27M, 30M (1M = 100 mm).

The length of balcony slab also depends on the balcony structure, planning requirements and architecture. Usually it is less than 43M.

The length of the balcony slab can also be more than 43M when there are a derange channels with incline in 2 directions (Figure 3.4 Long balcony slab with derange channels with incline in 2 directions) and when there is an additional support such as wall or column or cable.



Figure 3.4 Long balcony slab with derange channels with incline in 2 directions

If the length is more than 60M the balcony slab has to be made of prestressed concrete.

The thickness of the balcony slab mostly depends on reinforcement, connection unit and hooks. In average it is 250 mm.

Sometimes it is good to use standardized balcony slabs or a whole balcony unit. Some construction companies can make the whole balcony unit “on turnkey basis” with designing, manufacturing and installing.

3.6 Position

The vertical distance between 2 balconies slabs has to be a multiple of 3M (1M).

The dimensions of the balcony slab in plan have to be smaller than the distance between axes by 40 mm. So that the face surface of the balcony slab is at the 20 mm distance from axis (Figure 3.5 Plan position of the balcony slab).

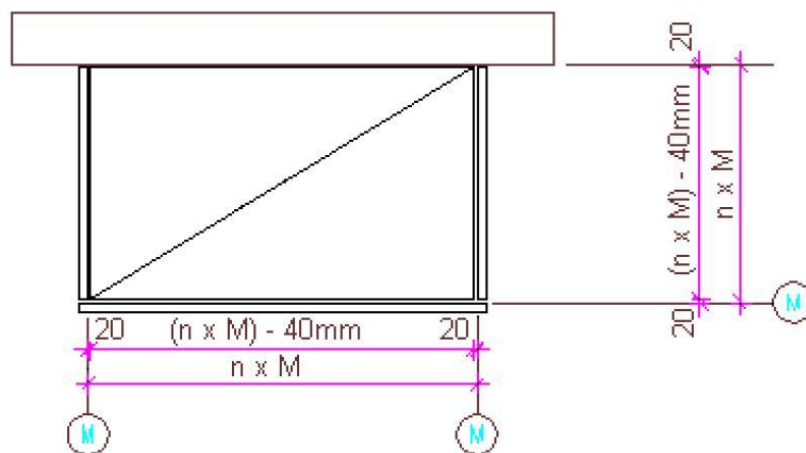


Figure 3.5 Plan position of the balcony slab

In accordance with Finnish standards F1 Esteetön rakennus the difference in height between the inside floor surface and the balcony door threshold should be less than

25 mm. Also the difference in height between the ready surface of balcony floor and the door threshold should be less than 25 mm. However, it is allowed to make the concrete surface of balcony slab more than 100 mm down from the door threshold because of some internal finished floor surface of the balcony (Figure 3.6 Position of balcony elements).

The height of the fencing in the balcony must be more than 1000 mm from the finished floor surface.

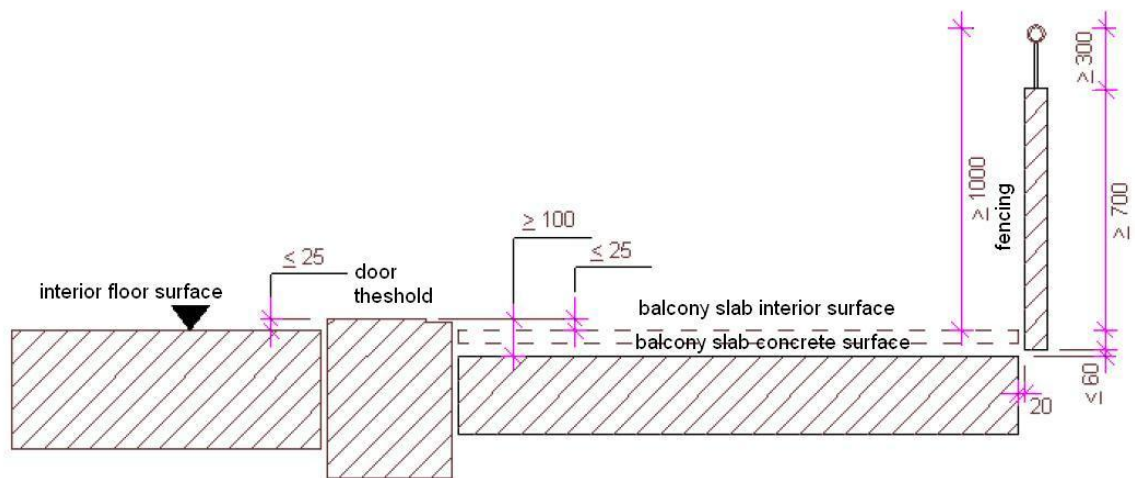


Figure 3.6 Position of balcony elements

The bottom surface of fencing has to be less than or equal to 60 mm from the concrete slab. The main part of the fencing should be at least 700 mm. The additional handrail should be at least 300 mm.

3.7 Rain water

The rain water must be removed from the balcony slab to outside area. A slab with incline in one direction is not good enough for that. In this case the moisture can get to the wall, floor or other building construction elements.

Some rules have to be taken into account in balcony slab designing:

- The slab surface incline is mandatory. Usually it is inclining with the angle 1:80.
- Water channels are also required. The incline for water channels should be with the one direction when plan size of the balcony slab is smaller than 43M or with two directions when plan size of the balcony slab is larger than 43M (Figure 3.7 Drainage requirements).
- Water should go directly to the tube drainage through the water collector. The diameter of tube has to be around 50-70 mm.
- The collector and tube hole have to be in the right position at the bottom point of the slab.
- It is recommended to have some heating of drainage in case of open balcony construction.

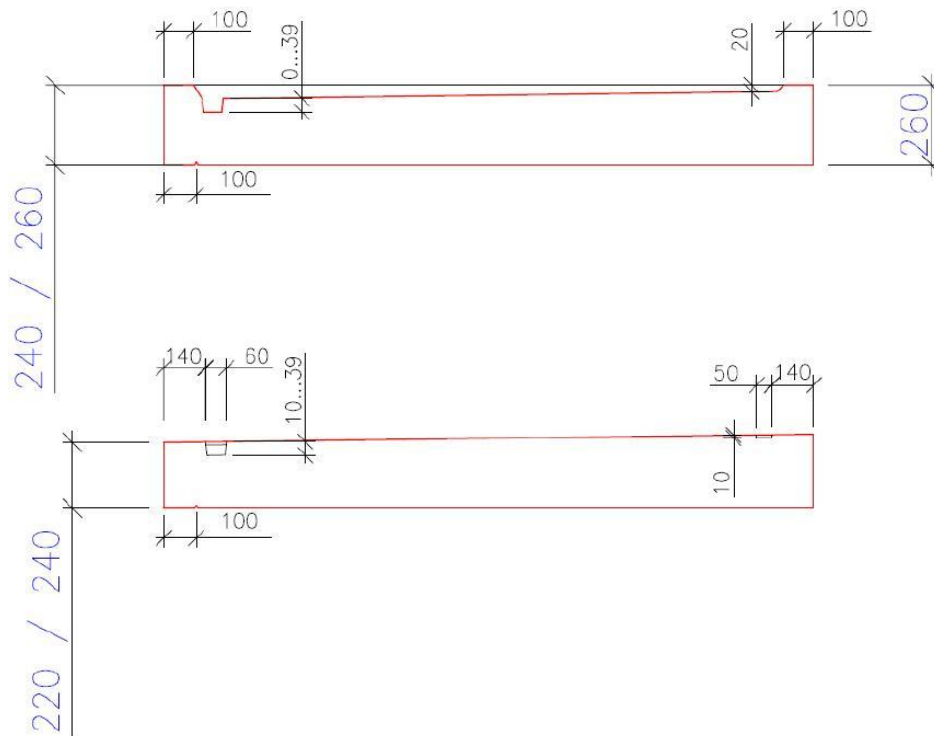


Figure 3.7 Drainage requirements

The water insulation also has to be taken into account. It is possible to use higher density concrete or finishing exterior and interior material like plastic materials.

Removal of moisture from the balcony roof is also mandatory. The roof incline has to be at least 1:60.

Between the balcony slab and the wall a special plastic layer should be installed (Figure 3.8 Plastic layer).

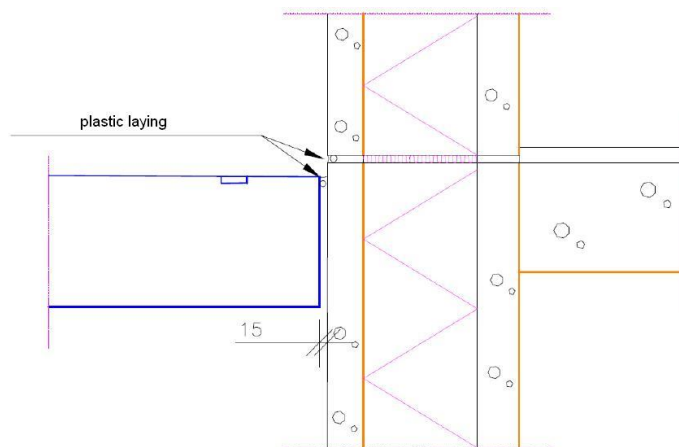


Figure 3.8 Plastic layer

3.8 Loads

There are 5 main loads to be considered during calculation of balcony slab:

- Own weight of balcony slab.
- Loads from people, furniture, and equipment.
- Own weight of other construction elements in the balcony like handrail.
- Wind load.
- Snow load.

In some special cases the designer has to take into account other factors, such as wind load for fencing, load from people to handrail.

In accordance with SFS-EN 1991-1-1 Table 6.2 Imposed load on balconies are $q_k=2.5-4.0 \text{ kN/m}^2$ (uniformly distributed load) and $Q_k=2.0-3.0 \text{ kN}$ (concentrated load).

The temperature deformations load is also an important part of calculation. The fire resistance class for balcony should be at least R30.

3.9 Jointing units

There are plenty of choices for balcony connections with the main frame of the building. Nowadays different factories produce many different joint units for connection of balcony slab with walls or slabs in the main frame of the building.

For example, Peikko group produces several types of connection units (Figure 3.9 PS balcony hinge by Peikko and Figure 3.10 P4 railing connection by Peikko).

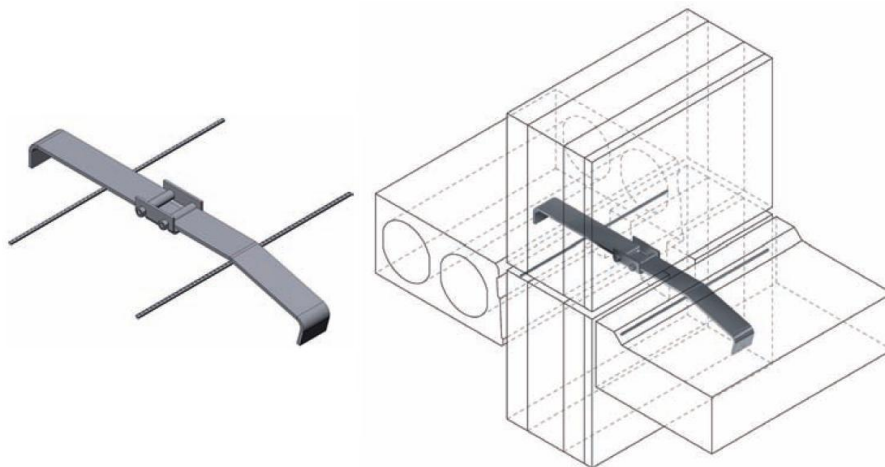


Figure 3.9 PS balcony hinge by Peikko

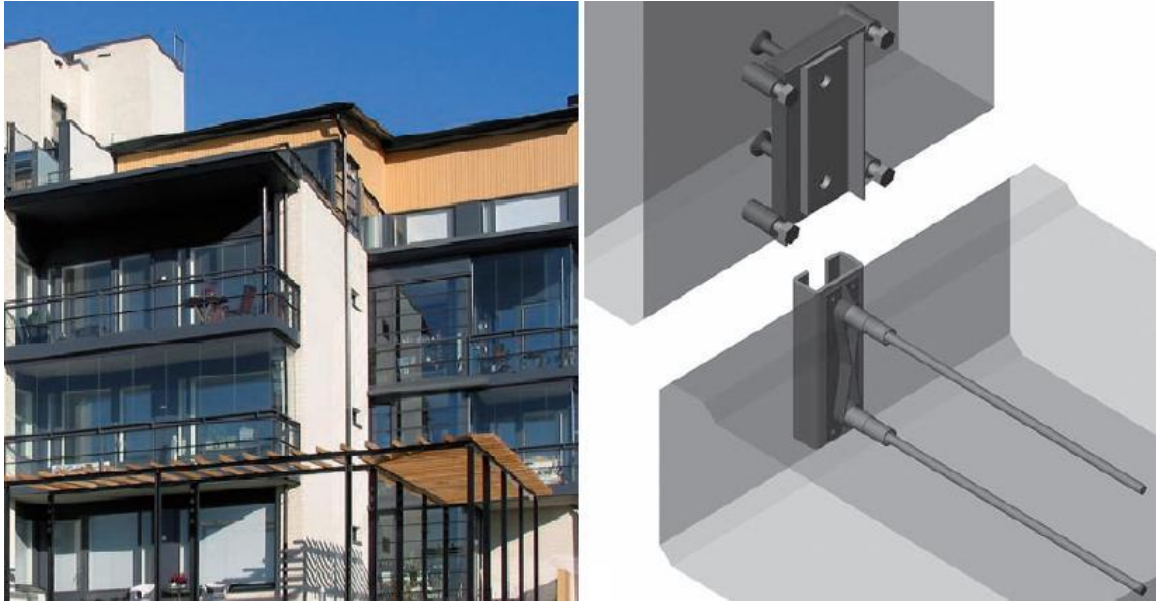


Figure 3.10 P4 railing connection by Peikko

The cost of these types of jointing can be quite high. However, all readymade elements are unified and the installation of elements with Peikko connection units is really fast and the construction company can save a good amount of money.

If the balcony construction includes cable support then the jointing unit of cable and balcony slab usually looks like in Figure 3.11

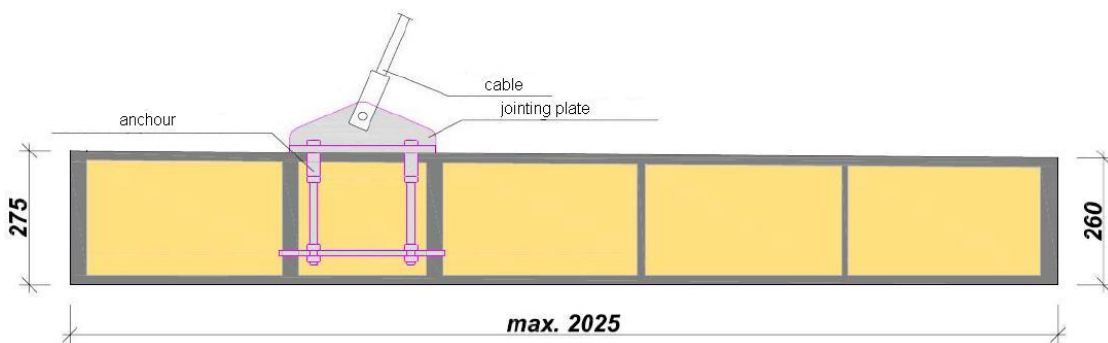


Figure 3.11 Cable – Slab connection

If the building is with recessed balcony then the connection between the balcony slab and the side walls looks like in figure 3.13.

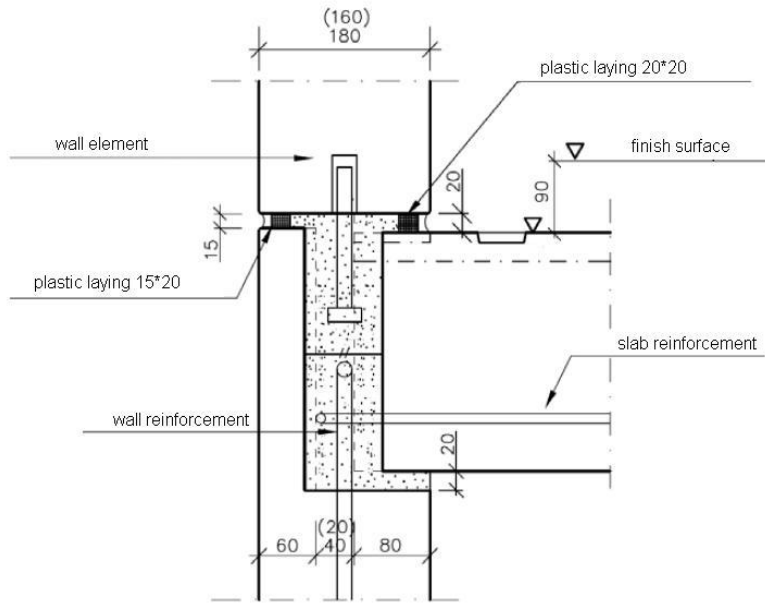


Figure 3.12 Slab-Back Wall connection

Also there is an example (Figure 3.13 Fencing Wall – Slab connection) of connection between the fencing wall and the balcony plate.

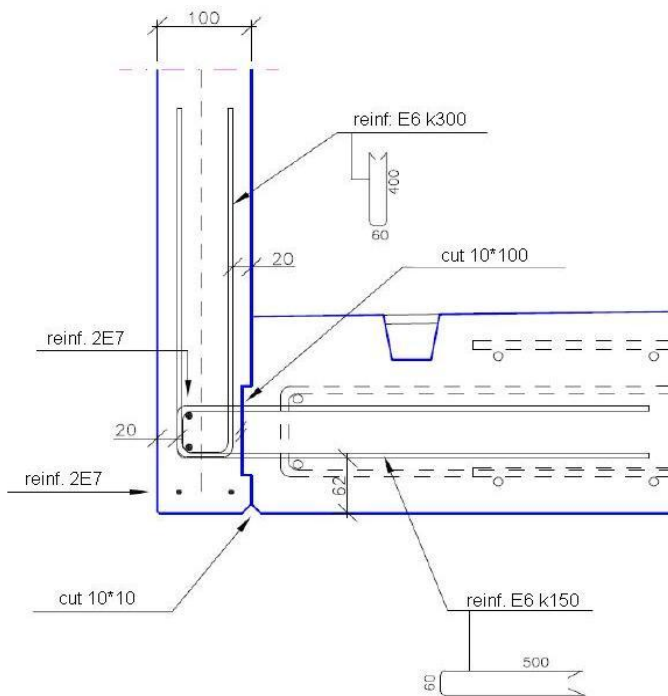


Figure 3.13 Fencing Wall – Slab connection

3.10 Exposure classes related to environmental conditions

Figure 3.14 shows the exposure classes for facade elements including balcony elements in accordance with EN1992-1-1:2004 part 4.

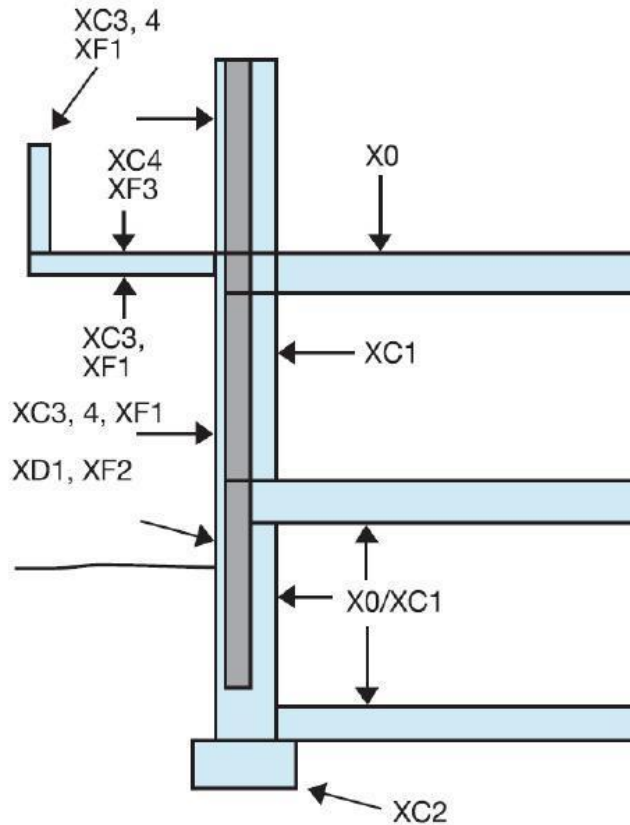


Figure 3.14 Exposure classes for facade of the building

- For balcony slab from outside area Exposure classes can be XC3, XF1.
- For balcony slab from inside area Exposure classes can be XC4, XF3.
- For fencing wall Exposure classes can be XC3, XC4, XF1.

In accordance with EN 1992-1-1:2004 (E) Table 3.1:

Table 3.1 Exposure classes for balcony

Class designation	Description of the environment
XC3	Moderate humidity
XC4	Cyclic wet and dry
XF1	Moderate water saturation, without de-icing agent
XF3	High water saturation, without de-icing agent

4 CUSTOM COMPONENTS

4.1 Introduction

There are some theoretical points before describing the Custom Components creation process.

Tekla Structures contains a set of tools for defining intelligent connections, parts, seams, and details, called custom components. Designer's custom components, which are similar to Tekla Structures system components can be created. Tekla Structures creates a dialog box for the custom component, which can be easily customized, if required. Custom components can be used in the same way as any Tekla Structures system component. Custom components can be created either by exploding and modifying an existing component, or by creating the component objects individually (Custom Component, Tekla Structures help). To browse a list of custom components: <Ctrl> + <F> should be pressed to open Component Catalog. Then Custom should be chosen in dropdown menu (Figure 4.1 Component Catalog).

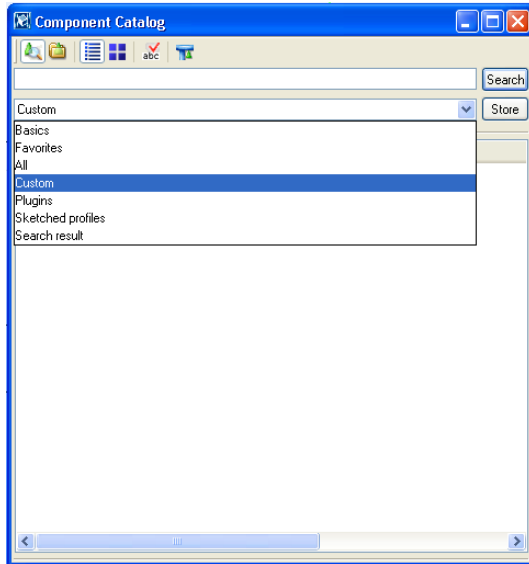


Figure 4.1 Component Catalog

Before a custom component is defined, a sample component in the model which contains all the necessary component objects, such as parts, fittings, bolts, and so on has to be created.

To quickly create a custom component, it is possible to explode a similar existing component and change it to suit. Explode Component is a very useful command to use when defining custom components. It ungroups the objects in an existing component, and designer can remove or modify parts and other objects in the component (Custom Component, Tekla Structures help).

To explode a component: Detailing – Component – Explode component, then component to explode should be selected. Tekla Structures ungroups the objects in the component.

The other way to define custom component is to create a sample component in the model containing all the necessary component objects, such as parts, fittings, bolts, and so on. When creating balcony slab and joint units all necessary parts should be created from the scratch.

Detailing – Component – Define Custom Component should be used to open Custom Component Wizard dialog box (Figure 4.2 Custom Component Wizard).

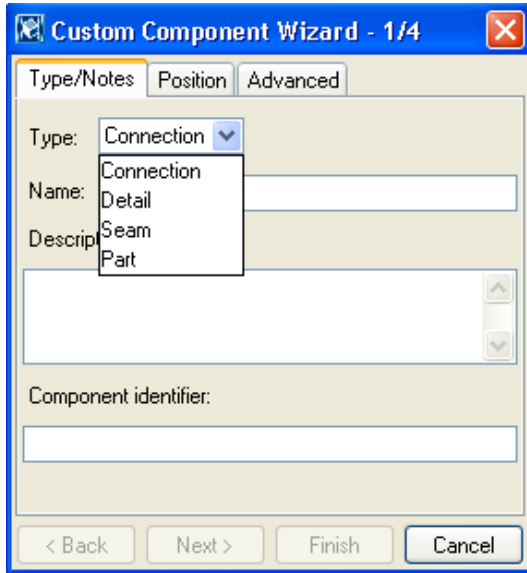


Figure 4.2 Custom Component Wizard

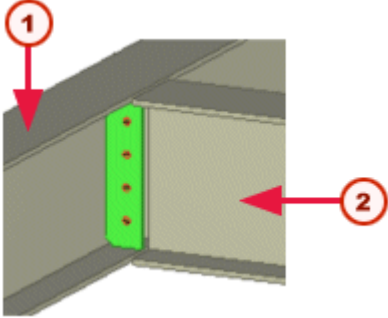
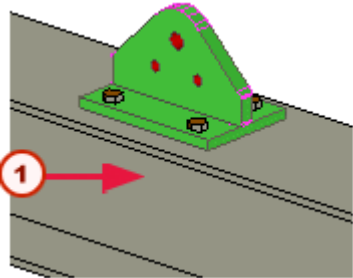
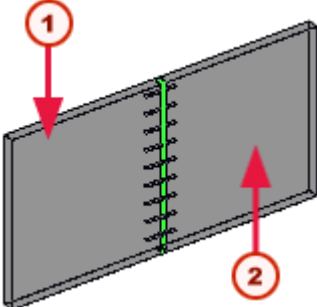
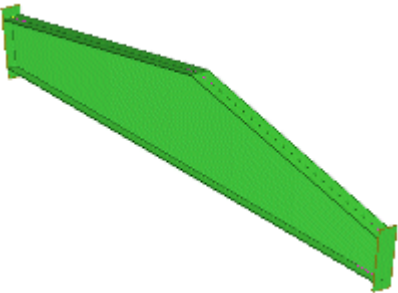
This command defines a simple custom component. The description is presented in table 4.1 (Custom Component, Tekla Structures help).

Table 4.1 Custom Component Wizard Description

Field	Description
Type	Affects how the user inserts the custom component into the model. Also defines if the custom component connects to existing parts.
Name	Unique name for the custom component. If the name already exists, the Next button is grayed out.
Description	Short description of the custom component. This will be shown in the component browser.
Component identifier	To include this in drawings, include Code in the connection mark.
Up direction	The default up direction. Used only in connections and details.
Position type	Position (or origin) of the connection, relative to the main part.
Detail type	Determines on which side of the main part the detail is located. The options are: Intermediate detail - Tekla Structures creates all details on the same side of the main part. End detail - Tekla Structures creates all details on the side of the main part closest to the detail.
Definition point position in relation to primary part	The position is picked to create the detail, relative to the main part. For connections, this determines where the connection is created, relative to the secondary part.
Allow multiple instances of connection between same parts	When checked, allows to create many connections to the same main part, in different locations.
Exact positions	When this checkbox is selected, Tekla Structures positions the seam based on the positions picked in the model. If this checkbox is cleared, Tekla Structures uses automatic seam recognition to position the seam. This is useful especially with warped seams.
Use the center of the bounding box in positioning	When this checkbox is selected, Tekla Structures positions the custom part based on the center of its bounding box (the box which surrounds the actual part profile).

Custom Components types are presented in table 4.2 (Custom Component, Tekla Structures help).

Table 4.2 Custom Component types

Type	Description	Example
<p>Connection</p>	<p>Creates connection objects and connects secondary part(s) to the main part. Component symbol is green.</p>	
<p>Detail</p>	<p>Creates detail objects and connects them to the main part at a picked location. Component symbol is green.</p>	
<p>Seam</p>	<p>Creates seam objects and connects parts along a line picked with two points. Component symbol is green.</p>	
<p>Part</p>	<p>Creates a group of objects which may contain connections and details. Gets no symbol, has the same position properties as beams.</p>	

4.2 Custom Components for balcony slab

The main task is to create a Custom Component for a balcony slab with all necessary inclines (also with possible incline in 2 directions) and a drainage system with channels and tube drainage pipe as in figure 3.5. The balcony slab will consist of 2 parts: edge part (main slab with incline and corner cuttings) and inner part (element which creates all water drainage). The inner part will be as “Part” type Custom Component and the edge part will be as “Detail” type Custom Component. It means that there will be 2 Custom Components (Figure 4.3 Balcony Custom Components concept). The first step is to create the edge Custom Component.

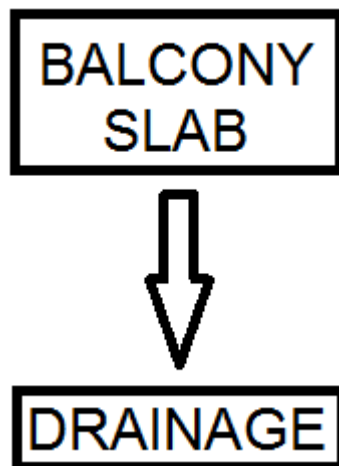


Figure 4.3 Balcony Custom Components concept

4.2.1 Edge Custom Component

As it was mentioned before the upper surface of the balcony slab body has to be with incline in 2 directions. To define the Custom Component single objects should be created. It is not possible to create a slab body from the single concrete beam profile or slab profile because this profile does not provide the incline in 2 directions.

In figure 4.4 it is shown that it is possible to make the incline in 2 with the help of chamfer properties for a single concrete slab. There are 2 parameters dz1 and dz2

which can be modified to change the thickness of concrete slab at one corner. However, it is impossible to modify these parameters in Custom Component Editor. Therefore, it is not recommended to use the single concrete slab in the custom component for balcony slab (Figure 4.4 Chamfer Parameters for concrete slab).

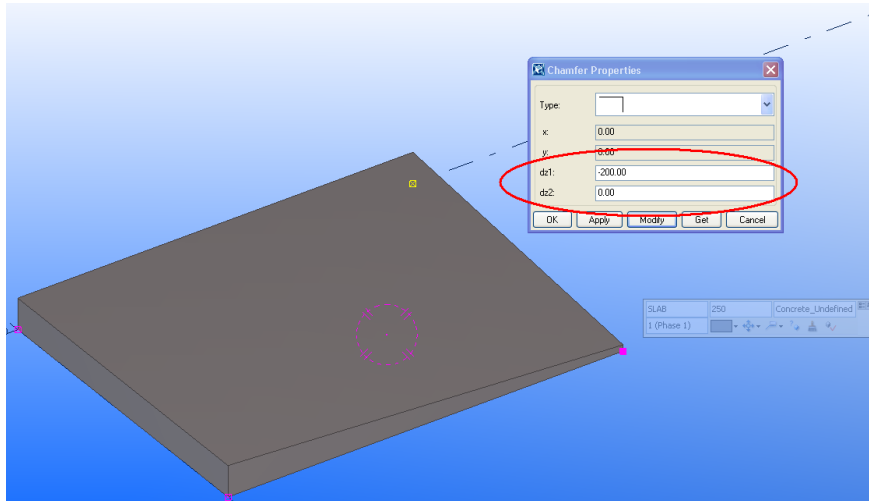


Figure 4.4 Chamfer Parameters for concrete slab

Finnmap Consulting Oy has a large database of own Custom Components and also own profiles. The profile BALCONY is Finnmap's own profile which can be used in case of creating a balcony slab because it is possible to create the incline in 2 directions with this profile (Figure 4.5 Using of BALCONY profile, Figure 4.6 Dimensions in BALCONY profile).

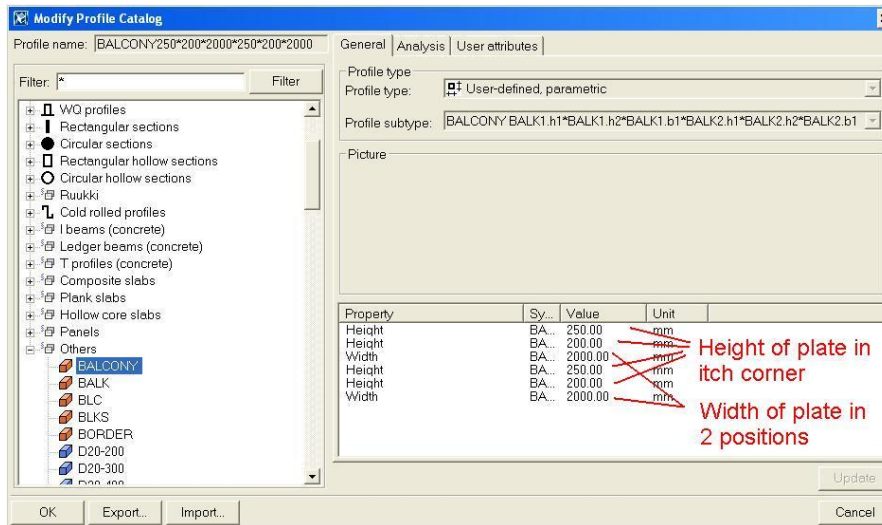


Figure 4.5 Using of BALCONY profile

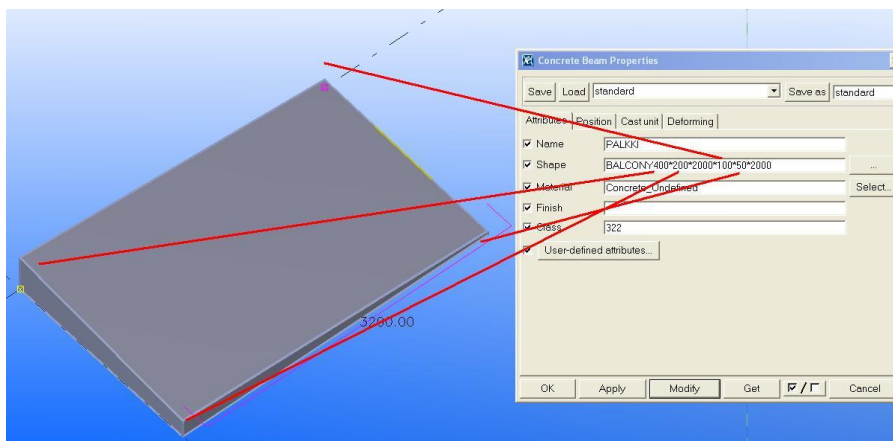


Figure 4.6 Dimensions in BALCONY profile

All necessary single elements for a future Custom component have to be created. In this case there are BALCONY profile elements and 2 cuttings at 2 corners of the slab. The slab is 2400 mm by 3200 mm. The height of the slab at the corners is 250 mm, 280 mm, 290 mm, 320 mm (incline is 1:80). Cuttings are necessary if the balcony plate shape is not rectangular. The cuttings are made with “Cut part with another part” command. The initial cutting object is the concrete plate. The height of cuttings is 20 mm larger than the corresponding corners of BALCONY profile height. The grains of cuttings should not be in one plane with BALCONY profile grains because Tekla Structures software does not allow making the cutting grains in one

plane with grains of other objects in the model (Figure 4.7 Objects in Slab Custom Component).

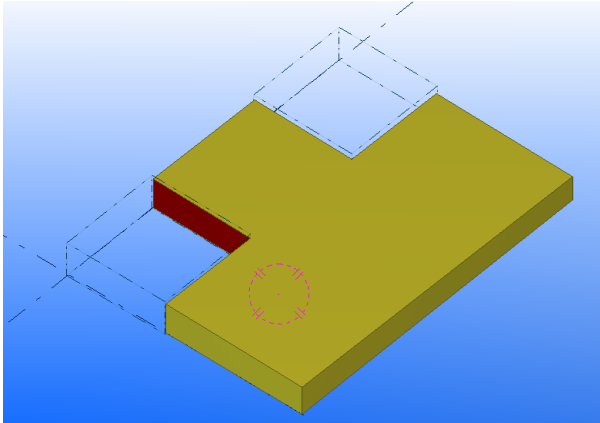


Figure 4.7 Objects in Slab Custom Component

Custom component is defined here: Detailing – Component – Define Custom Component.

Component type is a part; component name is Slab. “Use the center of the bounding box in positioning” should be unchecked (Figure 4.8 Advanced properties of Custom Component).

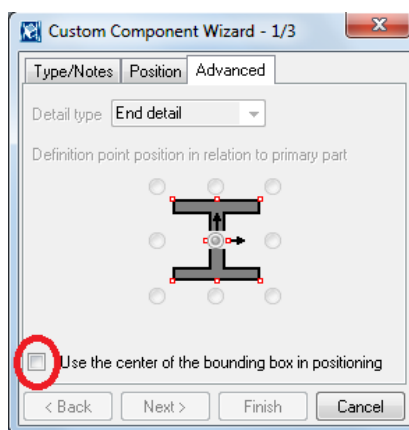


Figure 4.8 Advanced properties of Custom Component

Plate and 2 cuttings as component objects are chosen as component objects (Figure 4.9 Component objects).

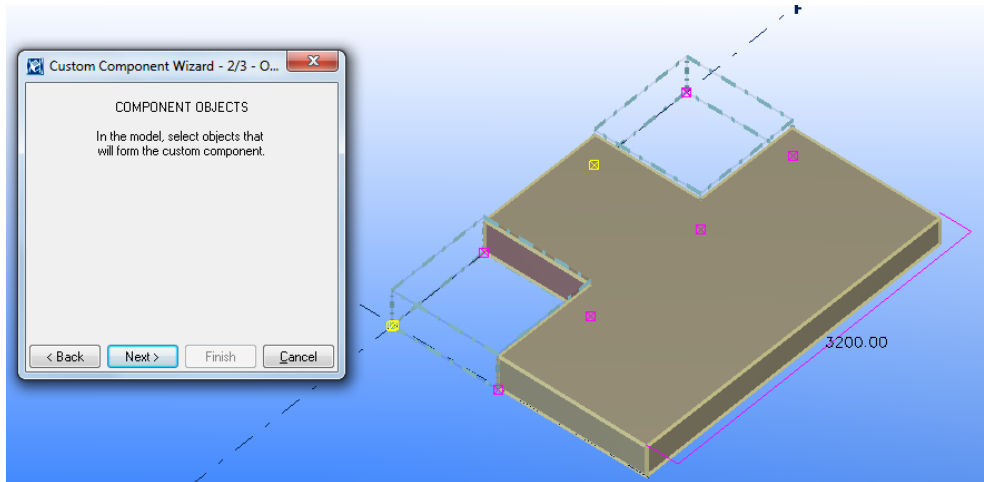


Figure 4.9 Component objects

Part position is at the 2 corners of the plate on the grid line.

Component Catalog is opened with <Ctrl> + <F>. Custom Component "Slab" can be found here. Custom Component "Slab" shall be modified with Custom Component Editor (Figure 4.10 Component Catalog).

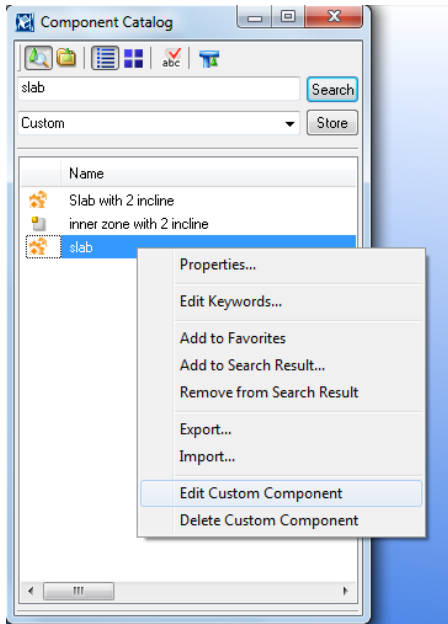


Figure 4.10 Component Catalog

Custom Component Editor allows making some dimensions and parameters of the Custom Component configurable. In this case the dimensions of plate and cuttings and chamfer parameters of inner corners of cuttings have to be configurable.

At first, the length of plate should be defined by the model with 2 reference points. It can be achieved with Binding to Plane of the point of plate. The second chamfer has to be selected and bonded to the back far plan of the plate. Also Component Planes should be selected in dropdown menu in Custom Component Editor (Figure 4.11 Bind to plane).

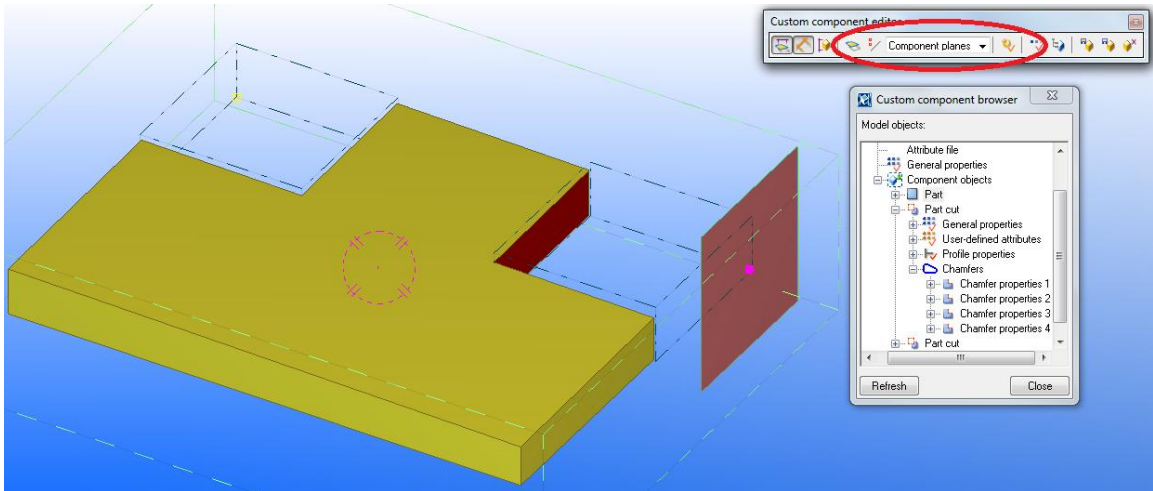


Figure 4.11 Bind to plane

Now it is possible to make the plate with any length. However, cuttings are still at the same position (Figure 4.12 Changeable length of the slab). To make the position of cuttings configurable with the change of the length of the plate, chamfers of cutting should be also bonded to plate planes.

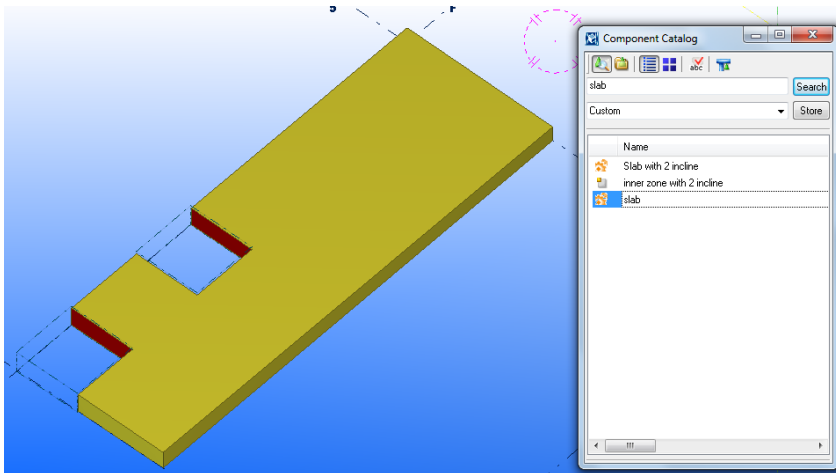


Figure 4.12 Changeable length of the slab

Variables – it is a list of bonded dimensions and formulas for Custom Component. After the first binding to plane of one chamfer of the plate there is the first line in the table (D1). All binding and changing is shown in this list and can be modified.

Similarly all chamfers of all objects in the Custom Component have to be bonded to the plane. Boundary plane should be chosen in order to achieve that (Figure 4.13 Variables).

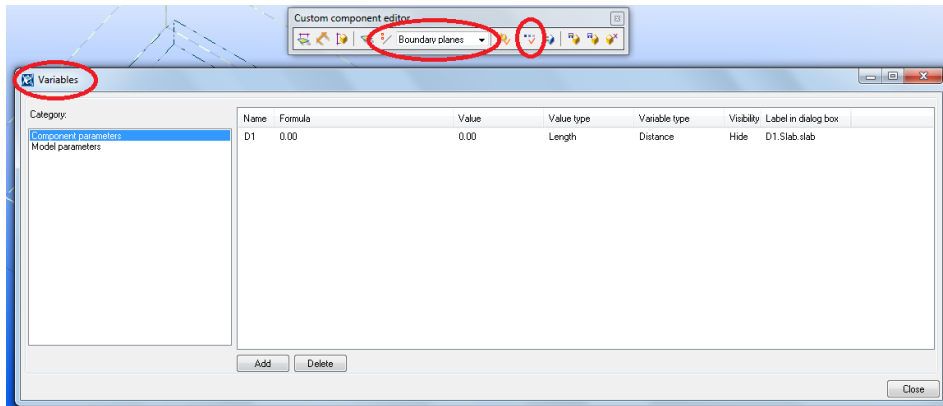


Figure 4.13 Variables

After binding to plane of all necessary chamfers the list will look similar to figure 4.14.

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D1	0.00	0.00	Length	Distance	Hide	D1.Slab.slab
D2	10.00	10.00	Length	Distance	Show	D2.Плита.Slab
D3	10.00	10.00	Length	Distance	Show	D3.Плита.Slab
D4	10.00	10.00	Length	Distance	Show	D4.Плита.Slab
D5	10.00	10.00	Length	Distance	Show	D5.Плита.Slab
D6	10.00	10.00	Length	Distance	Show	D6.Плита.Slab
D7	10.00	10.00	Length	Distance	Show	D7.Плита.Slab
D8	10.00	10.00	Length	Distance	Show	D8.Плита.Slab
D9	10.00	10.00	Length	Distance	Show	D9.Плита.Slab
D10	1000.00	1000.00	Length	Distance	Show	left y
D11	=D10	1000.00	Length	Distance	Show	D11.Плита.Slab
D12	1000.00	1000.00	Length	Distance	Show	left x
D13	=D12	1000.00	Length	Distance	Show	D13.Плита.Slab
D14	1000.00	1000.00	Length	Distance	Show	right y
D15	=D14	1000.00	Length	Distance	Show	D15.Плита.Slab
D16	1000.00	1000.00	Length	Distance	Show	right x
D17	=D16	1000.00	Length	Distance	Show	D17.Плита.Slab

Figure 4.14 List after binding to Plane

D2 – D9 are corresponding to the cuttings chamfers close to plate plans. D10 and D11 are 1000 mm – for chamfer of the left side cutting which is 1000 mm far from

the plan of the plate in Y direction. The label in the dialog box for these dimensions will be “left y”. “Left” means the left side cutting. “Y” means the distance on Y direction. D12 and D13 are 1000 mm – related to chamfers of the left side cutting which is 1000 mm far from the plan of the plate in X direction. The label in the dialog box for this dimension will be “left x”. “Left” means the left side cutting. “X” means the distance on X direction. D14 and D15 are 1000 mm – for chamfers of the right side cutting which is 1000 mm far from the plan of the plate in Y direction. The label in the dialog box for this dimension will be “right y”. “Right” means the right side cutting. “Y” means the dimension on Y direction. D16 and D17 are 1000 mm – for chamfers of the right side cutting which is 1000 mm far from the plan of the plate in X direction. The label in the dialog box for this dimension will be “right x”. “Right” means the right side cutting. “X” means the distance on X direction.

The other task is to make the Width of the plate configurable. Profile BALCONY is used for the plate. The shape for this profile is BALCONY320*290*2400*280*250*2400. 320, 290, 280, 250 is the height of the plate in each corner. 2400 is the Width of the plate. To make 2400 (Width parameter) changeable the formula for profile has to be added to Variables list. It is also necessary for making of the minimum height of the plate changeable. To make it 4 new lines have to be added. D18 is added reference distance is length of the plate (Formula is 3200, Label is “length”; given by point and plane (Figure 4.15 Add reference distance)). P1 – is variable for the Width of the plate (Formula 2400, Label – Width). P2 – is for minimum height of the plate (Formula 250, Label – MinHigh). P3 – is profile variable. Formula for P3 is “=“BALCONY” + (P2+(P1+D18)/80) + “*” + (P2+D18/80) + “*” + (P1) + “*” + (P2+P1/80) + “*” + (P2) + “*” + (P1)”.

$P2+(P1+D18)/80$ – is height for 1st corner.

$P2+D18/80$ – is height for 2nd corner.

P1 – is width for plate.

$P2+P1/80$ - is height for 3rd corner.

P2 – is height for 4th corner (Figure 4.16 Profile modifications)

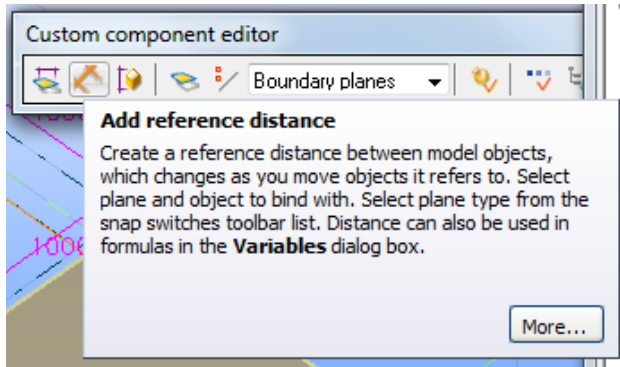


Figure 4.15 Add reference distance

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	2400.00	2400.00	Length	Parameter	Show	Wight
P2	250.00	250.00	Length	Parameter	Show	MinHigh
P3	= "BALCONY" + (P2+(P1+D18)/80) + ...	BALCONY320*290*2400*280*250*2400	Profile	Parameter	Show	profile
D1	0.00	0.00	Length	Distance	Hide	D1.Slab.slab
D2	10.00	10.00	Length	Distance	Show	D2.Плита.Slab
D3	10.00	10.00	Length	Distance	Show	D3.Плита.Slab
D4	10.00	10.00	Length	Distance	Show	D4.Плита.Slab
D5	10.00	10.00	Length	Distance	Show	D5.Плита.Slab
D6	10.00	10.00	Length	Distance	Show	D6.Плита.Slab
D7	10.00	10.00	Length	Distance	Show	D7.Плита.Slab
D8	10.00	10.00	Length	Distance	Show	D8.Плита.Slab
D9	10.00	10.00	Length	Distance	Show	D9.Плита.Slab
D10	1000.00	1000.00	Length	Distance	Show	left y
D11	=D10	1000.00	Length	Distance	Show	D11.Плита.Slab
D12	1000.00	1000.00	Length	Distance	Show	left x
D13	=D12	1000.00	Length	Distance	Show	D13.Плита.Slab
D14	1000.00	1000.00	Length	Distance	Show	right y
D15	=D14	1000.00	Length	Distance	Show	D15.Плита.Slab
D16	1000.00	1000.00	Length	Distance	Show	D16.Плита.Slab
D17	=D16	1000.00	Length	Distance	Show	D17.Плита.Slab
D18	3200.00	3200.00	Length	Distance	Hide	Length

Figure 4.16 Profile modifications

Equation for profile should be added. Equation can be modified in Custom Component Browser. Component – Component objects – Part – General properties – Add Equation – Profile = P3 (Figure 4.17 Equation for plate profile). Now the profile can be changed from Variable list.

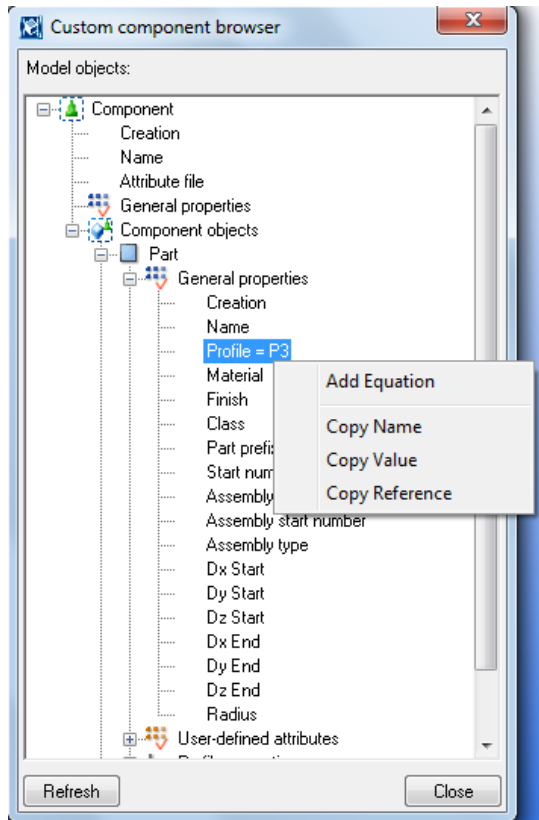


Figure 4.17 Equation for plate profile

The last modifications which are to be made in Custom Component Editor are height and chamfer properties for cuttings. To make the cutting height always corresponding to real dimensions of the plate in the equation for profile for cuttings “ $P2+(P1+D18)/80+20$ ” has to be added. “ $P2+(P1+D18)/80$ ” is the largest height in plate (Figure 4.18 Equation for cuttings profile).

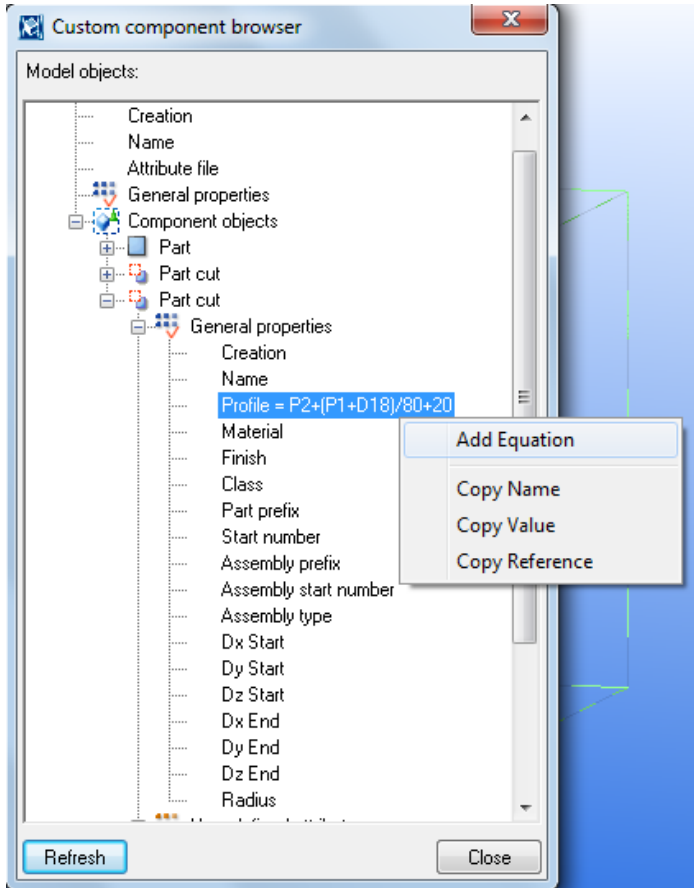


Figure 4.18 Equation for cuttings profile

For chamfers of cutting 6 lines should be added. P4 and P7 are for chamfer types (There are no formulas and Labels are “Chamfer left” and “Chamfer right”). P5, P6, P8 and P9 are for changing dimensions (Figure 4.19 Chamfer variables). Also equations for chamfers have to be added (Figure 4.20 Equations for chamfers).

P4			Chamfer type	Parameter	Show	Chamfer left
P5	0.00	0.00	Length	Parameter	Show	Chamfer left X
P6	0.00	0.00	Length	Parameter	Show	Chamfer left Y
P7			Chamfer type	Parameter	Show	Chamfer right
P8	0.00	0.00	Length	Parameter	Show	Chamfer right X
P9	0.00	0.00	Length	Parameter	Show	Chamfer right Y

Figure 4.19 Chamfer variables

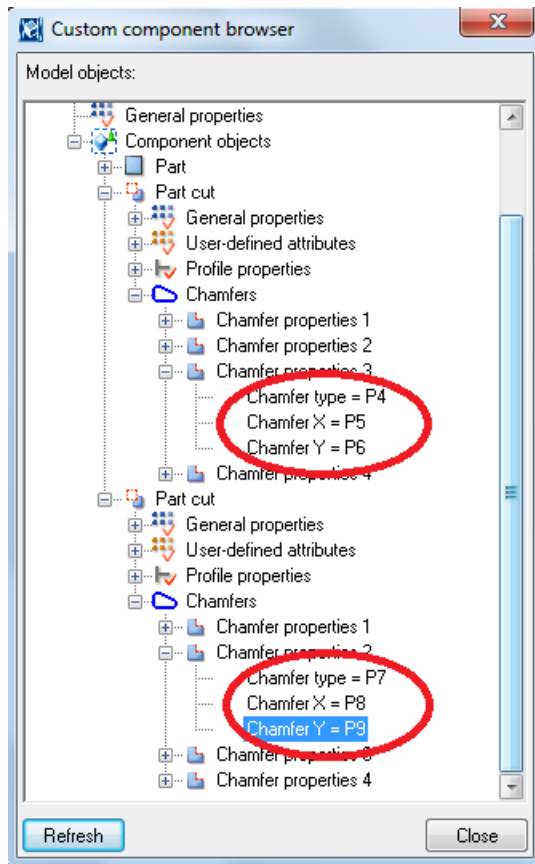


Figure 4.20 Equations for chamfers

Now all equations and variables are entered. After that all unnecessary formulas should be hidden (Figure 4.21 Show/Hide equations).

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog bo
P1	2400.00	2400.00	Length	Parameter	Show	Wight
P2	250.00	250.00	Length	Parameter	Show	MinHigh
P3	="BALCONY" + ...	BALCONY320*290*2400*280*250*2400	Profile	Parameter	Hide	profile
D1	0.00	0.00	Length	Distance	Hide	D1.Slab.slab
D2	10.00	10.00	Length	Distance	Hide	D2.Плита.Slab
D3	10.00	10.00	Length	Distance	Hide	D3.Плита.Slab
D4	10.00	10.00	Length	Distance	Hide	D4.Плита.Slab
D5	10.00	10.00	Length	Distance	Hide	D5.Плита.Slab
D6	10.00	10.00	Length	Distance	Hide	D6.Плита.Slab
D7	10.00	10.00	Length	Distance	Hide	D7.Плита.Slab
D8	10.00	10.00	Length	Distance	Hide	D8.Плита.Slab
D9	10.00	10.00	Length	Distance	Hide	D9.Плита.Slab
D10	1000.00	1000.00	Length	Distance	Show	left y
D11	=D10	1000.00	Length	Distance	Hide	D11.Плита.Slab
D12	1000.00	1000.00	Length	Distance	Show	left x
D13	=D12	1000.00	Length	Distance	Hide	D13.Плита.Slab
D14	1000.00	1000.00	Length	Distance	Show	right y
D15	=D14	1000.00	Length	Distance	Hide	D15.Плита.Slab
D16	1000.00	1000.00	Length	Distance	Show	right x
D17	=D16	1000.00	Length	Distance	Hide	D17.Плита.Slab
D18	3200.00	3200.00	Length	Distance	Hide	Length
P4			Chamfer type	Parameter	Show	Chamfer left
P5	0.00	0.00	Length	Parameter	Show	Chamfer left X
P6	0.00	0.00	Length	Parameter	Show	Chamfer left Y
P7			Chamfer type	Parameter	Show	Chamfer right
P8	0.00	0.00	Length	Parameter	Show	Chamfer right X
P9	0.00	0.00	Length	Parameter	Show	Chamfer right Y

Figure 4.21 Show/Hide equations

After all modification is done, then it is possible to exit from Custom Component Editor and test Custom Component (Figure 4.22 Testing the Custom Component).

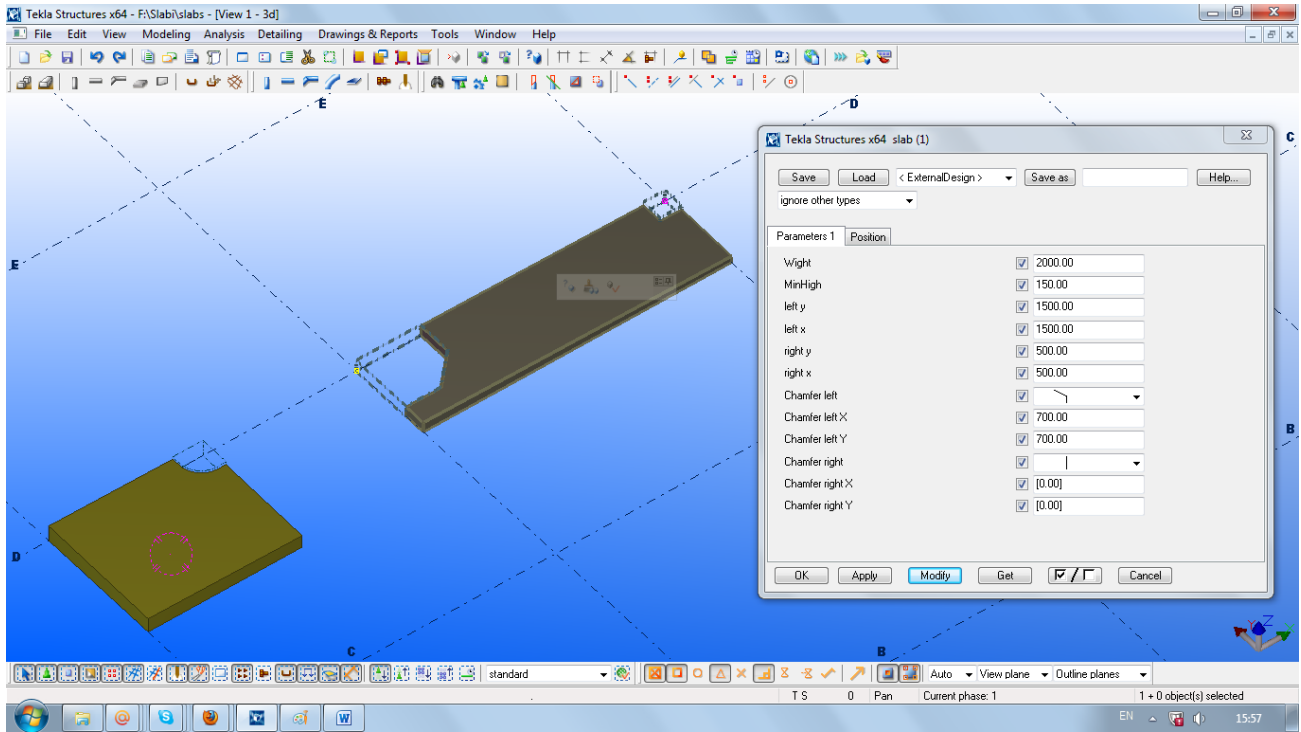


Figure 4.22 Testing the Custom Component

To work with Custom Component properties in a more comfortable way it is advisable to make a picture of component. It should be with all necessary zones for inputting all parameters and dimensions. This picture has to be done as BMP file. Therefore the easiest way to create this picture is to use standard Windows Paint editor. The example of this picture is in figure 4.23.

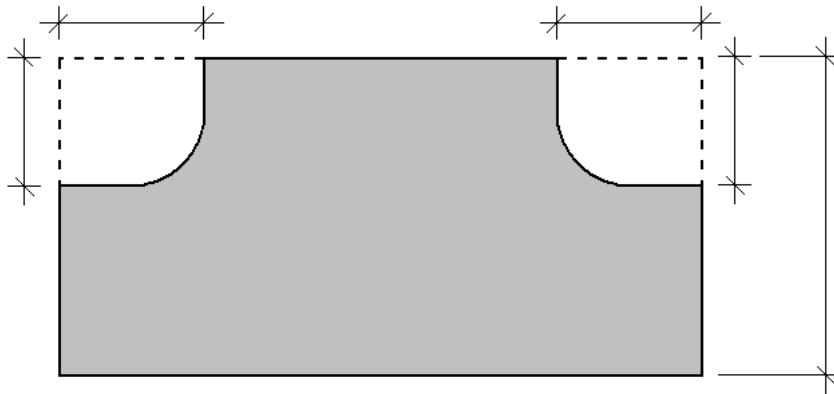


Figure 4.23 Picture for Custom Component

The next step is to import this picture in to the Custom Component Properties. To import the picture the program code of Custom Component has to be changed. The programming code is located in the model folder – CustomComponentDialogFiles – INP file with the name of Custom Component. In this case it is Slab.INP file. This file can be opened with standard Notepad Windows editor. The initial programming code looks like in figure 4.24.

```

page("TeklaStructures", "")
{
  macro(1, "slab")
  {
    tab_page("", " Parameters 1 ", 1)
    {
      parameter("wight", "P1", distance, number, 1)
      parameter("MinHigh", "P2", distance, number, 2)|
      parameter("left y", "D10", distance, number, 3)
      parameter("left x", "D12", distance, number, 4)
      parameter("right y", "D14", distance, number, 5)
      parameter("right x", "D16", distance, number, 6)
      parameter("Chamfer left ", "P4", chamfer_type, number, 7)
      parameter("Chamfer left X", "P5", distance, number, 8)
      parameter("Chamfer left Y", "P6", distance, number, 9)
      parameter("Chamfer right", "P7", chamfer_type, number, 10)
      parameter("Chamfer right X", "P8", distance, number, 11)
      parameter("Chamfer right Y", "P9", distance, number, 12)
    }
  }
}

```

Figure 4.24 Initial programming code for Slab Custom Component

tab_page("", " Parameters 1 ", 1) – is the name of the tab in the Custom Component properties.

"Width" – is the label of variable.

"P1" – is the name of variable.

distance, number – is the value type.

1 – is number of the line for each variable in the properties tab.

The name of the picture is Slab.BMP. The picture should be in the folder TeklaStructures – 16.0 (version number of Tekla Structures software can be different) – nt – bitmaps. Then, the code has to be modified. The tab page should be renamed from Parameters 1 to Parameters. Then the line with the command to

insert the picture has to be input. This line is “picture (“Slab”)”. Numbers of the line for each variable in the properties tab should be deleted. The Labels of some variables have to be deleted also and coordinates of the input boxes should be added. Then all modification has to be saved in the Notepad editor and Tekla Structures model has to be reloaded. After all modification the program code will look similar to figure 4.25.

```

page("TeklaStructures", "")
{
  macro(1, "slab")
  {
    tab_page("", " Parameters ", 1)
    picture ("slab")
    parameter("", "P1", distance, number, 1000,180)
    parameter("MinHigh", "P2", distance, number, 15)
    parameter("", "D12", distance, number, 230,10)
    parameter("", "D10", distance, number, 70,120)
    parameter("", "D16", distance, number, 750,10)
    parameter("", "D14", distance, number, 900,120)
    parameter("", "P4", chamfer_type, number, 225,120,100)
    parameter("", "P5", distance, number, 250,200)
    parameter("", "P6", distance, number, 350, 160)
    parameter("", "P7", chamfer_type, number, 735,120,100)
    parameter("", "P8", distance, number, 630,160)
    parameter("", "P9", distance, number, 700,200)
  }
}

```

Figure 4.25 Programming code after modifications

After modification of the programming code the new properties tab would be looking like in figure 4.26.

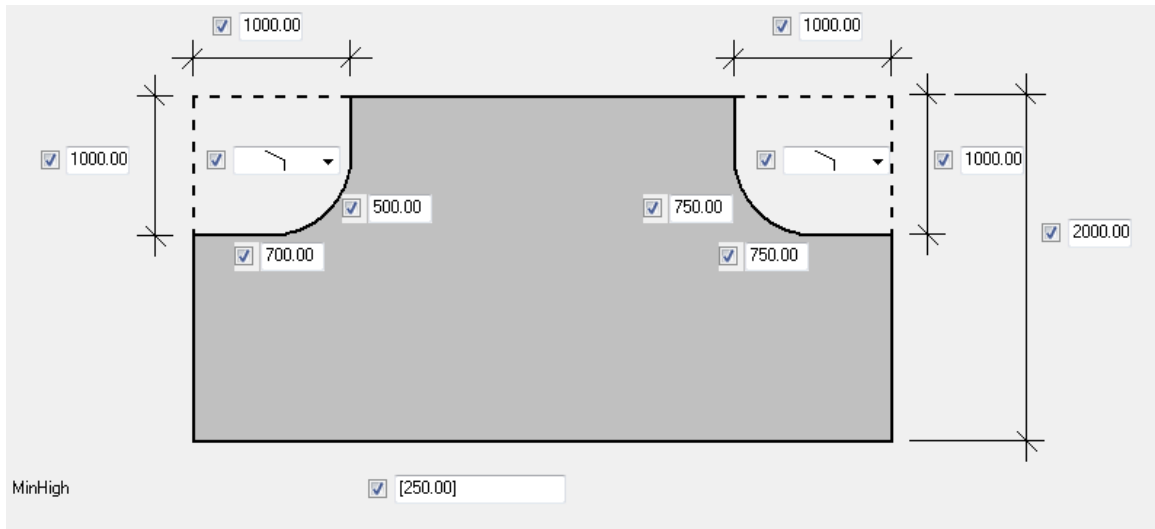


Figure 4.26 Properties tub for first Custom Component

It is recommended to save the NTP file to the other independent folder because after any modification the code will be returned to initial.

4.5.2 Inner Custom Component

The first Custom Component for edge slab element is almost ready. Now the Custom Component for inner drainage system should be created. Component objects for the second Custom Component will be initially only 2 cuttings. There are cuttings of the first (edge) custom component which are making the hollow channels in the plate. These cuttings are made with “Cut part with another part” command. The cutting parts are 2 slabs. The first slab cuts the edge plate on perimeter and the second cutting slab cuts the first cutting slab (Figure 4.27 Objects for inner Custom Component).

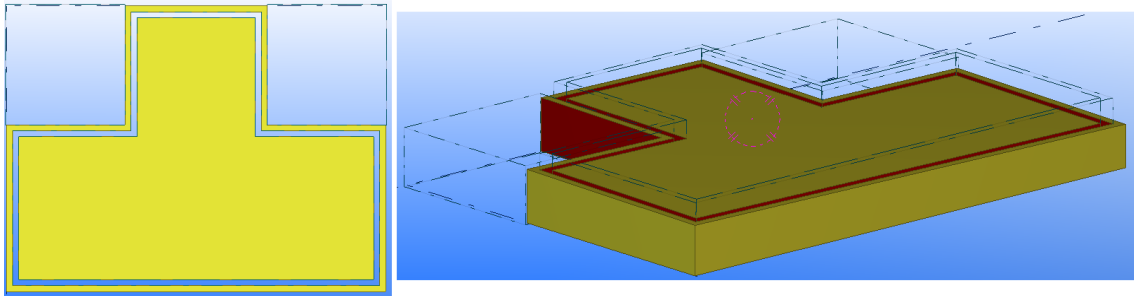


Figure 4.27 Objects for inner Custom Component

The type of Custom Component (in Custom Component Wizard) is “Detail” and the name is “Drainage” (Figure 4.28 Custom Component Wizard). Detail position (4th step) is “Main Part”. Main part in this case is Slab Custom Component.

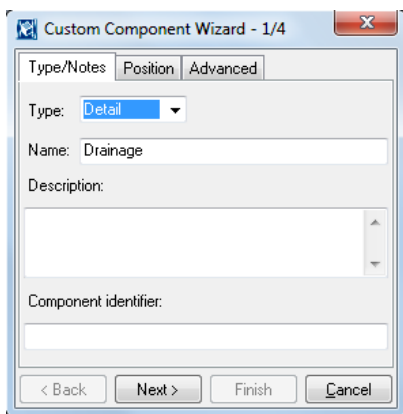


Figure 4.28 Custom Component Wizard

In the Custom Component Editor (for “Drainage” Custom Component) one more profile has to be created. It is necessary for the creation of the drainage channels. The profile has to be like the profile “BALCONY320*290*2400*280*250*2400” from the Slab Custom Component, but the height in each corner has to be a little less than the initial height: “BALCONY220*190*2400*180*150*2400”. The 100 mm difference in height for each corner means that the depth of the drainage channels is 100 mm. The location of this profile should be as in figure 4.29.

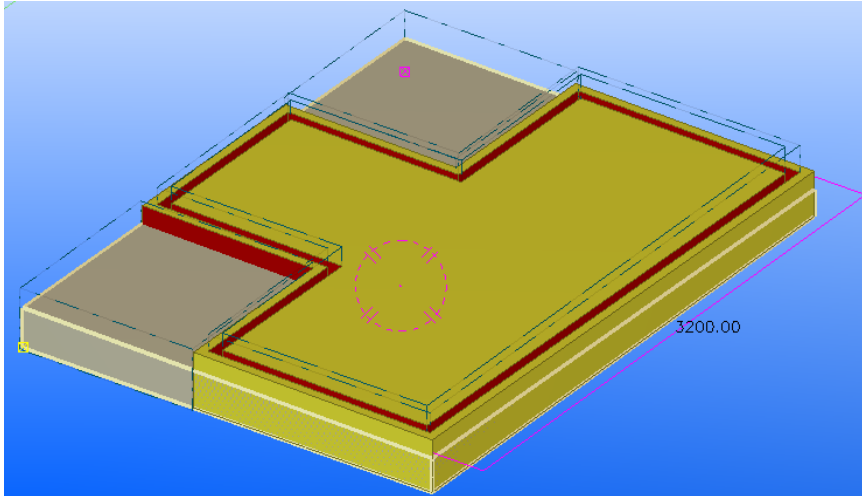


Figure 4.29 Profile for drainage channels

Next this profile can be cut in the corners by corner cuttings (Figure 4.7 Objects in Slab Custom Component). It is not necessary to make any other cuttings in this profile in spite of crossing of the elements because the Drainage Custom Component is the Detail unit and in the drawings both Custom Components will be shown as one whole unit. After cutting the new profile, 2 new cutting elements will be created like a 2 new components objects (Figure 4.30 Two new cutting elements are created as component objects).

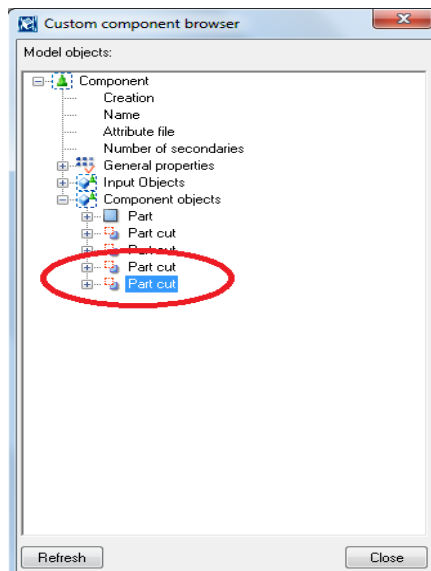


Figure 4.30 Two new cutting elements are created as component objects

The sizes of these two new cutting elements are always the same and not changing. Designer needs them to be modified in relation to the configurable initial cuttings. To make the sizes of two new cuttings (of new profile) configurable the designer has to modify the Slab Custom Component. In Custom Component Editor for Slab Custom Component: Properties of the BALCONY profile – User define attributes – In User field 1, User field 2, User field 3, User field 4 number equal to 1000 has to be entered 1000 (Figure 4.31 User define attributes for BALCONY profile).

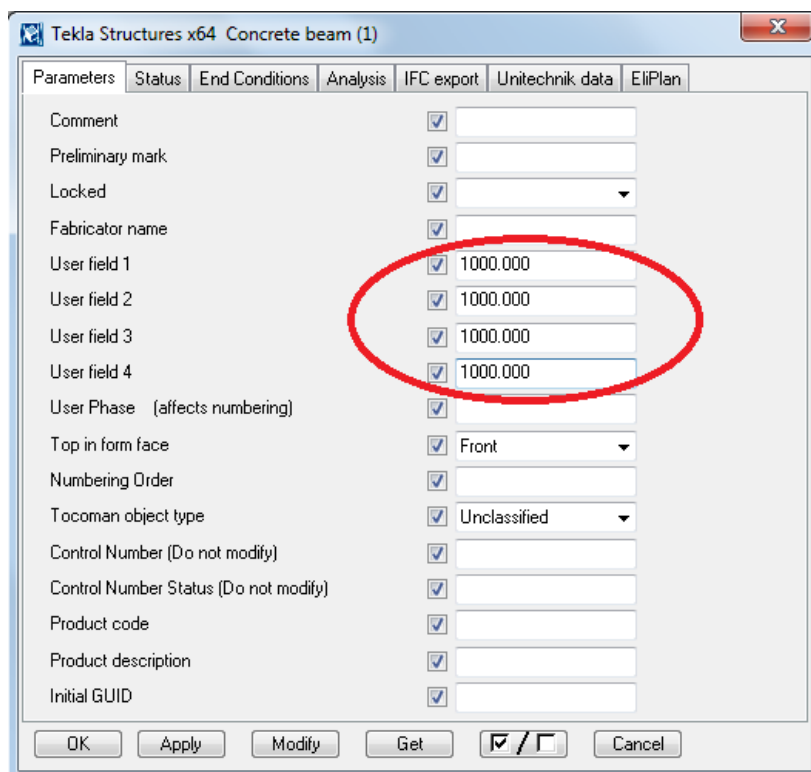


Figure 4.31 User define attributes for BALCONY profile

Then in the directory Component – Component objects – User-defined attributes 4 new lines should appear: USER_FIELD_1, USER_FIELD_2, USER_FIELD_3, USER_FIELD_4. In the figure 4.32 equations shown have to be added. This modification helps to make a reference from one Custom Component to other.

USER_FIELD_1=D16 – this line is making the reference of the distance of the right corner cutting in the X direction.

USER_FIELD_2=D14 – this line is making the reference of the distance of the right corner cutting in the Y direction.

USER_FIELD_3=D12 – this line is making the reference of the distance of the left corner cutting in the X direction.

USER_FIELD_4=D10 – this line is making the reference of the distance of the left corner cutting in the Y direction.

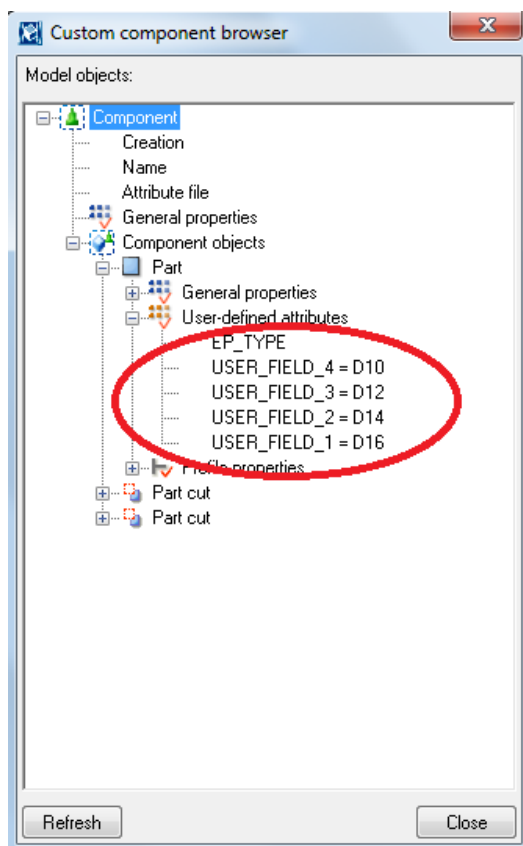


Figure 4.32 User define attributes for BALCONY profile (Custom component browser)

After making this reference modifications have to be made in Drainage Custom Component dimension. This is necessary because the thickness of concrete zones and channels sizes should be changeable in custom component. It can be done

with binding to plane as in Slab Custom Component. All chamfers of all cuttings have to be bonded to corresponding planes. After binding to plane the table of Variables will look like in figures 4.33 and 4.34.

P3, P5, P6 and P8 are making the reference to the dimensions of the corner cuttings. The references are taken from the Custom component browser from directory Component – Input Objects – Primary part – Component – Component objects – Part – User-defined attributes.

P1, P2, P4, P7, D1 – D32 are the thicknesses for concrete zones and drainage channels.

D33-D48 are defining the corner cuts dimensions.

D49 is defining the length of BALCONY profile in the Drainage Custom Component the same as the length of BALCONY profile in Slab Custom Component.

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	50.00	50.00	Length	Parameter	Show	ChannelDown
P2	50.00	50.00	Length	Parameter	Show	ChannelLeft
P3	=fP("USER_FIELD_3",480549)	1000.00	Length	Parameter	Show	LeftX
P4	50.00	50.00	Length	Parameter	Show	ChannelUp
P5	=fP("USER_FIELD_4",480549)	1000.00	Length	Parameter	Show	RightX
P6	=fP("USER_FIELD_2",480549)	1000.00	Length	Parameter	Show	RightY
P7	50.00	50.00	Length	Parameter	Show	ChannelRight
P8	=fP("USER_FIELD_1",480549)	1000.00	Length	Parameter	Show	RightX
D1	50.00	50.00	Length	Distance	Show	ConcreteDown
D2	=D1	50.00	Length	Distance	Show	D2.Плита.Slab
D3	=D1+P1	100.00	Length	Distance	Show	D3.Плита.Slab
D4	=D3	100.00	Length	Distance	Show	D4.Плита.Slab
D5	50.00	50.00	Length	Distance	Show	ConcreteLeft
D6	=D5	50.00	Length	Distance	Show	D6.Плита.Slab
D7	100.00	100.00	Length	Distance	Show	D7.Плита.Slab
D8	=D7	100.00	Length	Distance	Show	D8.Плита.Slab
D9	=P3+D5	1050.00	Length	Distance	Show	D9.Плита.Slab
D10	=D9	1050.00	Length	Distance	Show	D10.Плита.Slab
D11	=D9+P2	1100.00	Length	Distance	Show	D11.Плита.Slab
D12	=D11	1100.00	Length	Distance	Show	D12.Плита.Slab
D13	50.00	50.00	Length	Distance	Show	ConcreteUp
D14	=D13	50.00	Length	Distance	Show	D14.Плита.Slab
D15	100.00	100.00	Length	Distance	Show	=D13+P4
D16	=D15	100.00	Length	Distance	Show	D16.Плита.Slab
D17	=D13+P5	1050.00	Length	Distance	Show	D17.Плита.Slab
D18	=D17	1050.00	Length	Distance	Show	D18.Плита.Slab
D19	=D17+P4	1100.00	Length	Distance	Show	D19.Плита.Slab
D20	=D19	1100.00	Length	Distance	Show	D20.Плита.Slab
D21	=P6+D13	1050.00	Length	Distance	Show	D21.Плита.Slab
D22	=D21	1050.00	Length	Distance	Show	D22.Плита.Slab
D23	=D21+P4	1100.00	Length	Distance	Show	D23.Плита.Slab
D24	=D23	1100.00	Length	Distance	Show	D24.Плита.Slab

Figure 4.33 Variable of Drainage Custom Component after binding to plane

D25	50.00	50.00	Length	Distance	Show	ConcreteRight
D26	=D25	50.00	Length	Distance	Show	D26.Плита.Slab
D27	=D25+P7	100.00	Length	Distance	Show	D27.Плита.Slab
D28	=D27	100.00	Length	Distance	Show	D28.Плита.Slab
D29	=P8+D25	1050.00	Length	Distance	Show	D29.Плита.Slab
D30	=D29	1050.00	Length	Distance	Show	D30.Плита.Slab
D31	=D29+P7	1100.00	Length	Distance	Show	D31.Плита.Slab
D32	=D31	1100.00	Length	Distance	Show	D32.Плита.Slab
D33	10.00	10.00	Length	Distance	Show	D33.Плита.Slab
D34	=D33	10.00	Length	Distance	Show	D34.Плита.Slab
D35	=D33	10.00	Length	Distance	Show	D35.Плита.Slab
D36	=D33	10.00	Length	Distance	Show	D36.Плита.Slab
D37	=D33	10.00	Length	Distance	Show	D37.Плита.Slab
D38	=D33	10.00	Length	Distance	Show	D38.Плита.Slab
D39	=D33	10.00	Length	Distance	Show	D39.Плита.Slab
D40	=D33	10.00	Length	Distance	Show	D40.Плита.Slab
D41	=P3	1000.00	Length	Distance	Show	D41.Плита.Slab
D42	=D41	1000.00	Length	Distance	Show	D42.Плита.Slab
D43	=P3	1000.00	Length	Distance	Show	D43.Плита.Slab
D44	=D43	1000.00	Length	Distance	Show	D44.Плита.Slab
D45	=P8	1000.00	Length	Distance	Show	D45.Плита.Slab
D46	=D45	1000.00	Length	Distance	Show	D46.Плита.Slab
D47	=P6	1000.00	Length	Distance	Show	D47.Плита.Slab
D48	=D47	1000.00	Length	Distance	Show	D48.Плита.Slab
D49	0.00	0.00	Length	Distance	Hide	D49.Балка.Slab

Figure 4.34 Variable of Drainage Custom Component after binding to the plane

After the binding to plane all necessary chamfers the shape of all cuttings will be the same as the shape of plate in Slab Custom Component (Figure 4.35 Drainage channels).

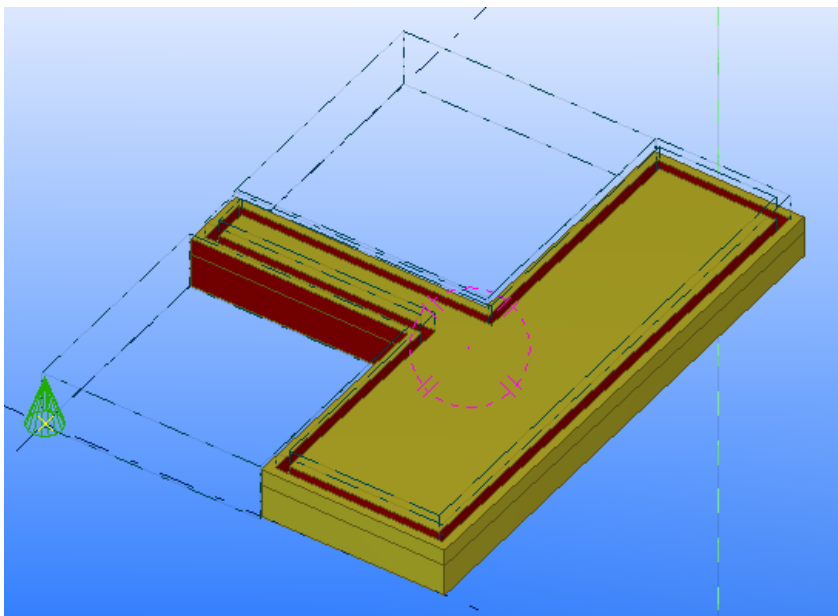


Figure 4.35 Drainage channels

The next step is to make the depth of the channel configurable. Some modifications in Slab custom component have to be done. One new User-defined attribute should be created (Figure 4.36 User-defined attribute for plate length). This new user-defined attribute is necessary for reference to the slab length. D18 is the name of the line of the slab length.

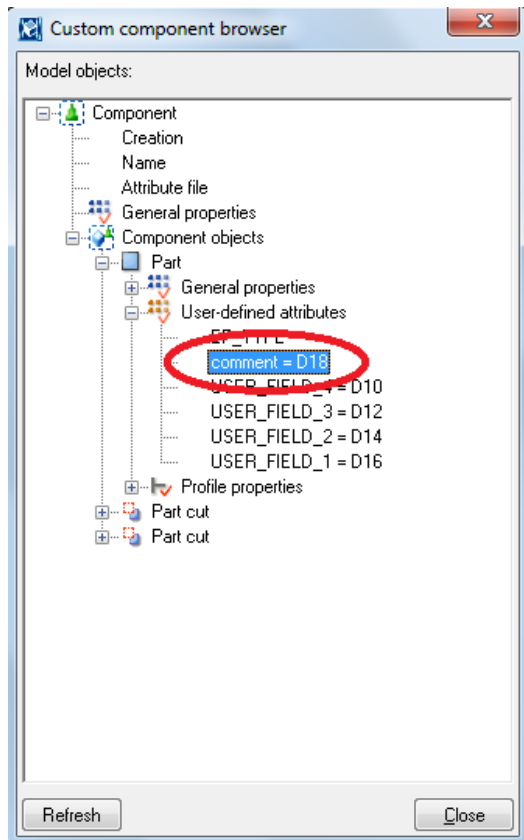


Figure 4.36 User-defined attribute for plate length

Also 3 new equations should be added to the Variables table of Drainage Custom Component.

P9 is the reference to the Component – Input Objects – Primary Part – Component – Component objects – Part – Profile properties – Height (it is the maximum height of the BALCONY profile from Slab Custom Component). Also the equation for P9 helps to make the height of profile corresponding to the BALCONY elements height.

P10 is the reference to the Component – Input Objects – Primary Part – Component – Component objects – Part – Profile properties – Width (it is the width of the BALCONY profile from Slab Custom Component).

P11 is the reference to the Component – Input Objects – Primary Part – Component – Component objects – Part – User-defined attributes – comment (it is the length of the BALCONY profile from Slab Custom Component). Figure 4.37 References to profile sizes.

P9	=P{Height,494917}	320.00	Length	Parameter	Show	Parameter9
P10	=P{Width,494917}	2400.00	Length	Parameter	Show	Parameter10
P11	=P{"comment",494917}	3200.00	Length	Parameter	Show	Parameter13

Figure 4.37 References to profile sizes

Lines for P9 – P17 in Variables list are for setting the BALCONY profile for Drainage Custom Component. P13 - P16 are equations for the height of plate in each corner. P17="BALCONY"+(P13)+"*"+(P14)+"*"+(P10)+"*"+(P15)+"*"+(P16)+"*"+(P10). P17 is equation for profile. Value type for P17 is profile (Figure 4.38 BALCONY profile installation). Reference to P17 should be made in Custom component browser for Drainage Custom Component.

P9	=P{Height,494917}	320.00	Length	Parameter	Show	Parameter9
P10	=P{Width,494917}	2400.00	Length	Parameter	Show	Parameter10
P11	=P{"comment",494917}	3200.00	Length	Parameter	Show	Parameter13
P12	50.00	50.00	Length	Parameter	Show	ChannelDepth
P13	=P9-P12	270.00	Length	Parameter	Show	Parameter15
P14	=P9-P10/80-P12	240.00	Length	Parameter	Show	Parameter16
P15	=P9-P11/80-P12	230.00	Length	Parameter	Show	Parameter17
P16	=P9-P10/80-P11/80-P12	200.00	Length	Parameter	Show	Parameter18
P17	= "BALCONY"+(P13)+"*"+(P14)+"*"+(P10)+"*"+(P15)+"*"+(P16)+"*"+(P10)	BALCONY270*240*2400*230*200*2400	Profile	Parameter	Show	Parameter19

Figure 4.38 BALCONY profile installation

P9 is reference to the maximum height of concrete elements. Therefore to make the height of cutting fit to the height of the concrete elements it is possible to make the profile for all cuttings (P9+10).

After setting the BALCONY profile, chamfer properties for the cuttings have to be updated. P18 – P23 are making the reference to the chamfer parameters of the

inside chamfers of corner cuttings of Slab Custom Component. In Custom component browser of the Drainage Custom Component the corresponding reference should be entered (Figure 4.39 Chamfer reference).

P18	=fP(Chamfer type,0)	0	Chamfer type	Parameter	Show	ChTypeLeft
P19	=fP(Chamfer X,0)	0.00	Length	Parameter	Show	ChXLeft
P20	=fP(Chamfer Y,0)	0.00	Length	Parameter	Show	ChYLeft
P21	=fP(Chamfer type,0)	0	Chamfer type	Parameter	Show	ChTypeRight
P22	=fP(Chamfer X,0)	0.00	Length	Parameter	Show	ChXRight
P23	=fP(Chamfer Y,0)	0.00	Length	Parameter	Show	ChYRight

Figure 4.39 Chamfer reference

An important attribute for a good drainage system in balcony slab is the drainage pipe. Drainage pipe can be created with the cutting with the shape of the round beam. Drainage pipe should be located in the lowest part of the channel (Figure 4.40 Drainage pipe).

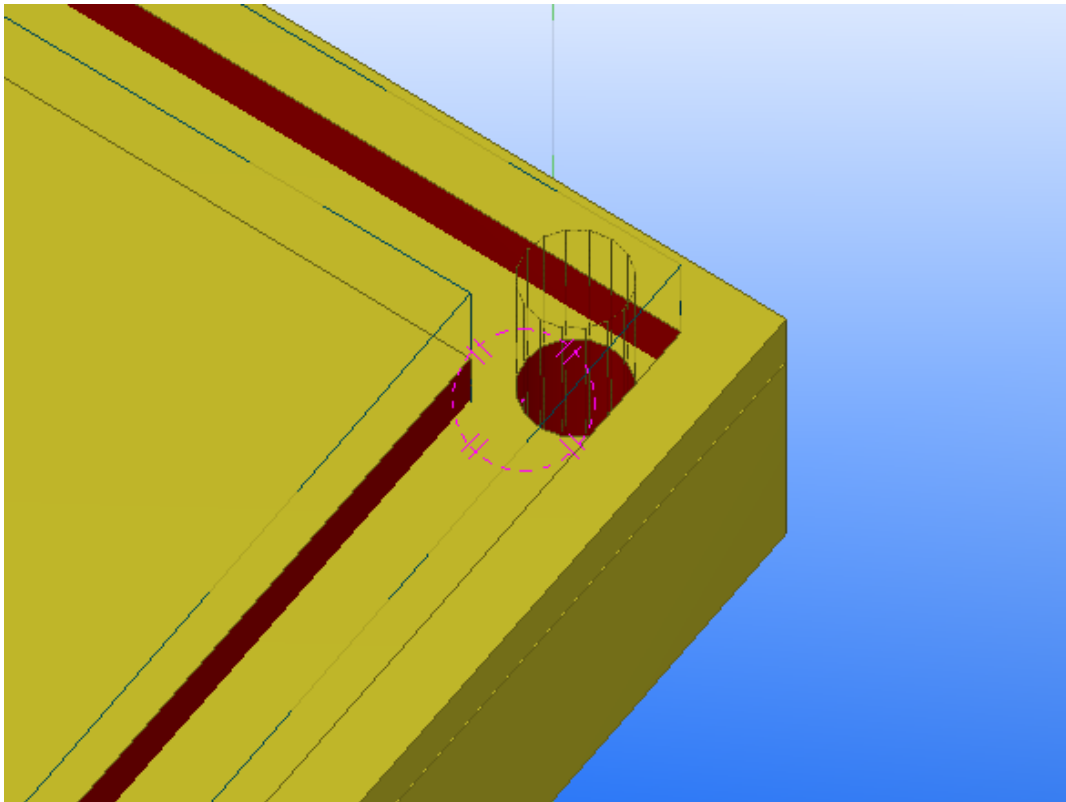


Figure 4.40 Drainage pipe

D50-D54, P24, P25 are variables for drainage tube. D50-D53 means that the center of tube cutting profile is always in the middle of channel. D54 means that the height of cutting is 10 mm larger than the maximum height of concrete part. P45 and P25 are equations for the diameter (Figure 4.41 Tube variables).

D50	=D1+P1/2	100.00	Length	Distance	Show	D50.PALKKI.Slab
D51	=D50	100.00	Length	Distance	Show	D51.PALKKI.Slab
D52	=D25+P7/2	100.00	Length	Distance	Show	D52.PALKKI.Slab
D53	=D52	100.00	Length	Distance	Show	D53.PALKKI.Slab
D54	=P9+10	330.00	Length	Distance	Show	D54.PALKKI.Slab
P24	80.00	80.00	Length	Parameter	Show	DiameterTube
P25	= "D" + (P24)	D80	Profile	Parameter	Show	Parameter25

Figure 4.41 Tube variables

After creating a picture (Figure 4.42 Sketch for Drainage Custom Component properties), hiding all unnecessary equations in Variables and remaking programming code Drainage Custom Component is ready.

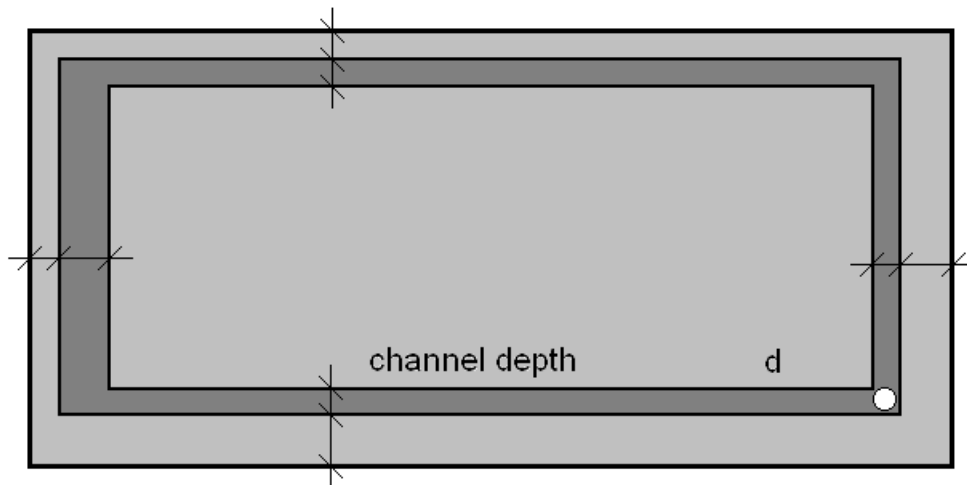


Figure 4.42 Sketch for Drainage Custom Component properties

Finally the Drainage Custom Component properties will look like in figure in APPENDIX 1. The programming code is in APPENDIX 2. Variable list is in APPENDIX 3.

4.6 Custom Component for jointing tube element

For balcony tube connection elements there are 6 different Custom Components. Tube connection elements can be used with Slab Custom Component or with other slabs (Figure 4.43 Balcony Custom Components and Tube Connection Custom Component concept).

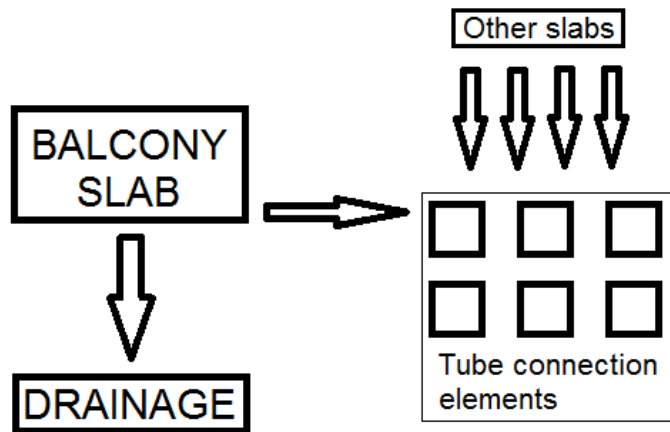


Figure 4.43 Balcony Custom Components and Tube Connection Custom Component concept

These components have 2 main differences: difference in reinforcement location and difference in amount of tube elements. Reinforcement location depends on the reaction force on the support. If the reaction force has an upwards vector then the reinforcement should be like in figure 4.44. If the reaction force has a downwards vector then the reinforcement should be like in figure 4.45. If the reaction force is directed in both directions then the reinforcement should be like in figure 4.46. If the reaction force has an upwards and there is a big bending moment in the tube then the reinforcement should be like in figure 4.47. If the reaction force has a downwards vector and there is a big bending moment in the tube then the reinforcement should be like in figure 4.48. If the reaction force can be directed in both directions and there is a big bending moment in the tube then the reinforcement should be like in figure 4.49.

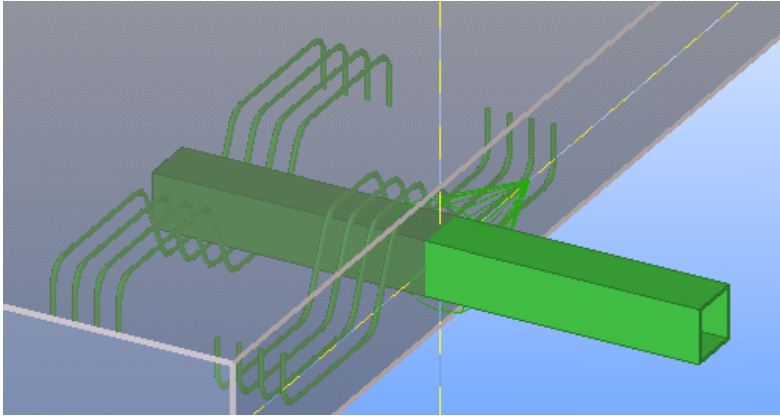


Figure 4.44 Compression on support

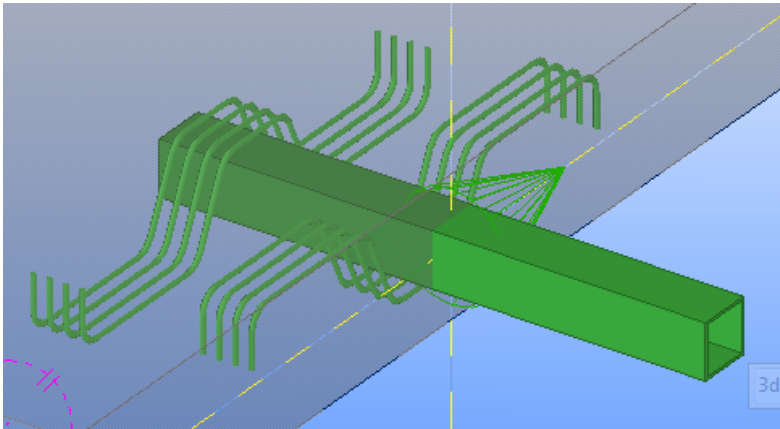


Figure 4.45 Tension on support

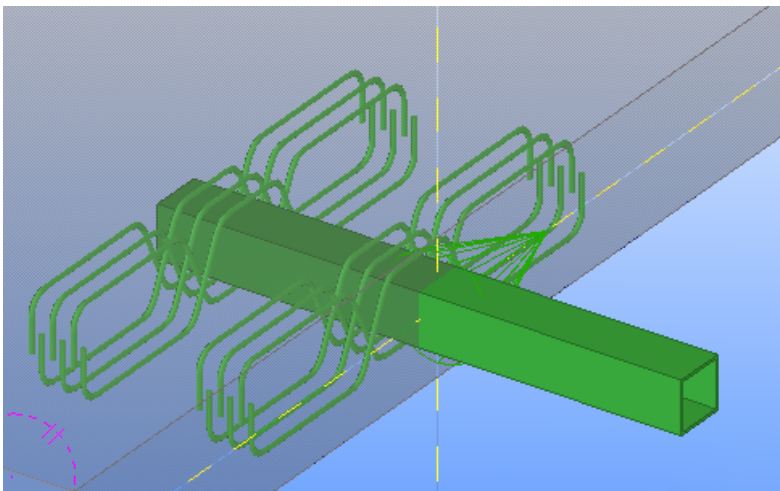


Figure 4.46 Tension and compression on support

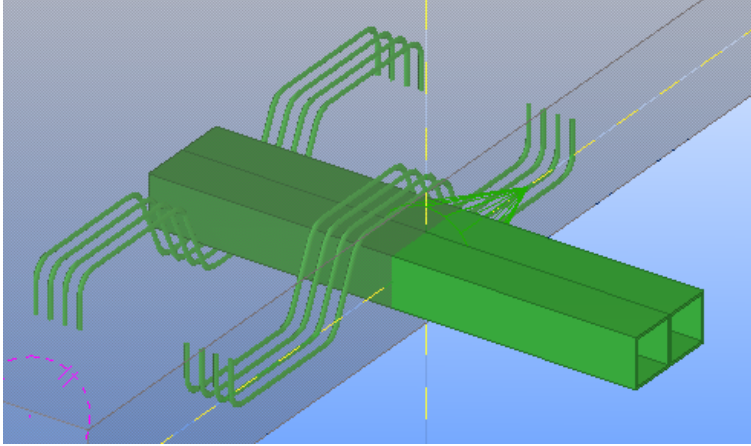


Figure 4.47 Compression of support with big moment

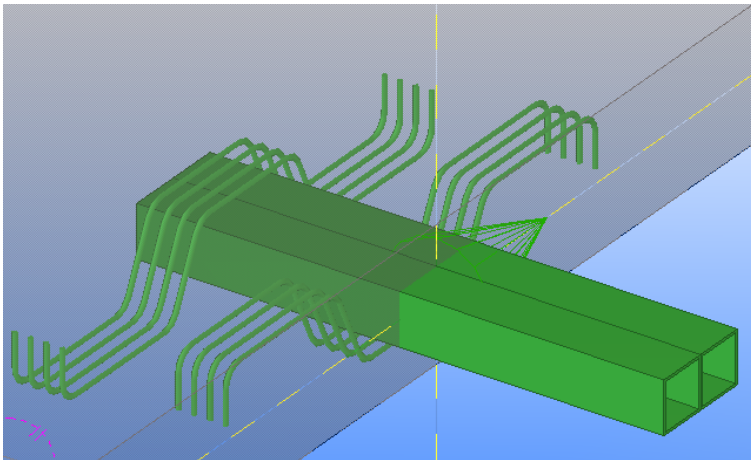


Figure 4.48 Tension on support with big moment

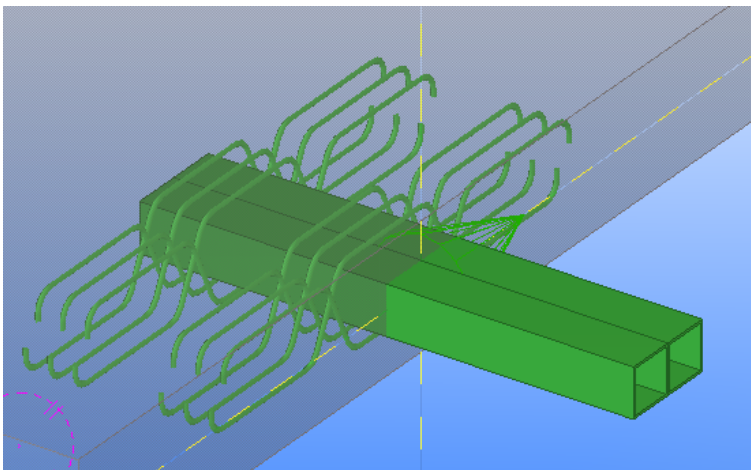


Figure 4.49 Tension and compression on support with big moment

In this report the jointing element as in figures 4.45, 4.50 will be described.

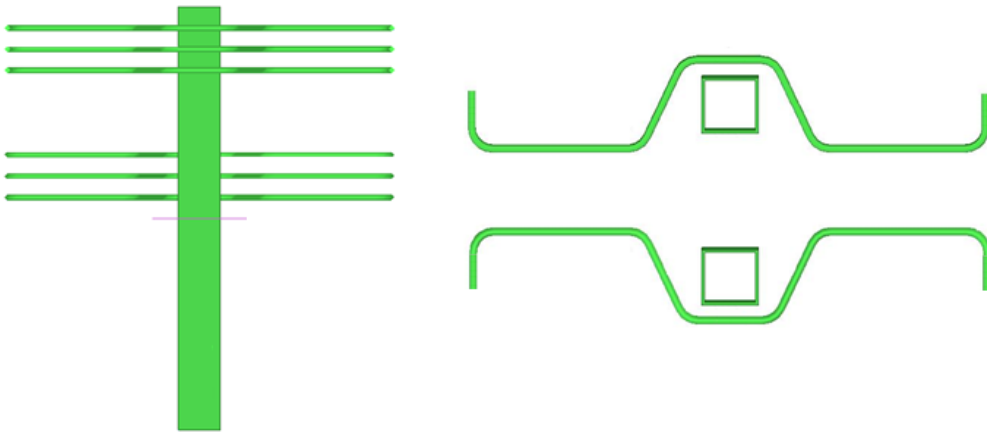


Figure 4.50 Tube jointing custom component

First of all, 2 objects for a future custom component should be created: a concrete plate with any dimensions (the thickness has to be sufficient for jointing part) and a tube element. Also it is possible to use Slab Custom Component as an initial slab. The tube element parameters have to be similar to: length 100 mm, cross section 100 mm by 100 mm by 5 mm. The length of the tube inside and outside of the slab has to be close to 500 mm (Figure 4.51 Dimensions for tube and slab).

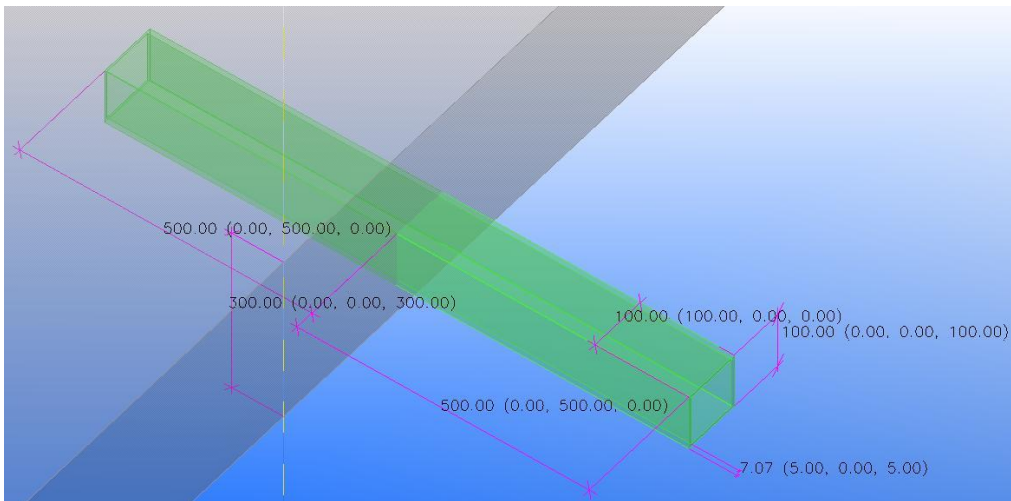


Figure 4.51 Dimensions for tube and slab

In custom component Wizard the name of the component is STALA SINGLE TENS, the type (Type/Notes) is «seam», «Allow multiple instances of connection between same part» ticked. All other settings are default. Tube element is a component object, slab is a main part. There are no secondary parts. The seam position will be like in figure 4.52.

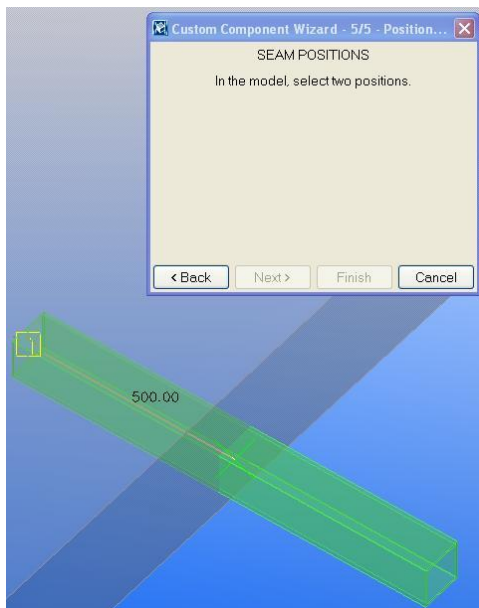


Figure 4.52 Seam position

After the creation of custom component it can be modified with custom component editor. Component Catalog can be opened with <Ctrl>+<F>.

Now it is possible to add reinforcement to the unit. It is better to use reinforcement bar group in this case (Figure 4.53 Reinforcing bar group command). The reinforcement part can be either slab or tube. The shape of the bars in the zone close to slab surface is like in figure 4.50 (cover thicknesses in reinforcing bar properties is 0). The range with 150-200 mm from surface of the plate to inside can be indicated.



Figure 4.53 Reinforcing bar group command

In the same way the reinforcement in the 2nd zone can be made. When the reinforcement is ready the next step is to make the quantity of bars, material for bars and the diameters of bars configurable. In the variables display there are 6 new parameters: 2 with the formula «4», the value type «Number», label for dialog box «number 1» and «number 2». 2 with formula A500HW, the value type «Material», label for dialog box «class 1» and «class 2». 2 with formula 12, value type «Rebar size», label for dialog box «size 1» and «size 2» (Figure 4.54 Variables).

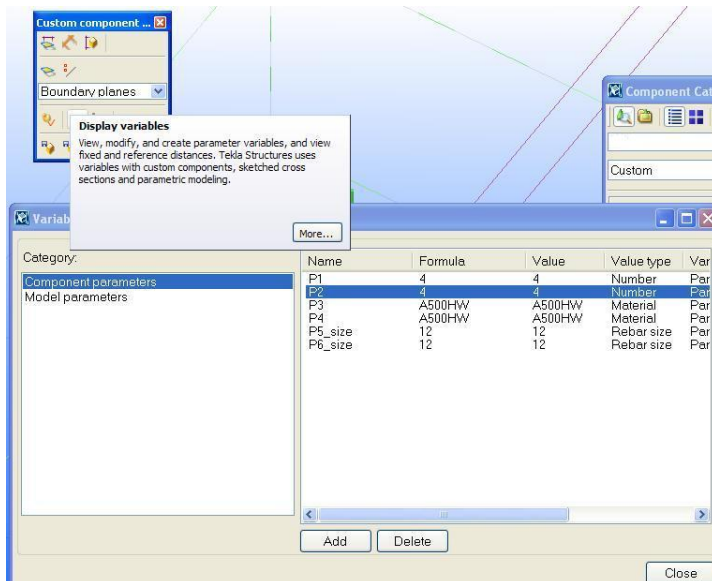


Figure 4.54 Variables

Then some properties for both reinforcements have to be changed. Creation method is «Equal distribution by number of reinforcing bars» (in Group window) (Figure 4.55 Reinforcement parameters).

For 1st rebar group in Custom component browser:

Component - Component objects - Rebar group - General properties - Size=P5_size.

Component - Component objects - Rebar group - General properties - Grade=P3.

Component - Component objects - Rebar group - Group properties - Number=P1.

For 2nd rebar group:

The same with:

Size=P6_size.

Grade=P4.

Number=P2.

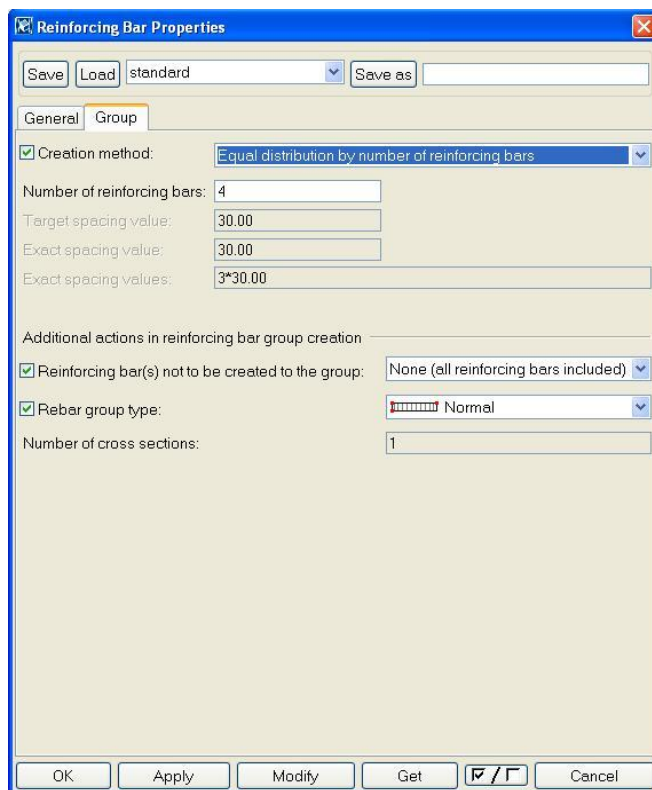


Figure 4.55 Reinforcement parameters

Now it is possible to make all equations for the plan and cross section parameters for jointing element. Inside chamfer of the tube element has to be bonded to the back surface slab plane. After that the corresponding equation will appear in the variables. In the same way the equation for the outside tube length can be installed (D1, D2, figure 4.56). The labels are inside length and outside length.

The plan parameters for reinforcements also have to be configurable in the custom component. All chamfers of reinforcement close to the back surface of the slab should be selected (it is possible to use <Alt> + <Left mouse button> for handling the chamfer zone). Then chamfers have to be bonded to the plan of the back side of the slab. The corresponding equations are shown in figure 4.56.

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	4	4	Number	Parameter	Show	number 1
P2	4	4	Number	Parameter	Show	number 2
P3	A500HW	A500HW	Material	Parameter	Show	class 1
P4	A500HW	A500HW	Material	Parameter	Show	class 2
P5_size	12	12	Rebar size	Parameter	Show	size 1
P6_size	12	12	Rebar size	Parameter	Show	size 2
D1	500.00	500.00	Length	Distance	Show	inside length
D2	500.00	500.00	Length	Distance	Show	outside length
D3	40.00	40.00	Length	Distance	Show	caver
D4	=D3	40.00	Length	Distance	Hide	D4.REBAR.PARVEKELAA...
D5	=D3	40.00	Length	Distance	Hide	D5.REBAR.PARVEKELAA...
D6	=D3	40.00	Length	Distance	Hide	D6.REBAR.PARVEKELAA...
D7	=D3	40.00	Length	Distance	Hide	D7.REBAR.PARVEKELAA...
D8	=D3	40.00	Length	Distance	Hide	D8.REBAR.PARVEKELAA...
D9	=D3	40.00	Length	Distance	Hide	D9.REBAR.PARVEKELAA...
D10	=D3	40.00	Length	Distance	Hide	D10.REBAR.PARVEKELAA...
D11	=D3	40.00	Length	Distance	Hide	D11.REBAR.PARVEKELAA...

Figure 4.56 Variables after first bonding in plan

Similarly all equations for all dimensions of reinforcement in plan (like space between bars in the 1st reinforcement, space between bars in the 2st reinforcement, space from the beginning of the 2nd reinforcement and inside chamfer of the tube) can be created.

After binding to plane all chamfers in horizontal plane it is possible to make equations for geometry parameters for cross section view. It can be made similarly to plan geometry parameters. The equations could be made for dimensions shown in figure 4.57. The corresponding chamfers of the reinforcement for reinforcement 1 and 2 should be bonded to tube planes.

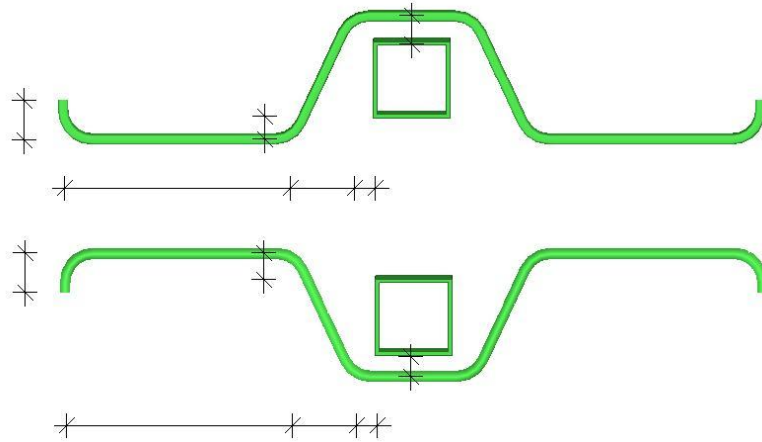


Figure 4.57 Cross section dimensions

The variables after all modifications will be looking like in figure 4.58.
 P1-P4 and P5_size and P6_size are reinforcing element parameters.
 P7-P9, D1-D22 are plan dimensions parameters.
 P10-P15, D22-D62 are cross section dimensions parameters.
 P7 is tube elements parameter.

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	4	4	Number	Parameter	Show	number 1
P2	4	4	Number	Parameter	Show	number 2
P3	A500HW	A500HW	Material	Parameter	Show	class 1
P4	A500HW	A500HW	Material	Parameter	Show	class 2
P5_size	12	12	Rebar size	Parameter	Show	size 1
P6_size	12	12	Rebar size	Parameter	Show	size 2
P7	40.00	40.00	Length	Parameter	Show	Sp b/w bars 2nd
P8	40.00	40.00	Length	Parameter	Show	caver2
P9	40.00	40.00	Length	Parameter	Show	Sp b/w bars 1st
P10	75.00	75.00	Length	Parameter	Show	size1.4
P11	300.00	300.00	Length	Parameter	Show	size1.5
P12	150.00	150.00	Length	Parameter	Show	size1.6
P13	75.00	75.00	Length	Parameter	Show	size2.4
P14	300.00	300.00	Length	Parameter	Show	size2.5
P15	100.00	100.00	Length	Parameter	Show	size2.6
P16	CFRHS100X1...	CFRH...	Profile	Parameter	Show	section for tube
P17	AISI304	AISI304	Material	Parameter	Show	class for tube
D1	500.00	500.00	Length	Distance	Show	Inside length
D2	500.00	500.00	Length	Distance	Show	outside length
D3	40.00	40.00	Length	Distance	Show	caver1
D4	=D3	40.00	Length	Distance	Hide	D4.REBAR.PARVEKELAA...
D5	=D3	40.00	Length	Distance	Hide	D5.REBAR.PARVEKELAA...
D6	=D3	40.00	Length	Distance	Hide	D6.REBAR.PARVEKELAA...
D7	=D3	40.00	Length	Distance	Hide	D7.REBAR.PARVEKELAA...
D8	=D3	40.00	Length	Distance	Hide	D8.REBAR.PARVEKELAA...
D9	=D3	40.00	Length	Distance	Hide	D9.REBAR.PARVEKELAA...
D10	=D3	40.00	Length	Distance	Hide	D10.REBAR.PARVEKELAA...
D11	=D3	40.00	Length	Distance	Hide	D11.REBAR.PARVEKELAA...
D12	=D1-P8	460.00	Length	Distance	Hide	D12.REBAR.PARVEKELAA...
D13	=D12-P7*(P2-1)	340.00	Length	Distance	Hide	D13.REBAR.PARVEKELAA...
D14	=D13	340.00	Length	Distance	Hide	D14.REBAR.PARVEKELAA...
D15	=D13	340.00	Length	Distance	Hide	D15.REBAR.PARVEKELAA...
D16	=D13	340.00	Length	Distance	Hide	D16.REBAR.PARVEKELAA...
D17	=D13	340.00	Length	Distance	Hide	D17.REBAR.PARVEKELAA...
D18	=D13	340.00	Length	Distance	Hide	D18.REBAR.PARVEKELAA...
D19	=D13	340.00	Length	Distance	Hide	D19.REBAR.PARVEKELAA...
D20	=D13	340.00	Length	Distance	Hide	D20.REBAR.PARVEKELAA...
D21	=D13	340.00	Length	Distance	Hide	D21.REBAR.PARVEKELAA...
D22	=D3+P10*(P1-1)	265.00	Length	Distance	Hide	D22.REBAR.PARVEKELAA...
D23	30.00	30.00	Length	Distance	Show	size1.1
D24	=D23	30.00	Length	Distance	Hide	D24.REBAR.CFRHS100X1...
D25	=D23	30.00	Length	Distance	Hide	D25.REBAR.CFRHS100X1...
D26	=D23	30.00	Length	Distance	Hide	D26.REBAR.CFRHS100X1...
D27	30.00	30.00	Length	Distance	Show	size1.2
D28	=D27	30.00	Length	Distance	Hide	D28.REBAR.CFRHS100X1...
D29	=D27	30.00	Length	Distance	Hide	D29.REBAR.CFRHS100X1...
D30	=D27	30.00	Length	Distance	Hide	D30.REBAR.CFRHS100X1...
D31	30.00	30.00	Length	Distance	Show	size1.3
D32	=D31	30.00	Length	Distance	Hide	D32.REBAR.CFRHS100X1...
D33	=D31	30.00	Length	Distance	Hide	D33.REBAR.CFRHS100X1...
D34	=D31	30.00	Length	Distance	Hide	D34.REBAR.CFRHS100X1...
D35	=D31+P11	330.00	Length	Distance	Hide	D35.REBAR.CFRHS100X1...
D36	=D35	105.00	Length	Distance	Hide	D36.REBAR.CFRHS100X1...
D37	=D35+P12	255.00	Length	Distance	Hide	D37.REBAR.CFRHS100X1...
D38	=D37	405.00	Length	Distance	Hide	D38.REBAR.CFRHS100X1...
D39	=D37	405.00	Length	Distance	Hide	D39.REBAR.CFRHS100X1...
D40	=D37	405.00	Length	Distance	Hide	D40.REBAR.CFRHS100X1...
D41	=P13-D27	45.00	Length	Distance	Hide	D41.REBAR.CFRHS100X1...
D42	=D41	120.00	Length	Distance	Hide	D42.REBAR.CFRHS100X1...
D43	30.00	30.00	Length	Distance	Show	size2.1
D44	=D43	30.00	Length	Distance	Hide	D44.REBAR.CFRHS100X1...
D45	=D43	30.00	Length	Distance	Hide	D45.REBAR.CFRHS100X1...
D46	=D43	30.00	Length	Distance	Hide	D46.REBAR.CFRHS100X1...
D47	30.00	30.00	Length	Distance	Show	size2.2
D48	=D47	30.00	Length	Distance	Hide	D48.REBAR.CFRHS100X1...
D49	=D47	30.00	Length	Distance	Hide	D49.REBAR.CFRHS100X1...
D50	=D47	30.00	Length	Distance	Hide	D50.REBAR.CFRHS100X1...
D51	30.00	30.00	Length	Distance	Show	size2.3
D52	=D51	30.00	Length	Distance	Hide	D52.REBAR.CFRHS100X1...
D53	=D51	30.00	Length	Distance	Hide	D53.REBAR.CFRHS100X1...
D54	=D51	30.00	Length	Distance	Hide	D54.REBAR.CFRHS100X1...
D55	=D51+P14	330.00	Length	Distance	Hide	D55.REBAR.CFRHS100X1...
D56	=D55	105.00	Length	Distance	Hide	D56.REBAR.CFRHS100X1...
D57	=D55+P15	205.00	Length	Distance	Hide	D57.REBAR.CFRHS100X1...
D58	=D57	405.00	Length	Distance	Hide	D58.REBAR.CFRHS100X1...
D59	=D57	405.00	Length	Distance	Hide	D59.REBAR.CFRHS100X1...
D60	=D57	405.00	Length	Distance	Hide	D60.REBAR.CFRHS100X1...
D61	=P16-D47	0.00	Length	Distance	Hide	D61.REBAR.CFRHS100X1...
D62	=D61	70.00	Length	Distance	Hide	D62.REBAR.CFRHS100X1...

Figure 4.58 Variable for STALA SINGLE TENS Custom Component

To make the properties of STALA SINGLE TENS Custom Component better looking there are 2 BMP pictures: figure 4.59.

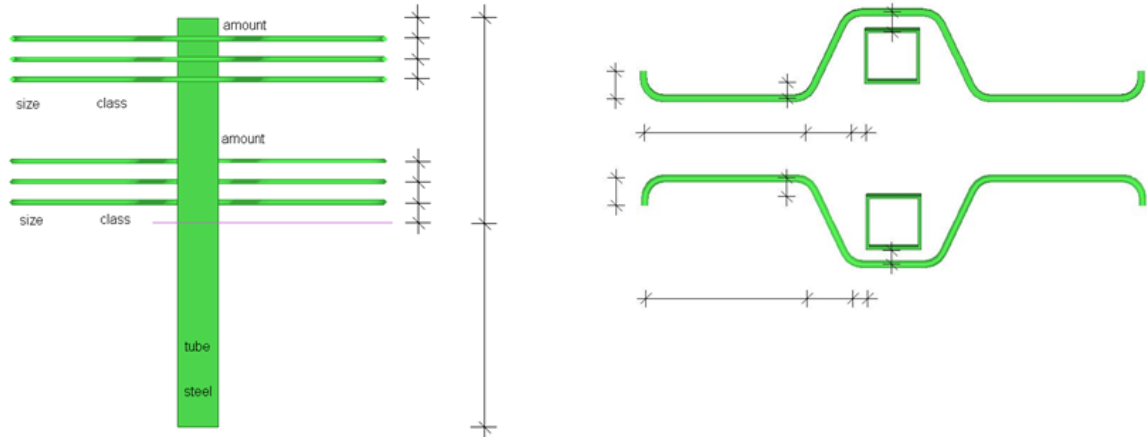


Figure 4.59 Sketches for STALA SINGLE TENS Custom Component

Finally the STALA SINGLE TENS Custom Component properties will be looking like in the figure in APPENDIX 1. The programming code is in APPENDIX 2. Variable list is in APPENDIX 3.

5 TUBE CONNECTION ELEMENT CALCULATOR

5.1 Excel sheet calculator

BALCONY SUPPORT CALCULATOR is an excel calculator file which can help calculate the reinforcement (amount, cross section, anchoring length) and cross section parameters of tube for tube jointing unit (Figure 5.1 Excel calculator concept).

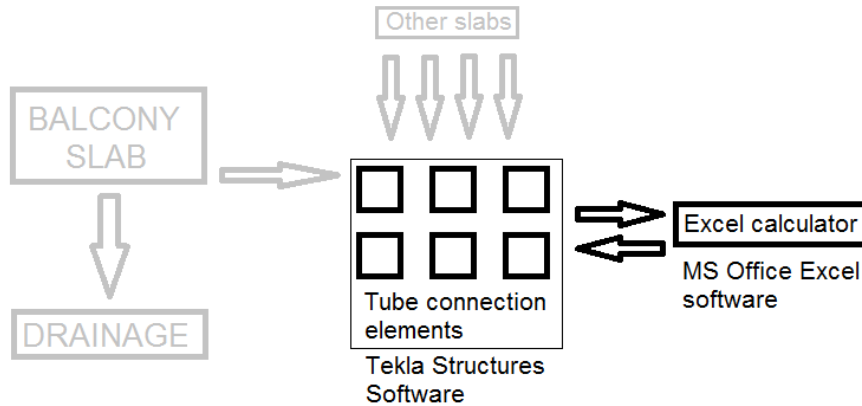


Figure 5.1 Excel calculator concept

The BALCONY SUPPORT CALCULATOR consists of 8 worksheets:

- plates
- CalcA
- CalcB
- CalcC
- CalcD
- Concrete data
- Tube data
- Cross sections

The list Plates is divided into 6 parts:

- Slab type 1
- Slab type 2
- Slab type 3
- Slab type 4
- Slab type 5
- Input material data

There the user has to choose the required type of balcony slab (1, 2, 3, 4 or 5).

In the upper right corner of window for each type of plate there is a small table. The value of support forces (Force, kN) and the character of these forces (comp/ten,

compression on support or tension on support) have to be selected for each support (Figure 5.2 Value of force and character).

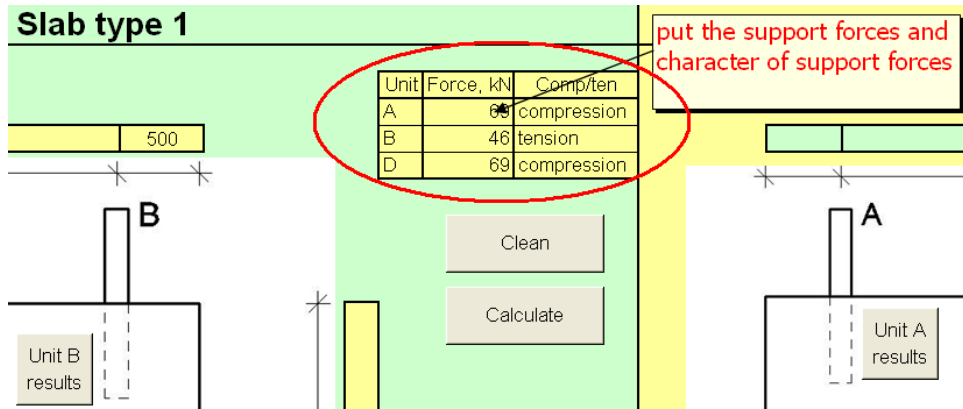


Figure 5.2 Value of force and character

The value and the character of these support forces can be found in any building-mechanic static calculation software (Figure 5.3 FEM-Design 9.0 – Plate concept). The program FEM-Design 9.0 – Plate is a good choice for this case (widely used in FMC group, figure 5.4 FEM-Design 9.0 – Plate).

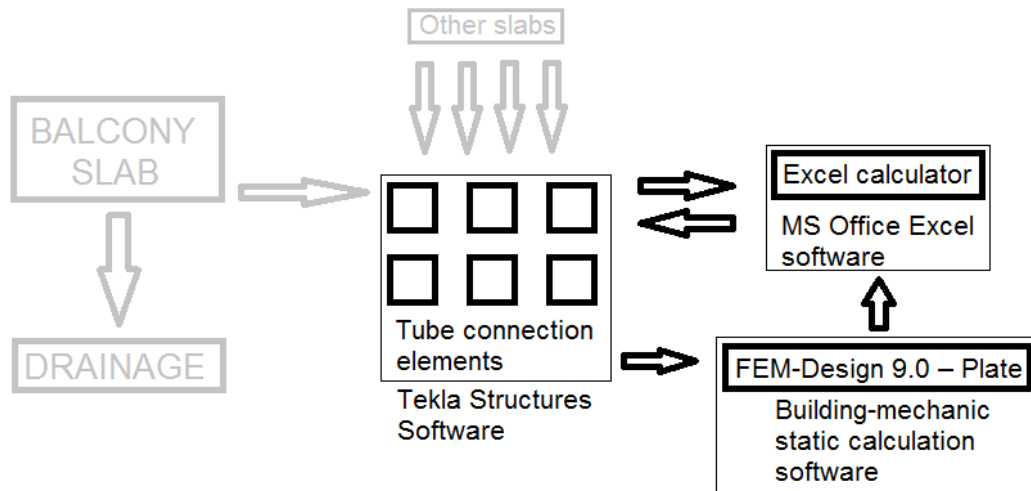


Figure 5.3 FEM-Design 9.0 – Plate concept

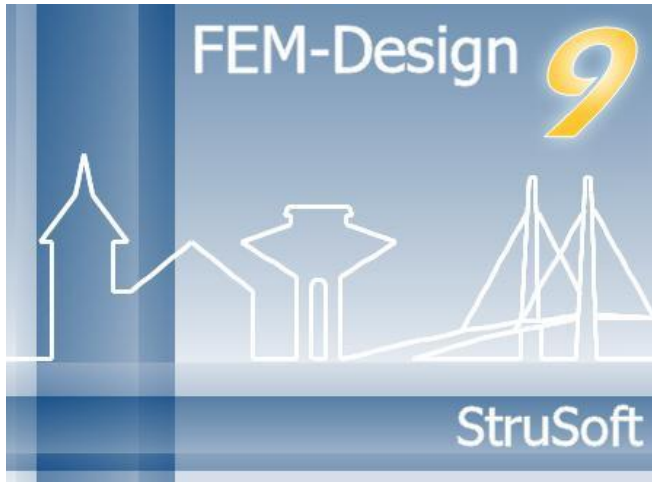


Figure 5.4 FEM-Design 9.0 – Plate

In FEM-Design 9.0 – Plate it is possible to create plate with required dimensions and thickness (Figure 5.5 Slab dimensions).

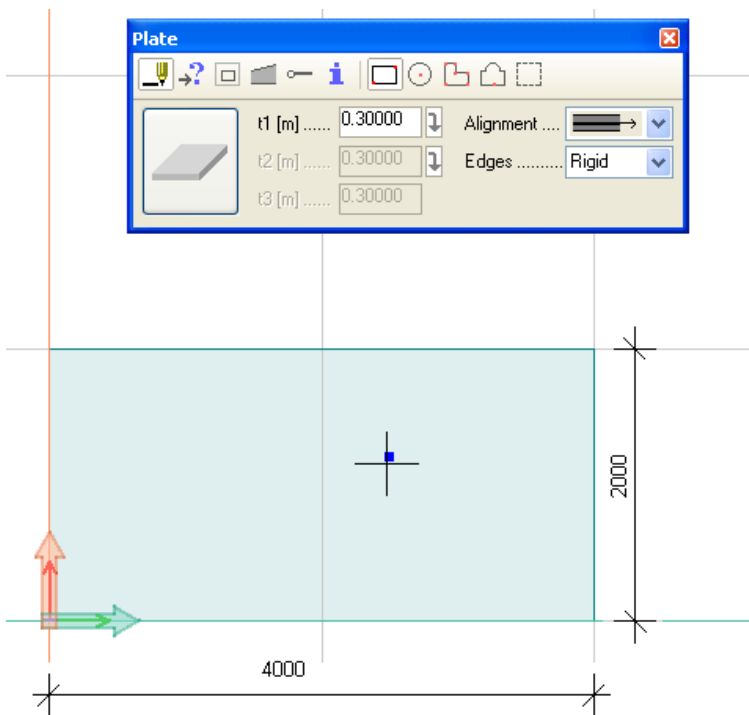


Figure 5.5 Slab dimensions

Then it is possible to make the support tube consoles (Figure 5.6 Tube consoles).

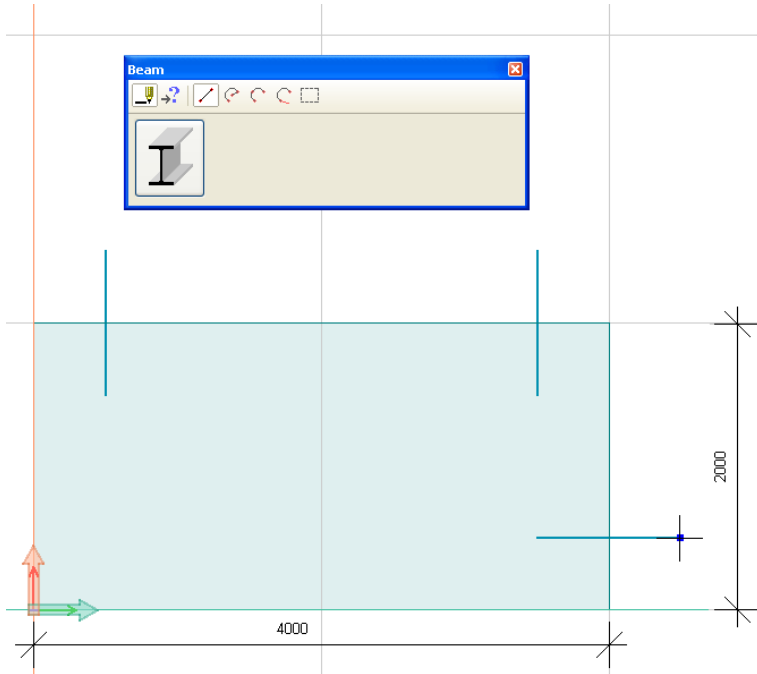


Figure 5.6 Tube consoles

The support points have to be at the ends of consoles beam (Figure 5.7 Support point).

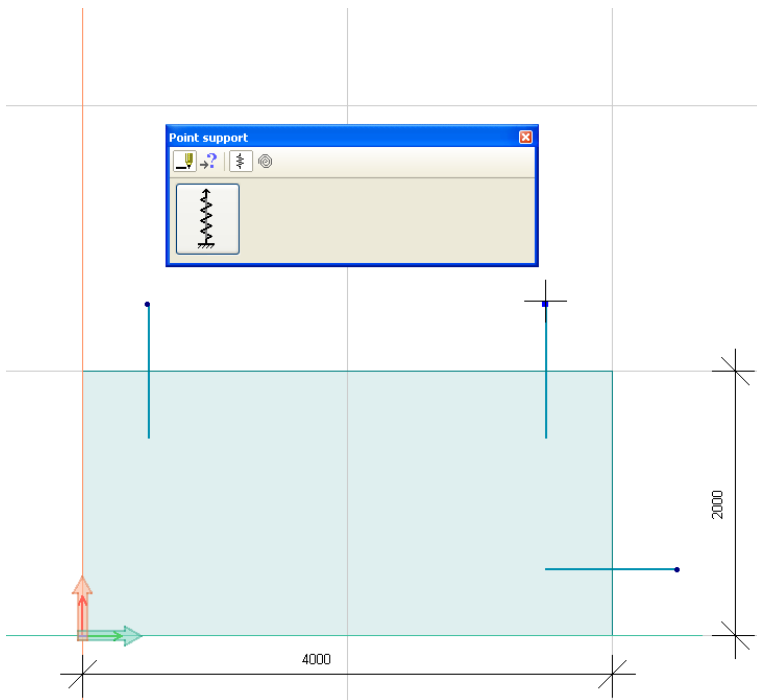


Figure 5.7 Support point

Then the load and load combinations have to be selected. (4 kN/m is the imposed load on balconies (SFS-EN 1991-1-1 6.3.1.2), 7.5 kN/m is the self-weight load of the slab in case of 300 mm thickness, figure 5.8 Load and load combination).

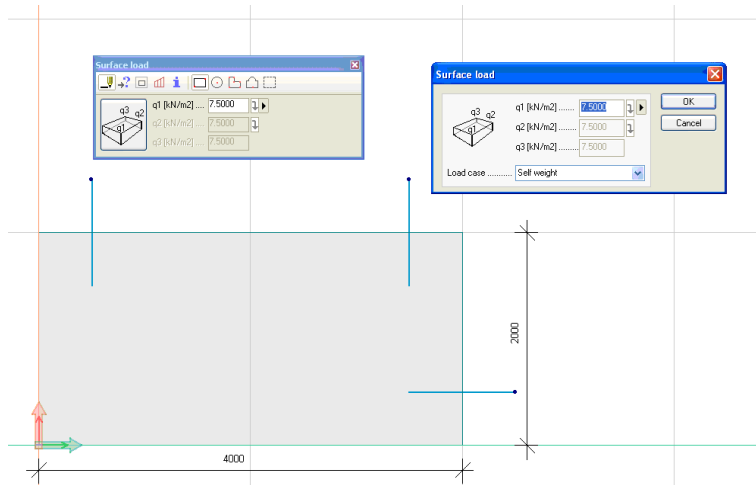


Figure 5.7 Load and load combination

Then the model is calculated and the results are shown (Figure 5.8 Results of calculations).

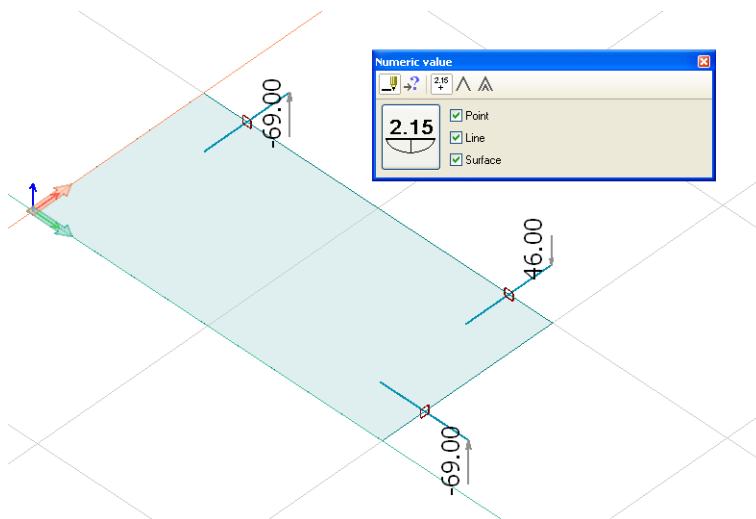


Figure 5.8 Results of calculations

In this case Support Force for Unit A is 69,00 kN (compression on support), for Unit B is 46,00 kN (tension on support), for Unit C is 69,00 kN (compression on support) (these results have been taken with load combination of self weight 7,5 kN/m² and people and equipment load 4 kN/m² without dead load and any multipliers). These values can be found with any other software with the same algorithm.

Also some balcony slab dimensions can be put in special cells (not necessary). These parameters do not have any influence on the result of calculation, but it is good to write them to make comprehension easier (Figure5.9 Balcony dimensions).

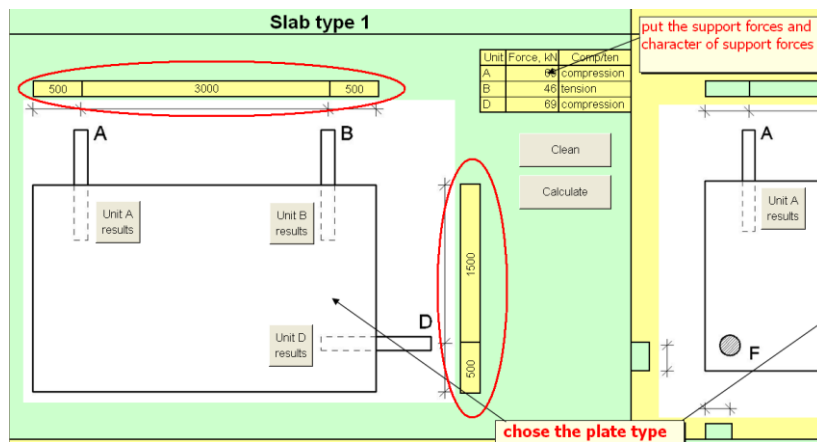


Figure 5.9 Balcony dimensions

Also the worksheet Plates consists of the input material data box (Figure 5.10 Input material data box). There user can choose the concrete class for balcony slab (C12/15, C16/20, C20/25, C25/30, C30/37, C35/45, C40/50, C45/55, C50/60, C55/67, C60/75, C70/85, C80/95, C90/105), the reinforcement steel class for connection unit (A400H, A400HW, A500H, A500HW, B500K, B500P or A600H), steel class for tube element. The steel classes for tube element are taken from the STALA (<http://www.stalatube.com/Link.aspx?id=1031281>) tube database (304, 304L, 321, 316, 316L, 316Ti or High strength class). Also on the bottom part of this box the user has to put the length of tube outside the balcony slab.

Input material data

Concrete class	C25/30
Reinforcement steel class	A500HW
Tube steel class	High strength class

Force, kN Computer

Clean

Calculate

A= 0.5[m] (<0.6)

Note! In the balcony types 1 and 2 the unit B (in the type 1) and units B and C (in the type 2) can experienced both compression and tension on supports (it is depends on location of the load on the slab). Therefore it is good to make the same reinforcement in the both sides (on top and on the bottom in the points 1 and 2). After finding the support forces for each supports it is better for designer to choose the highest force and to make the cross section for tube element and reinforcement equal for each supports for this force.

Figure 5.10 Input material data box

The button Clean clears all information and data in the corresponding supporting force information table and in the input material data box in the worksheet Plates and the same information in other worksheets.

The button Calculate does all the calculation of cross section of the tube and reinforcement parameters.

It is good to press Clean before writing all parameters in the support force table and input material data table. After cleaning of all unnecessary numbers the user can input the requirement information and press the Calculate button (Figure 5.11 Clean and Calculate buttons).

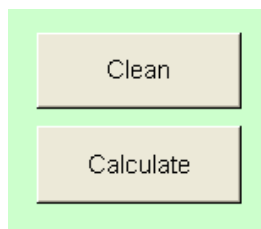


Figure 5.11 Clean and Calculate buttons

To see the results of calculation the user can push the button Unit_Results nearby any of the support units. Then the Worksheet CalcA, CalcB, CalcC or CalcD appear (Figure 5.12 Result button).

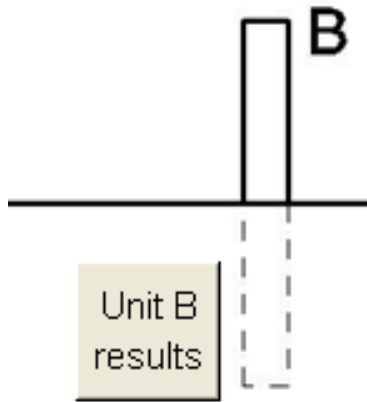


Figure 5.12 Result button

The Worksheet CalcA(B,C,D) consists of 5 main parts.

- Material data

Input material data		
Concrete class	C25/30	
Reinforcement steel class	A500HW	
Tube steel class	High strength class	
Strength material data		
Concrete		
f_{ck}	25	N/mm ²
$f_{ck,cube}$	30	N/mm ²
$f_{ctk,0,05}$	1,8	N/mm ²
Steel for reinforcement		
f_{yk}	500	N/mm ²
f_{yd}	435	N/mm ²
Tube steel		
$R_{p0,2}$	350	N/mm ²

Figure 5.13 Material data table

There is user data. Strength parameters are calculated.

- Geometry data

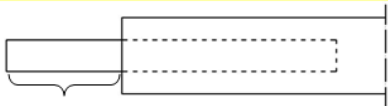

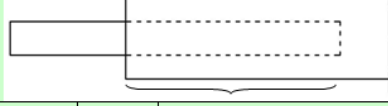
Input geometry data			
			
A	0,5	m	($\leq 0,6$)
Output geometry data			
			
L	1	m	
			
B	0,5	m	

Figure 5.14 Geometry data table

A is the length of anchoring. L is the total length of tube. B is the length of tube inside of the balcony slab.

- Load data

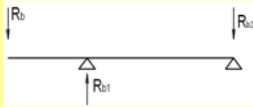
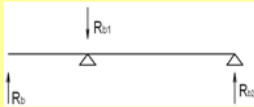
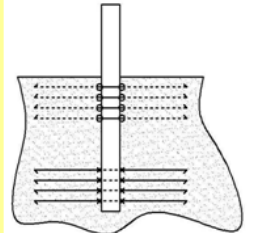
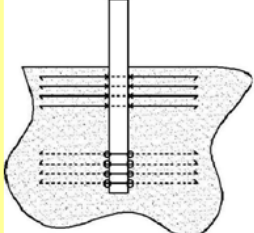
Input load data			
R_p	69	kN	
compression			
Compression on support		Tension on support	
			
			
R_{b1}	241,50	kN	R_{b1}
R_{b2}	172,50	kN	R_{b2}
maxM	34,50	kNm	maxM

Figure 5.15 load data table

The distance between the 1st and the 2nd point is (B-0.25m) (see calculation part).

There are the inner forces in point 1 (R_{b1}) and point 2 (R_{b2}). The maximum bending moment is at the point on surface of the slab. In case of compression on support the R_{b1} , R_{b2} and maxM appear in the left part of the table under corresponding scathes. In case of tension on support the R_{b1} , R_{b2} and maxM appear in the right part of the table under corresponding sketches. These sketches show where the reinforcement has to be installed.

- Tube cross section information

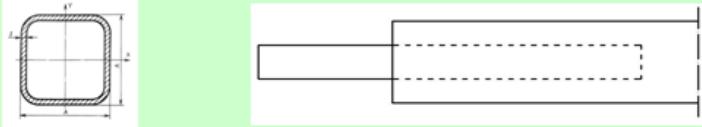
Tube cross section					
					
W_{req}	98571	mm ³	=	98,57	cm ³
W_{el}	112,80	cm ³			
Cross section		140	140	4	1 times

Figure 5.16 Cross section parameters table

W_{req} is the required resistance moment of tube cross section, W_{el} is the resistance moment of real cross section (more than W_{req}). Also the geometry parameters of tube cross section are shown.

- Reinforcement information

Reinforcement			
A_{req1}	555,45	mm^2	
A_e	565	mm^2	
Reinforcement	in point 1	12	* 5
Anchoring l_{bd}	in point 1	450	
A_{req2}	396,75	mm^2	
A_e	452	mm^2	
Reinforcement	in point 2	12	* 4
Anchoring l_{bd}	in point 2	400	

Figure 5.17 Reinforcement information table

In this part the information about reinforcement in point 1 and in point 2 is shown (diameters, amount and length of anchoring).

Also in the worksheets CalcA,B,C,D the user can take advantage of relative buttons to move to relative page (Figure 5.18 Relative buttons to move to relative page).

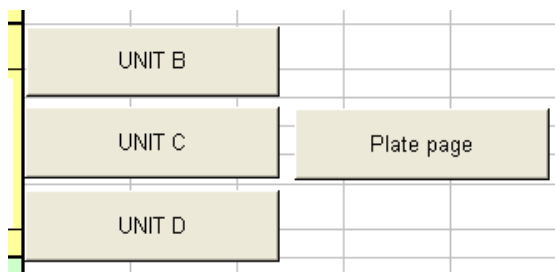


Figure 5.18 Relative buttons to move to relative page

5.2 Calculation notes for Excel Sheet calculator

5.2.1 Introduction

As it was mentioned before the calculation of the support forces is done in some special software. It is recommended to use FEM-Design 9.0 - Plate.

The concrete classes C12/15, C16/20, C20/25, C25/30, C30/37, C35/45, C40/50, C45/55, C50/60, C55/67, C60/75, C70/85, C80/95 and C90/105 are the usual concrete classes widely used in Europe (EN 1992-1-1:2004 (E) Table 3.1). The reinforcement steel classes are A400H, A400HW, A500H, A500HW, B500K, B500P or A600H. The steel classes for tube elements were taken from the <http://www.stalatable.com/Link.aspx?id=1031281> (STALA tube elements). There are 304, 304L, 321, 316, 316L, 316Ti or High strength class. The resistance of this steel class is also shown in STALA data tables ($R_{p0,2}$, in the worksheet Tube Data).

The length of tube outside of the slab can vary from 0sm to 60sm. It depends on the construction of the support wall and slab.

The normative concrete compression cylinder resistance (f_{ck}), the normative concrete compression cube resistance ($f_{ck, cube}$) and the normative concrete tension resistance ($f_{ctk, 005}$) are taken from EN 1992-1-1:2004 (E) Table 3.1. The calculation reinforcement steel resistance (f_{yd}) is calculated with the safety factor 1.15 (Persistent and Transient) (EN 1992-1-1:2004 (E) Table 2.1N). All this data is shown in worksheets Concrete data and Reif.data.

5.2.2 Calculation of cross section for tube

The cross section for tube is calculated with the normal stress requirements (σ). After evaluation of the support reaction for connection element it is possible to find

the maximum bending moment (the maximum bending moment is at the cross point of tube with the surface of the plate):

$$\max M = R_b \cdot A \quad (5.1)$$

R_b – is support reaction.

A – is length of tube outside of the balcony slab.

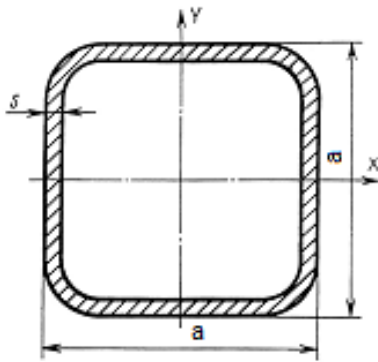


Figure 5.19 Tube cross section

After that the required resistance moment for tube can be found:

$$W_{req} = \frac{\max M}{R_{p0.2}} \quad (5.2)$$

$R_{p0.2}$ – yield tube steel resistance.

W_{req} – is requirement static moment of tube.

In the worksheet Cross Section there are different tube cross sections with different dimensions and real static moment (W_{el}) values. The calculator will find the cross section with $W_{el} > W_{req}$.

5.2.3 Calculation of the reinforcement for tube support

There are 5 possible types of balcony slabs:

- 1

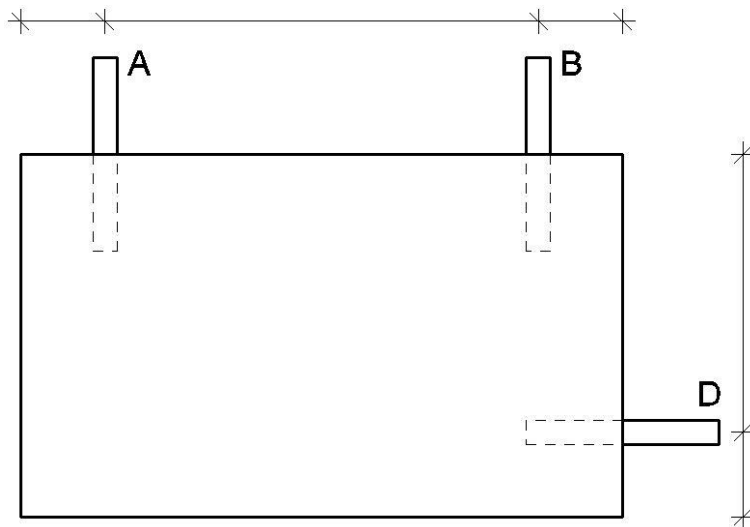


Figure 5.20 Balcony with 3 tube supports without column support

- 2

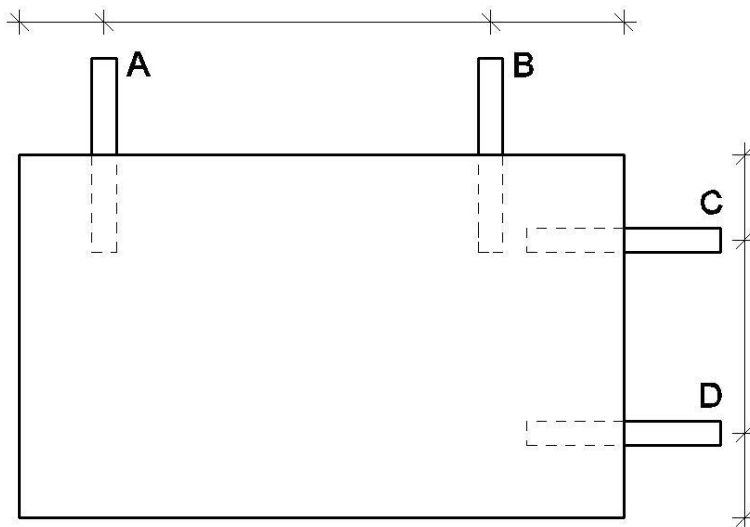


Figure 5.21 Balcony with 4 tube supports without column support

- 3

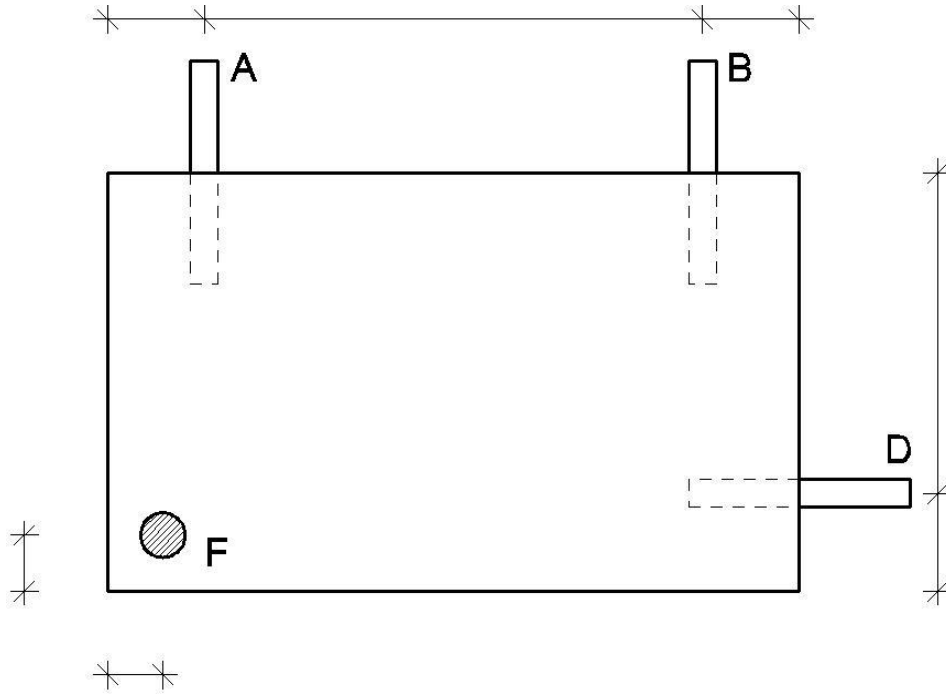


Figure 5.22 Balcony with 3 tube supports and column support

- 4

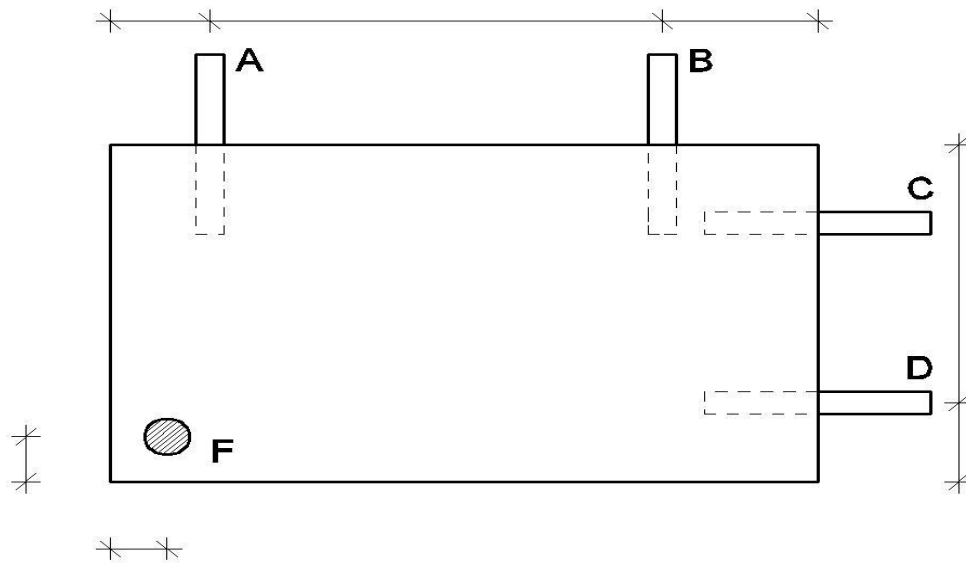


Figure 5.23 Balcony with 4 tube supports and column support

- 5

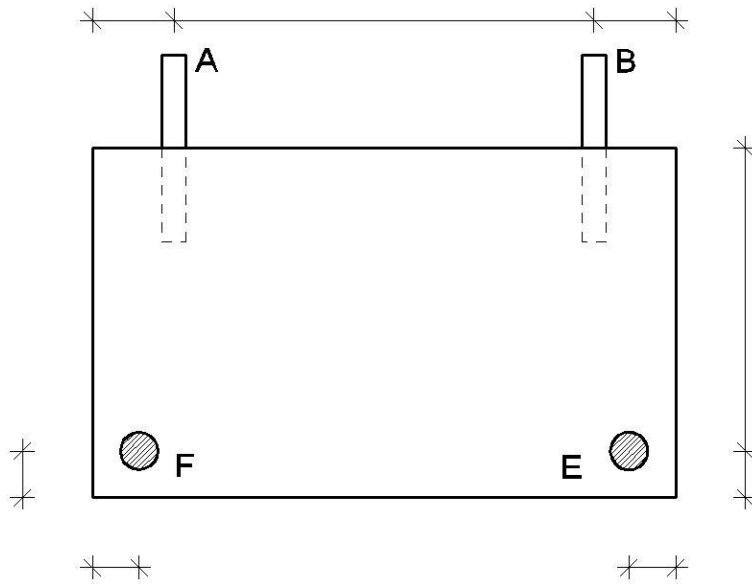


Figure 5.24 Balcony with 2 tube supports and 2 column supports

For types 3, 4 and 5 all supports experience only compression on support. In the balcony types 1 and 2 the unit B (in the type 1) and units B and C (in the type 2) can experience both compression and tension on supports (it depends on location of the load on the slab). Therefore it is good to make the same reinforcement on both sides (on top and on the bottom in both reinforcement zones).

After evaluating the support forces for each support it is better for the designer to choose the highest force and to make the cross section for tube element and reinforcement equal for each support based on the amount of this force. It is recommended from the construction point of view. This way the difference in the cost will not be really high but the constructor company may save some time and money by making them equal units.

For tube element the support unit mechanical scheme will be looking like in figure 5.25 and figure 5.26.

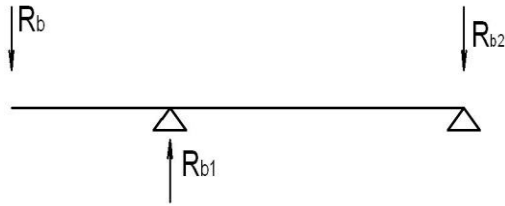


Figure 5.25 Static scheme in case of compression on support

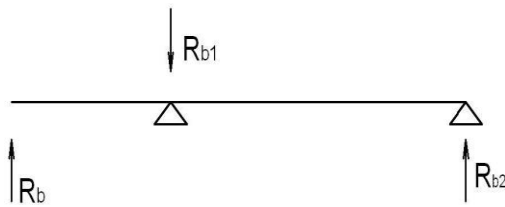


Figure 5.26 Static scheme in case of tension on support

R_b – Inner force on the support.

Actually R_b force is located at $2/3$ parts of support anchoring length from the end of tube. However, for safety reasons, the end location is widely recommended (Figure 5.27 Inner force on the support).

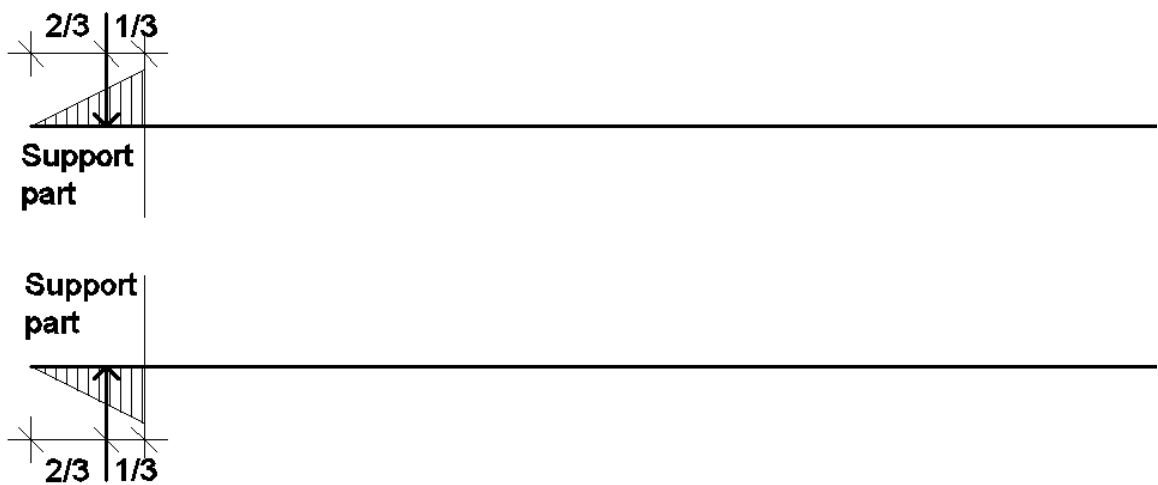


Figure 5.27 Inner force on the support

R_{b1} is the inner force close to the face of the balcony slab in the middle of reinforcement area in the middle of the tube. The force location is 125 mm from the surface to the inner of plate accepted.

R_{b2} is the inner force close to the end of tube in the inner of balcony slab. The force location is at 125 mm from the end of the tube (Figure 5.28 Inner forces in case of compression on support; Figure 5.29 Inner forces in case of tension on support).

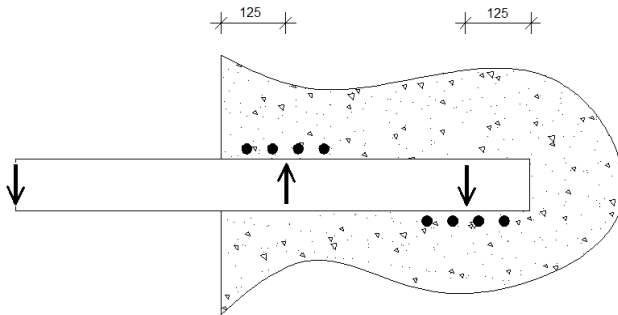


Figure 5.28 Inner forces in case of compression on support

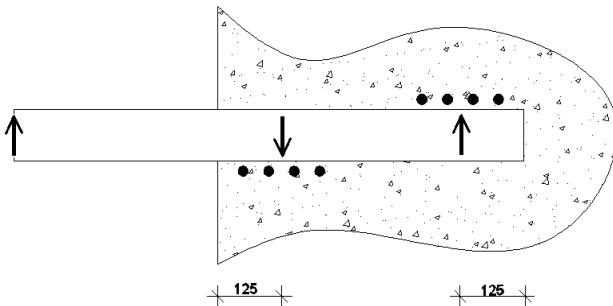


Figure 5.29 Inner forces in case of tension on support

After the finding of R_b value the R_{b1} and R_{b2} can be calculated.

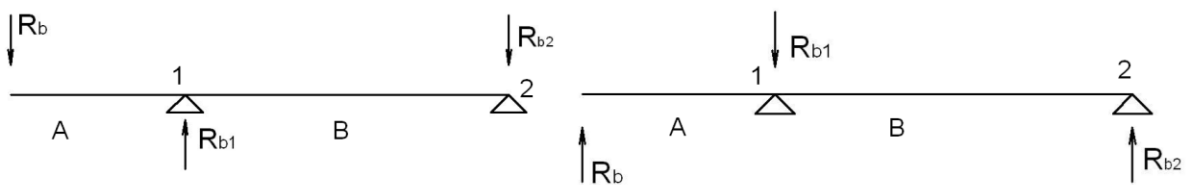


Figure 5.30 Static schemes

The easiest way to find R_{b2} is to set the equation of the moment for the 1st point.

$$M_{(1)}=R_b A-R_{b2} B=0, R_{b2}=R_b A/B \quad (5.3)$$

The easiest way to find R_{b1} is to set the equation of the moment for the 2nd point.

$$M_{(2)}=R_b(A+B)-R_{b1} B=0, R_{b1}=R_b(A+B)/B \quad (5.4)$$

The possible cracks are shown in figure 5.40. The force is transferring in to 2 sides to the reinforcement. Each side is taking the half of the force.

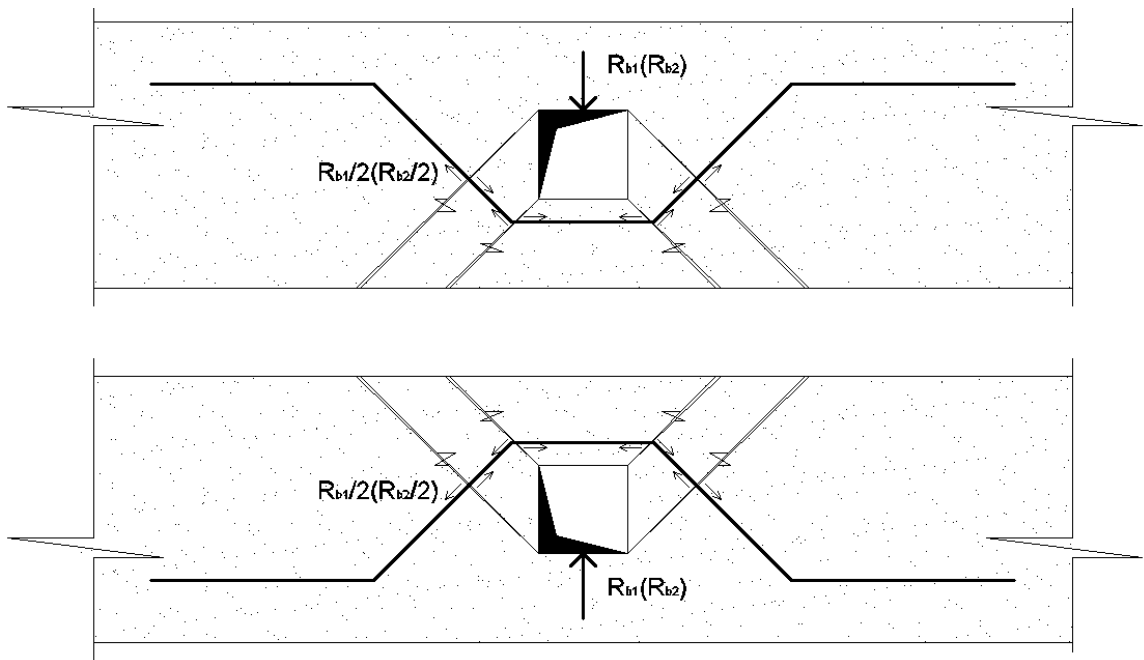


Figure 5.40 Possible cracks

In this way the area for the reinforcement will be:

$$A_s=R_{b1}(R_{b2})/f_{yd} \quad (5.5)$$

f_{ud} is the calculation resistance of the steel for reinforcement.

In the calculation of the area of reinforcement of cross section it is accepted that the force in the reinforcement is R_{b1} or R_{b2} . That is due to the safety factor and temperature deformation.

If the structure of the balcony includes columns then there can be temperature extensions in height (Figure 5.41 Tube connection and column supports; Figure 5.42 Deformations due to the temperature extensions; Figure 5.43 Forces of temperature extension).

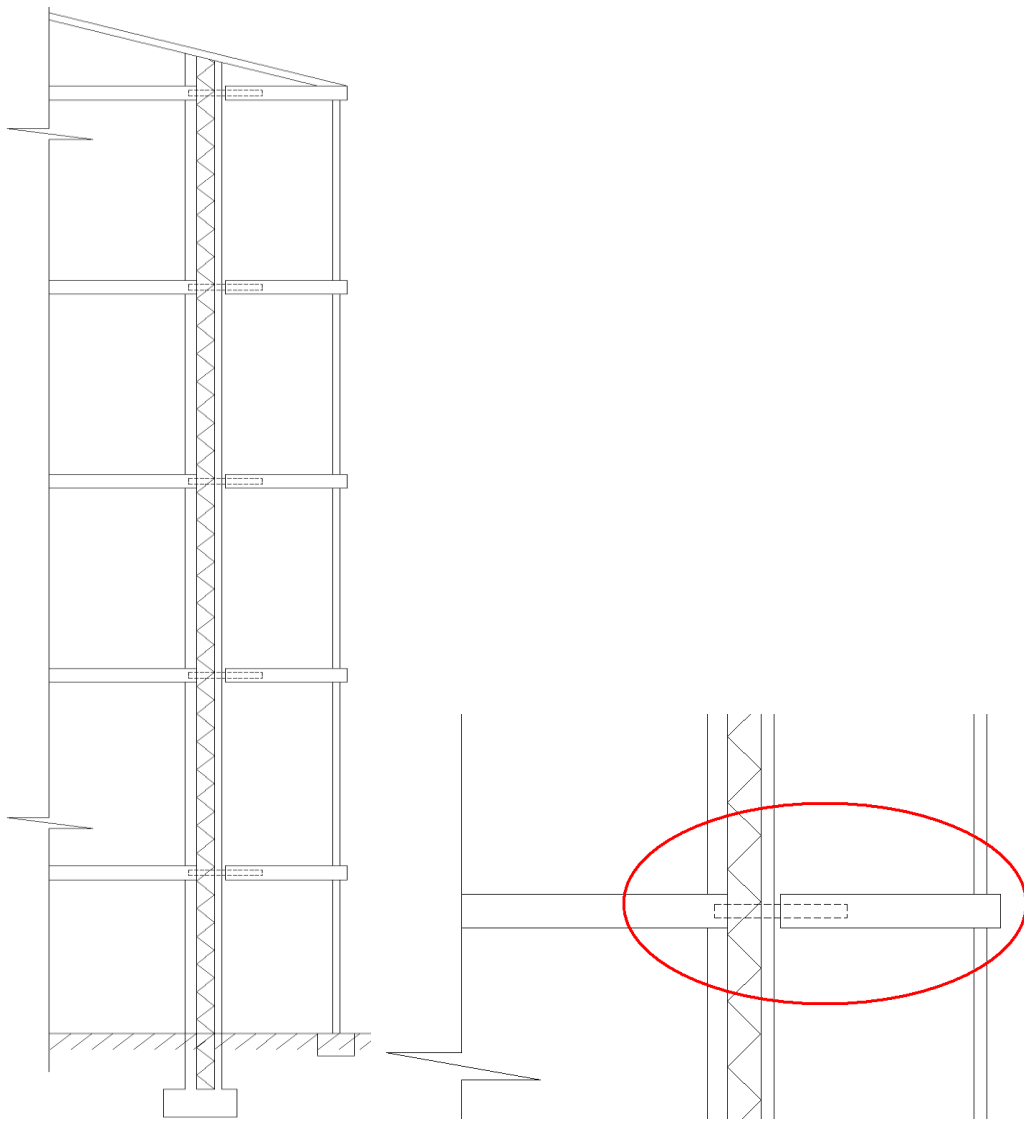


Figure 5.41 Tube connection and column supports

Due to the temperature extension of the columns in height there can be deformation in the console part of tube connection like in figure 5.42. The maximum deformation will be on the highest tube console.

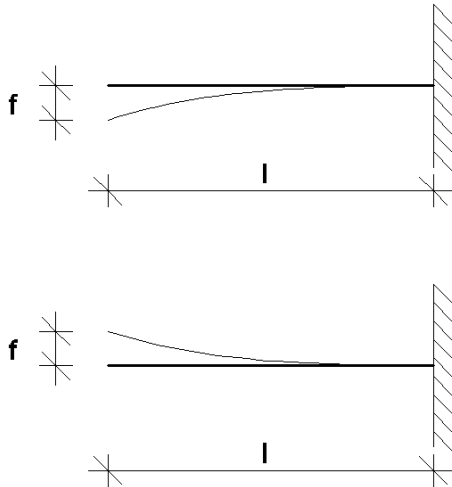


Figure 5.42 Deformations due to the temperature extensions

Here is an example of calculation of deformation force in the highest tube console. The number of levels is 5. The height of the level is 3 m (the height of the balcony support column is 3 m). The cross section for the tube is 100*100*8. The length of the console part is 500 mm.

The thermal extension coefficient for concrete is 0.00001 in average. The amplitude of temperature changing is 25°C. The inertia moment for this cross section is 3659000 mm⁴ (RAUTARUUKIN PUTKIPALKKIKASIKIRJA 2000 Liite 9.1). The elastic module is 210000 N/mm² in average for steel.

The deformation is

$$f = 5 \text{ levels} \cdot 3 \text{ m} \cdot 0.00001 \frac{1}{^{\circ}\text{Cm}} \cdot 25^{\circ}\text{C} \cdot 1000 \text{ mm} = 0.25 \frac{\text{mm}}{\text{m}} \cdot 15 \text{ m} = 3.75 \text{ mm} \quad (5.6)$$

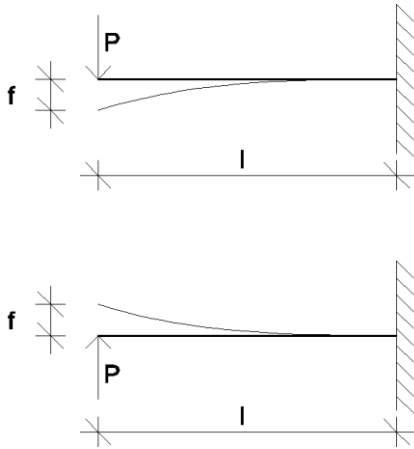


Figure 5.43 Forces of temperature extension

The deformation force is

$$P = \frac{3 \cdot f \cdot EI}{l^3} = \frac{3 \cdot 3.75 \text{ mm} \cdot 210000 \frac{\text{N}}{\text{mm}^2} \cdot 3659000 \text{ mm}^4}{500^3 \text{ mm}^3} = 69155 \text{ N} \approx 70 \text{ kN} \quad (5.7)$$

(RAKENTAJAIN KALENTERI 2002 Statiikkaa p. 50)

There is support deformation force for each tube connection at the balcony construction.

Often in the support point for tube connection there is a special flexible layer to prevent any deformation of the tube (Figure 5.44 Flexible layer).

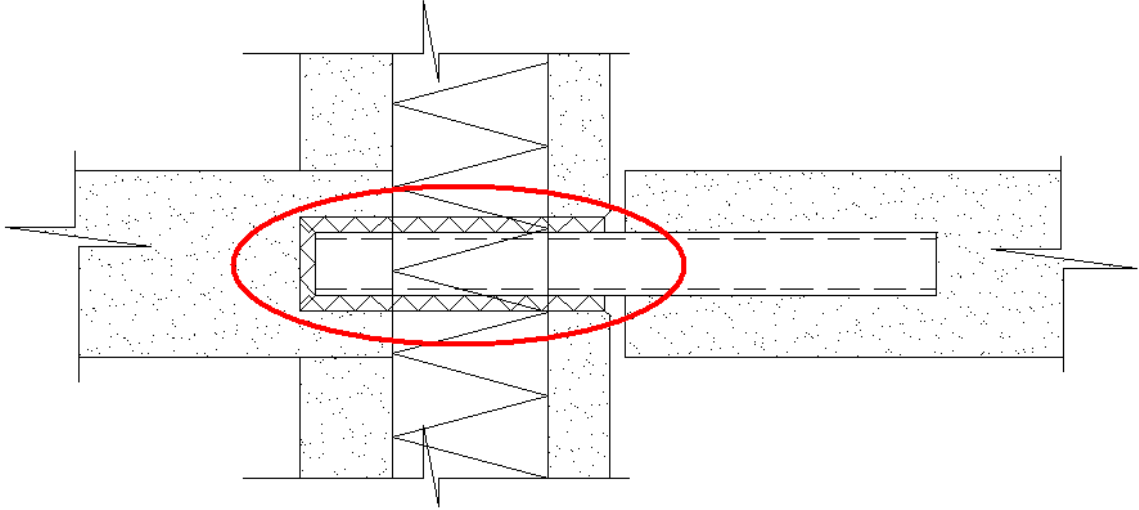


Figure 5.44 Flexible layer

If there are no special flexible layers it is necessary to take temperature deformation into account in the calculation of cross section of tube and reinforcement of connection unit.

5.2.4 Calculation of anchoring length

The design value of the ultimate bonds stress for ribbed bars may be taken as:

$$f_{bd} = 2.25\eta_1\eta_2f_{ctd} \quad (5.8)$$

(EN 1992-1-1:2004 (E) 8.4.2)

The design value of concrete tensile strength:

$$f_{ctd} = \frac{\alpha_{ct}f_{ctk,0.05}}{\gamma_c} \quad (5.9)$$

(EN 1992-1-1:2004 (E) 3.1.6)

$\gamma_c = 1.5$ is the partial safety factor for concrete (Persistent and Transient, EN 1992-1-1:2004 (E) 2.4.2.4).

$\alpha_{ct} = 1$ is the coefficient taking into account long term effects on the compressive strength and unfavorable effects resulting from the way the load is applied (the recommended value is 1.0).

$\eta_1 = 1.0$ is a coefficient related to the quality of the bond condition and the position of the bar during concreting (the ``good`` conditions are obtained).

$\eta_2 = 1.0$ is related to the bar diameter (the diameter is less than 32 mm).

The basic required anchorage length $l_{b,rqd}$, for anchoring the force $A_s \sigma_{sd}$ is a straight bar assuming constant bond stress equal to f_{bd}

$$l_{b,rqd} = \frac{\phi \sigma_{sd}}{4 f_{bd}} \quad (5.10)$$

(EN 1992-1-1:2004 (E) 8.4.3)

σ_{sd} is the design stress of the bar at the position from where the anchorage is measured from.

The design anchorage length is:

$$l_{bd} = \alpha_1 \alpha_2 \alpha_3 \alpha_4 \alpha_5 l_{b,rqd} \succ l_{b,\min} \quad (5.11)$$

(EN 1992-1-1:2004 (E) 8.4.4)

$\alpha_1 = 1.0$ is for the effect of the form of the bars assuming adequate cover (straight bars).

$$\alpha_2 = 1 - \frac{0.15(c_d - \phi)}{\phi} \quad (5.12)$$

(from 0.7 to 1.0) – is for effect of concrete minimum cover.

$\alpha_3 = 1$ is for the effect of confinement by transverse reinforcement (there is no one).

$\alpha_4 = 1$ is for the influence of one or more welded transverse bars along the design anchorage length (there is no one).

$\alpha_5 = 1$ is for the effect of the pressure transverse to the plane of splitting along the design anchorage length (there is no any pressure).

$\alpha_1 - \alpha_5$ did not have a great influence to the anchoring length (also from the safety point of view). Therefore $\alpha_1 \alpha_2 \alpha_3 \alpha_4 \alpha_5 = 1$.

$l_{b,\min} \succ \max\{0.3l_{b,rqd}, 10\phi, 100\text{mm}\}$ - is the minimum anchorage length if no other limitation is applied.

$$l_{bd} = l_{b,rqd} = \frac{\phi \sigma_{sd}}{4 f_{bd}} = \frac{\phi \sigma_{sd}}{4 \cdot 2.25 \eta_1 \eta_2 f_{ctd}} = \frac{\phi \sigma_{sd} \gamma_c}{4 \cdot 2.25 \eta_1 \eta_2 \alpha_{ct} f_{ctk,0.05}} = \frac{1.5 \phi \sigma_{sd}}{10 \cdot 1 \cdot 1 \cdot 1 \cdot f_{ctk,0.05}} = 0.15 \frac{\phi \sigma_{sd}}{f_{ctk,0.05}} \quad (5.13)$$

Result: in calculation of length of the anchoring for connection reinforcement the formula 5.14 can be used.

$$l_{bd} = 0.15 \frac{\phi \sigma_{sd}}{f_{ctk.0.05}} \quad (5.14)$$

Anchoring length is the length of the straight end part of bars (Figure 5.55 Anchoring length).

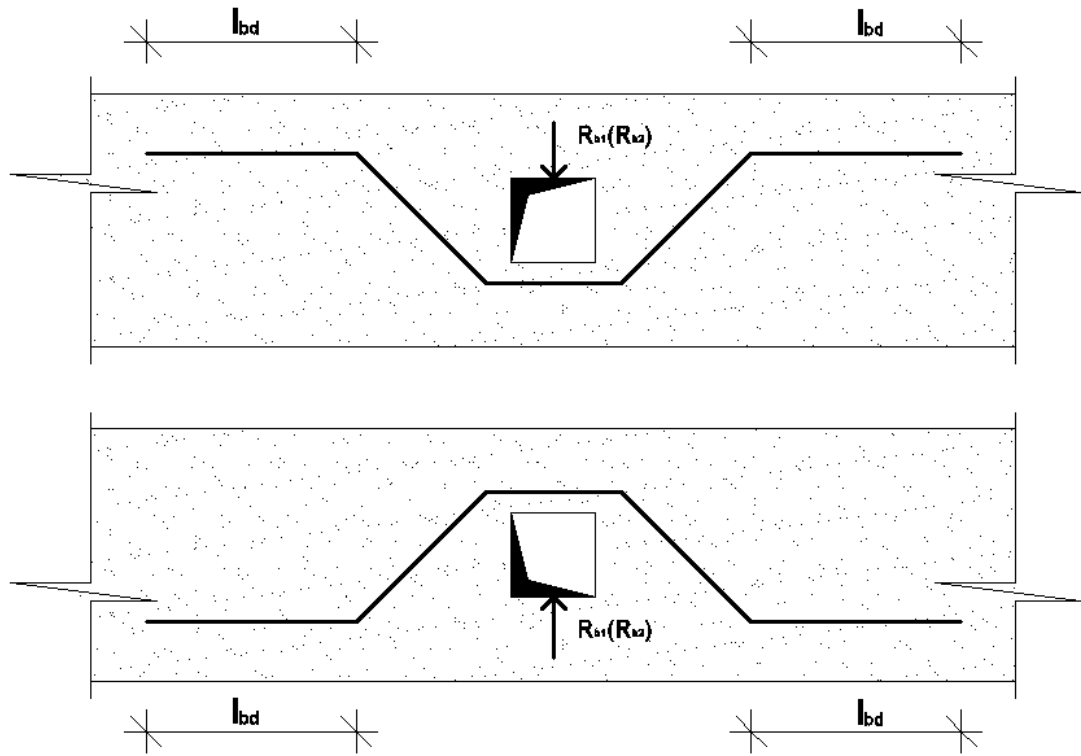


Figure 5.55 Anchoring length

6 CONCLUSION

As a result of four month working at the Finnmap Consulting Oy Company under the supervision of leader of Lappeenranta department of Finnmap Consulting Oy Company Mr. Tommi Turunen and instructor of thesis working at the Saimaa University of Applied Sciences Timo Lehtoviita 8 new Custom Components for Tekla Structures software (2 Custom Components for creating of balcony slab and 6 custom components for creating a jointing tube elements) and 1 excel calculation sheet (for calculation of parameters of jointing tube element) were done.

General information (properties, sizes, calculation, and moisture problems) about Balcony and introduction information of Tekla Structures (information about Tekla Structures software and components) are included in the report as a theoretical base.

This thesis should ideally be used as a guide of how to create custom components in Tekla Structures software with balcony slabs and jointing elements examples. The creation process of Custom Component is considered “step-by-step”. All properties dialogues, programming codes and appearances are shown in APPENDICES.

The interface and calculation base for the excel calculator sheet are also presented in this work.

REFERENCES

BETONIELEMENTTIPARVEKKEET. BETONITEOLLISUUS RY. ELOKUU 2010.
<http://www.elementtisuunnittelu.fi/Download/23624/Betonielementtiparvekkeet.pdf>

Rakentajain kalenteri, Timo Nieminen et al. 2002. Karisto Oy. Hameenlinna 2001.

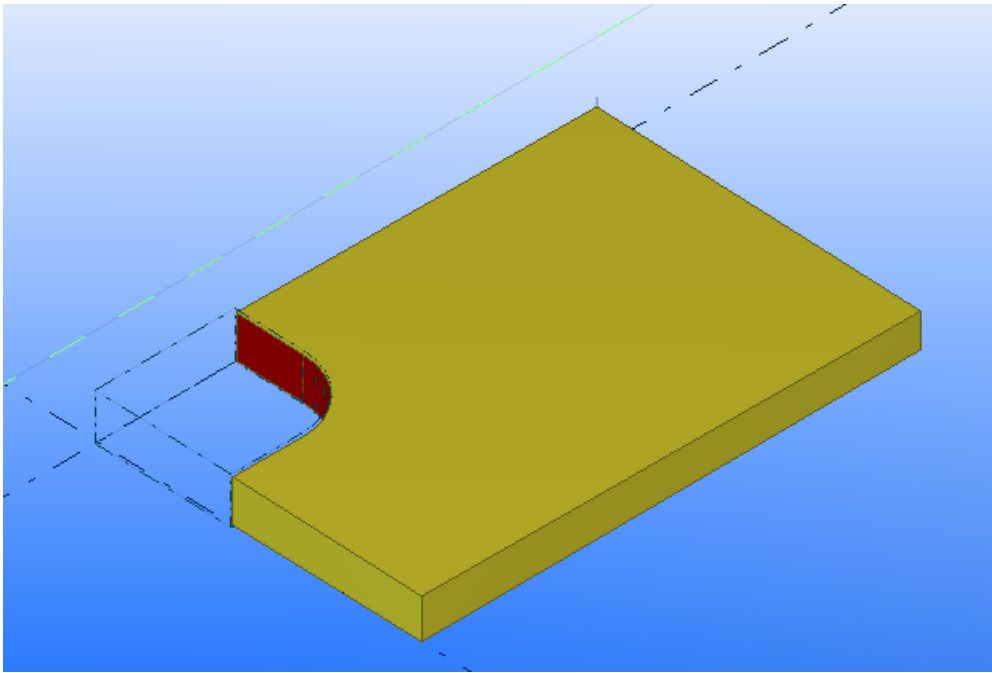
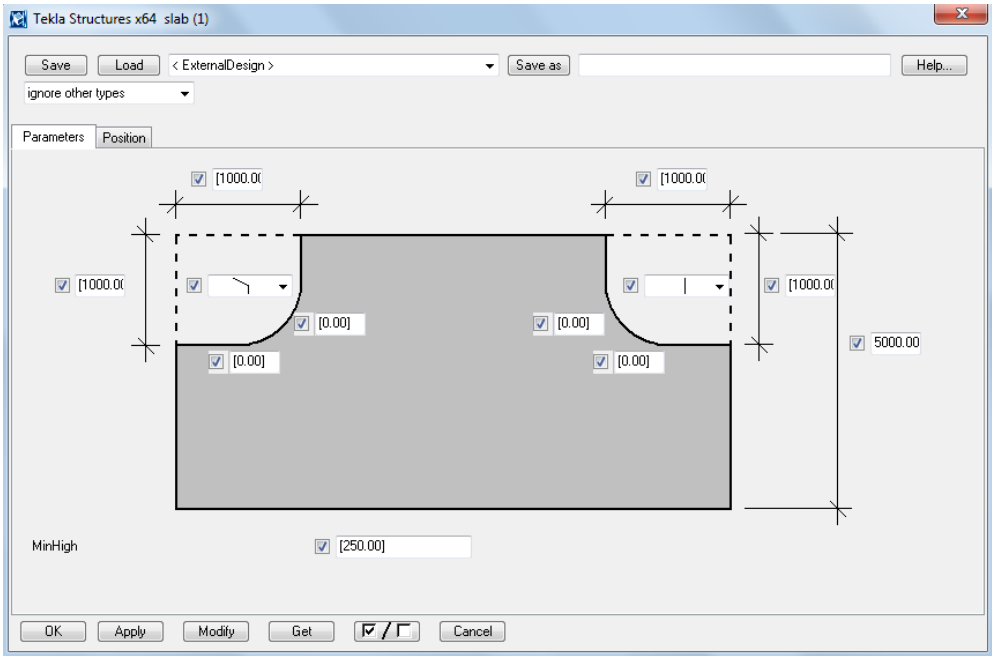
RAUTARUUKIN PUTKIPALKKI-KASIKIRJA. 2000.RAUTARUUKKI metform.
RAUTARUUKKI OYI METFORM. 2000.

SFS-EN 1991-1-1. Eurocode 1: Actions on structures. Part 1-1: General actions. Densities, self-weight, imposed loads for buildings. SUOMEN STANDARDISOIMISLIITTO SFS ry HELSINKI. 2010.

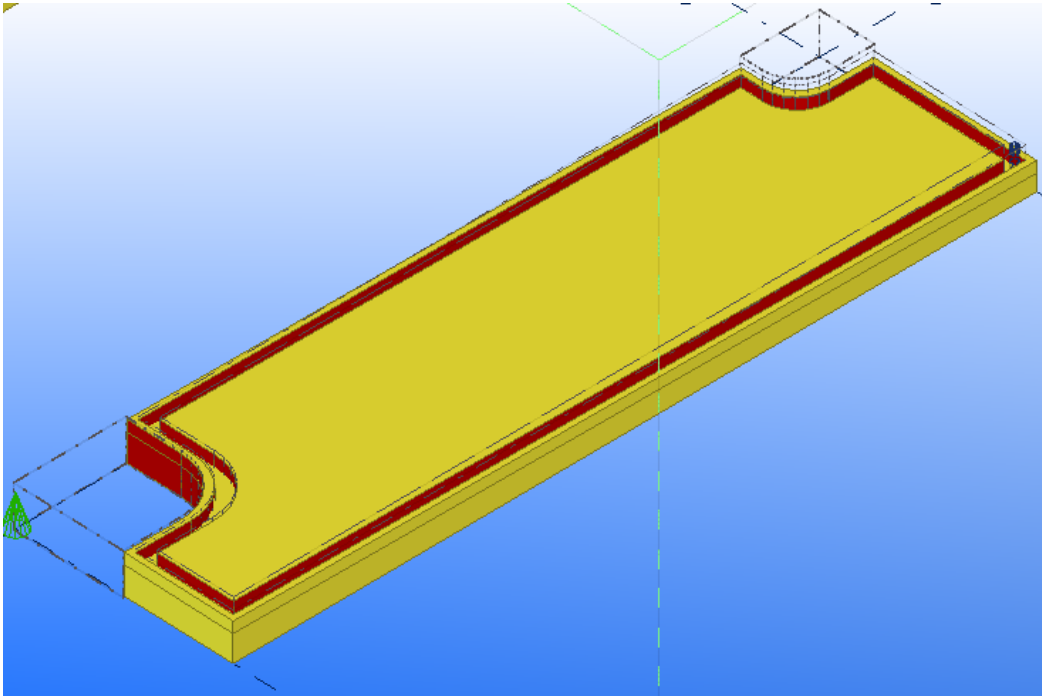
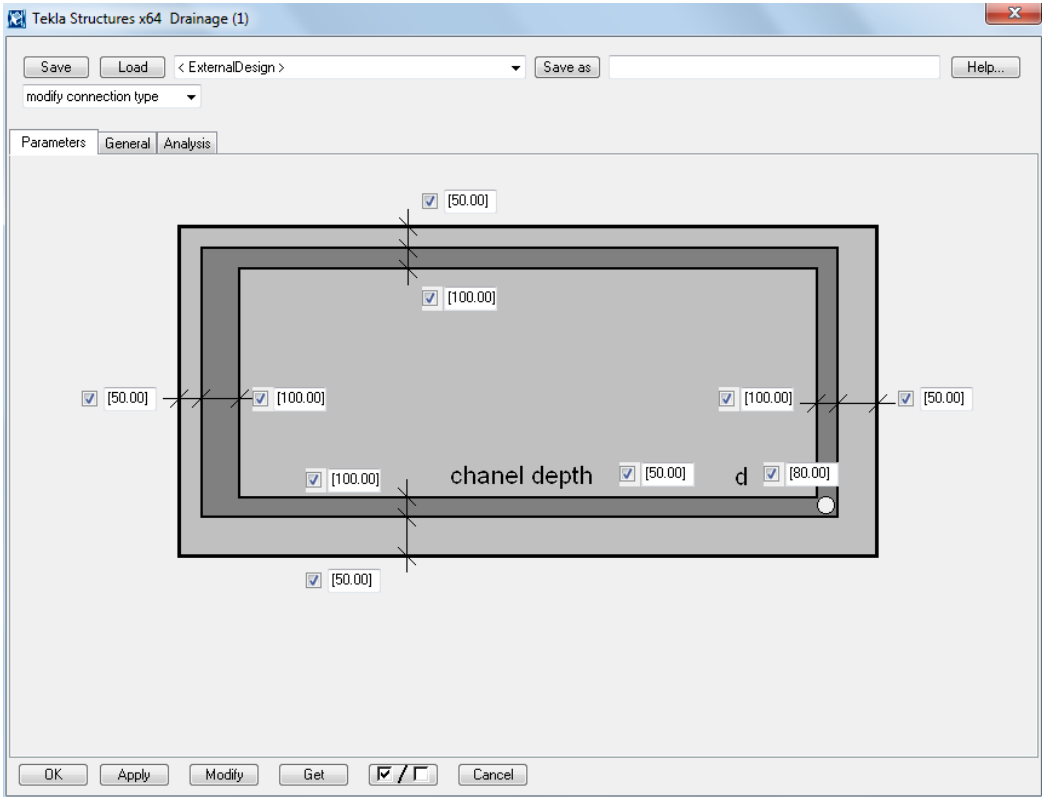
SFS-EN 1991-1-1:en. Eurocode 2: Design of concrete structures. Part 1-1: General rules and rules for buildings. SUOMEN STANDARDISOIMISLIITTO. HELSINKI. 2005.

APPENDIX 1 CUSTOM COMPONENTS PROPERTIES AND APPEARANCE

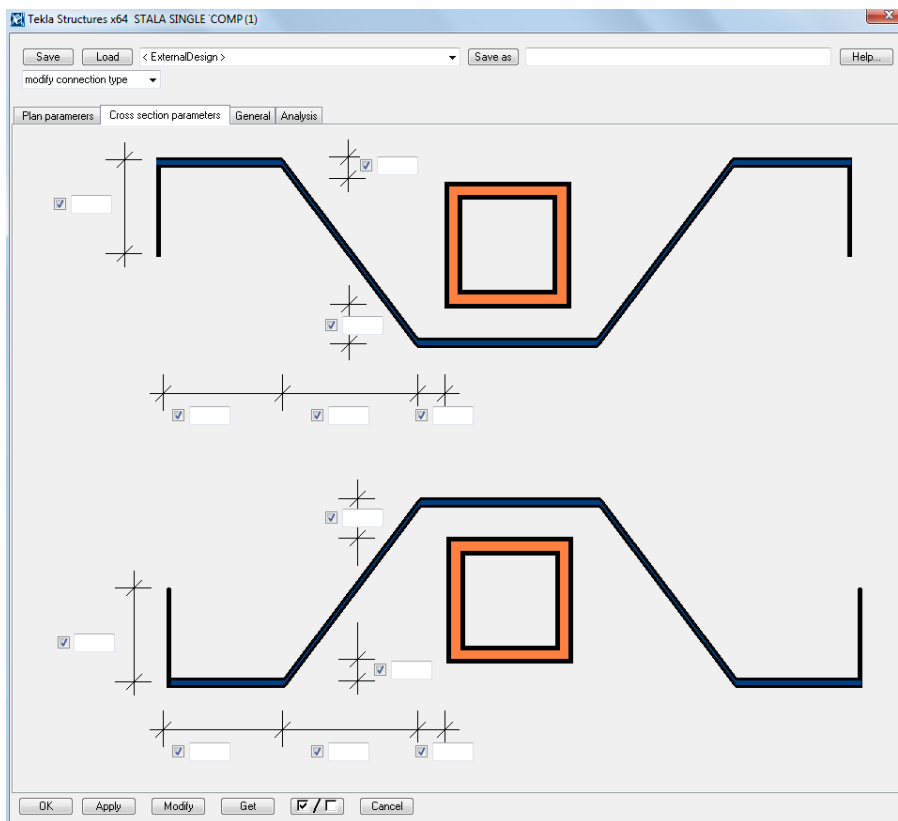
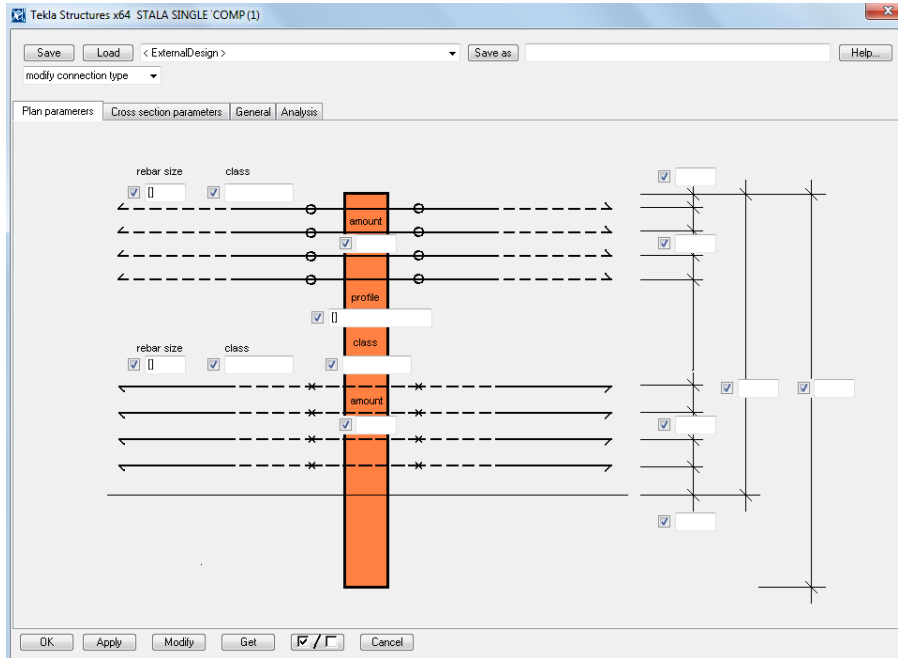
Slab Custom component

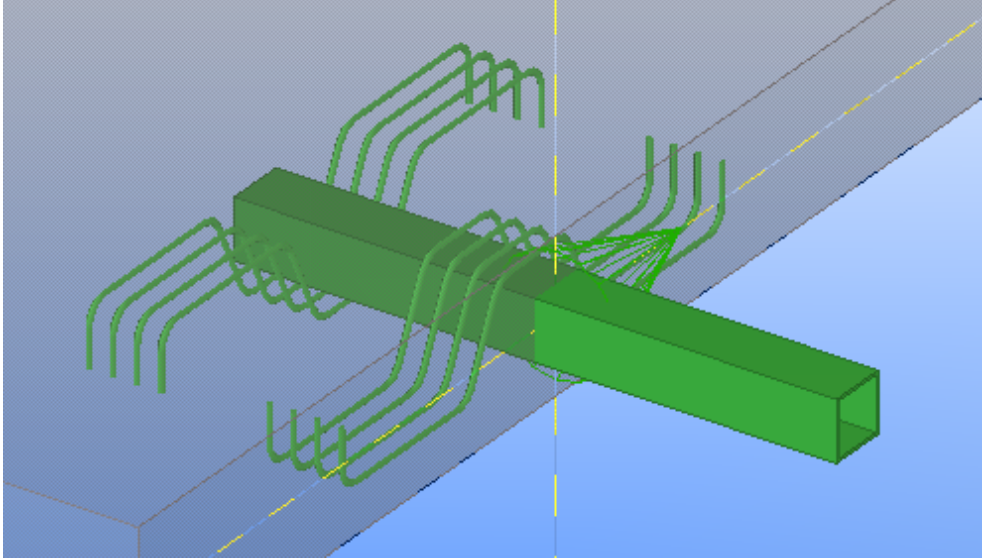


Drainage Custom Component

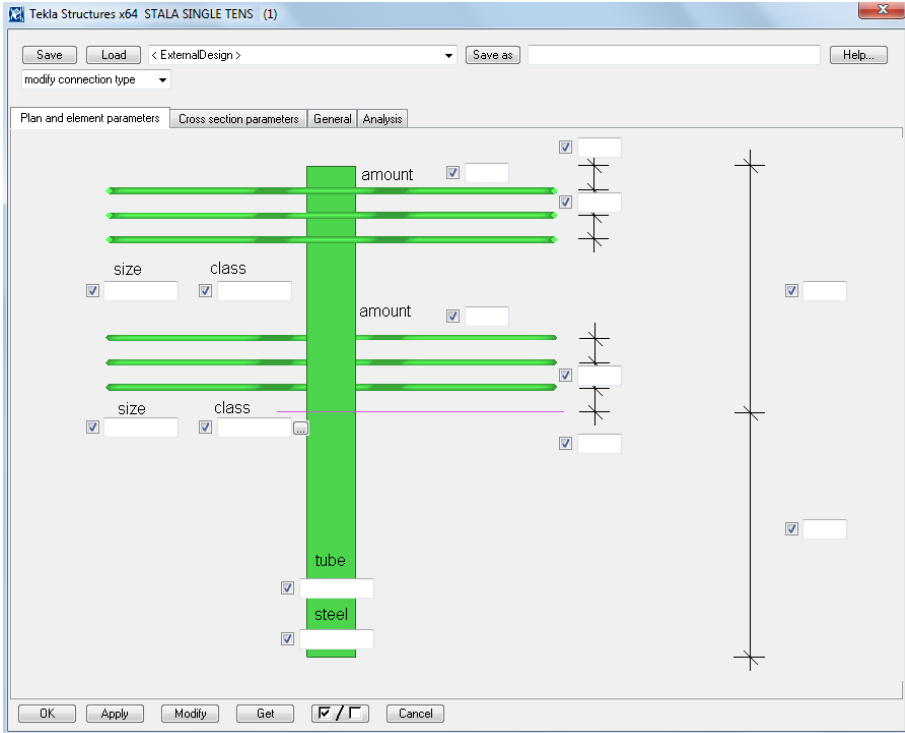


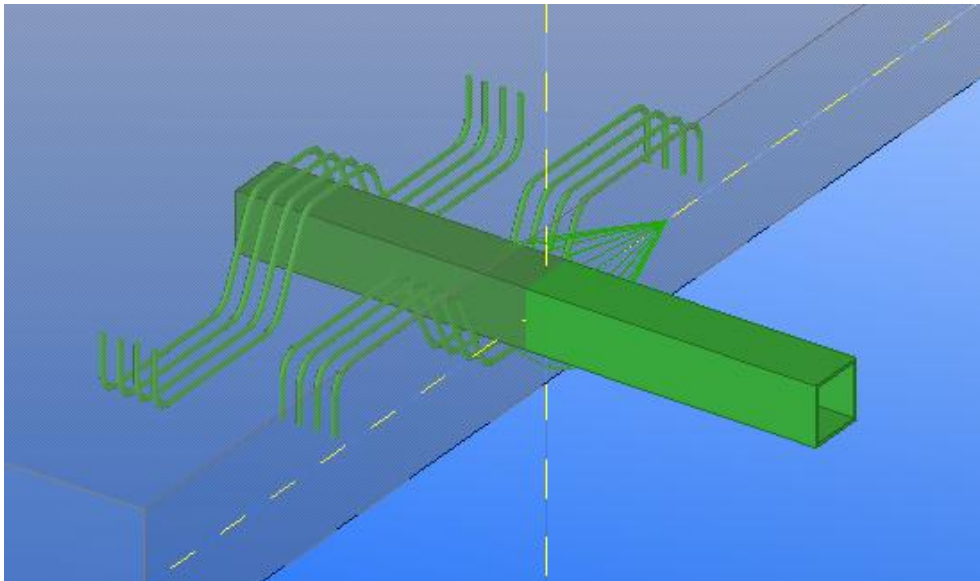
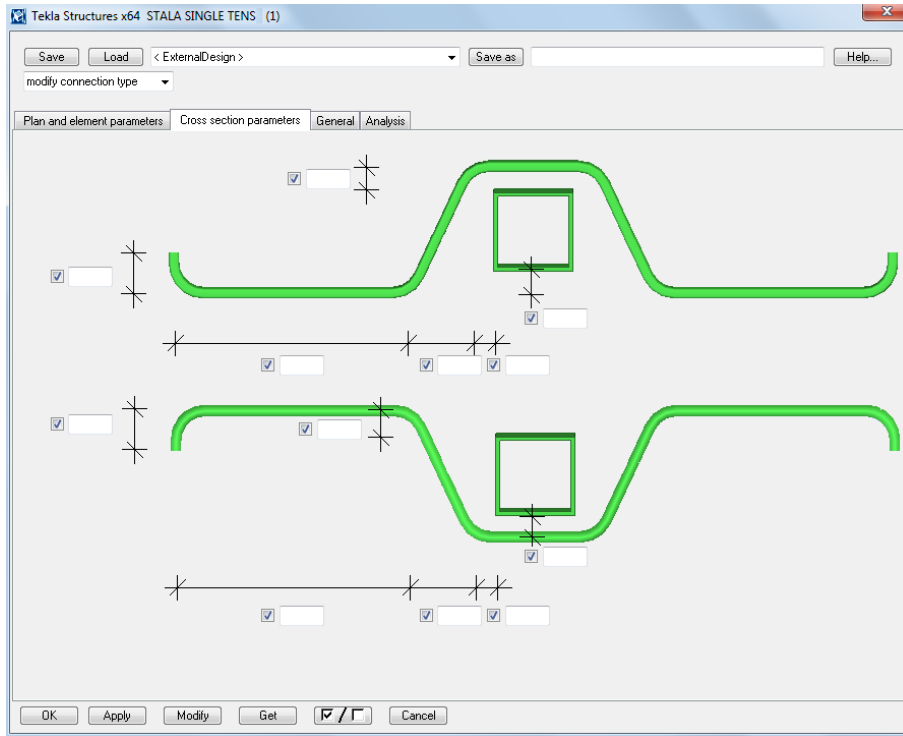
STALA SINGLE COMP Custom Component



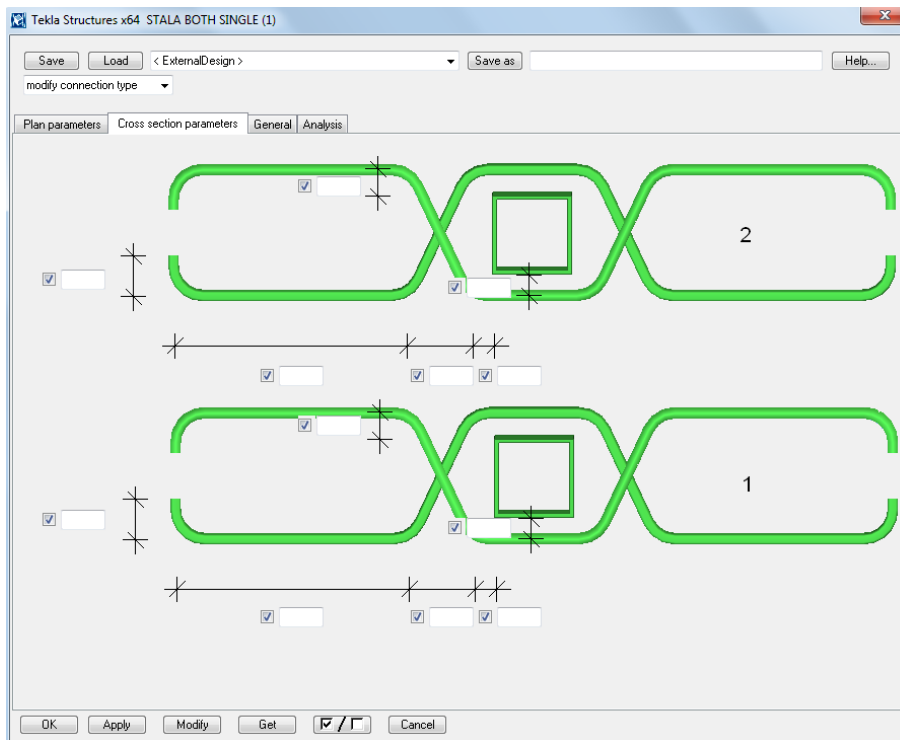
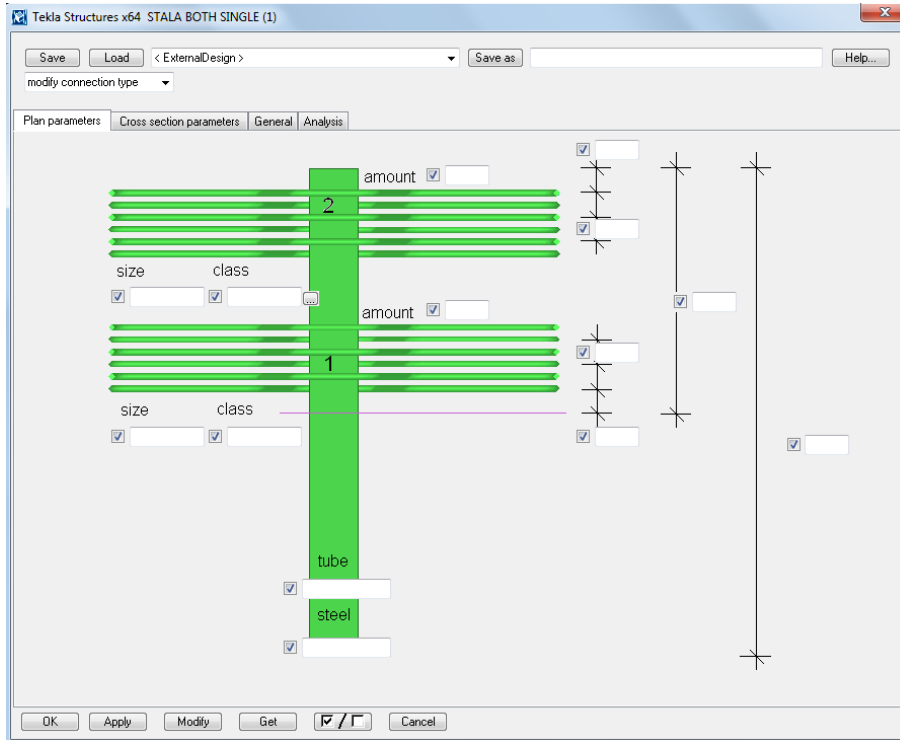


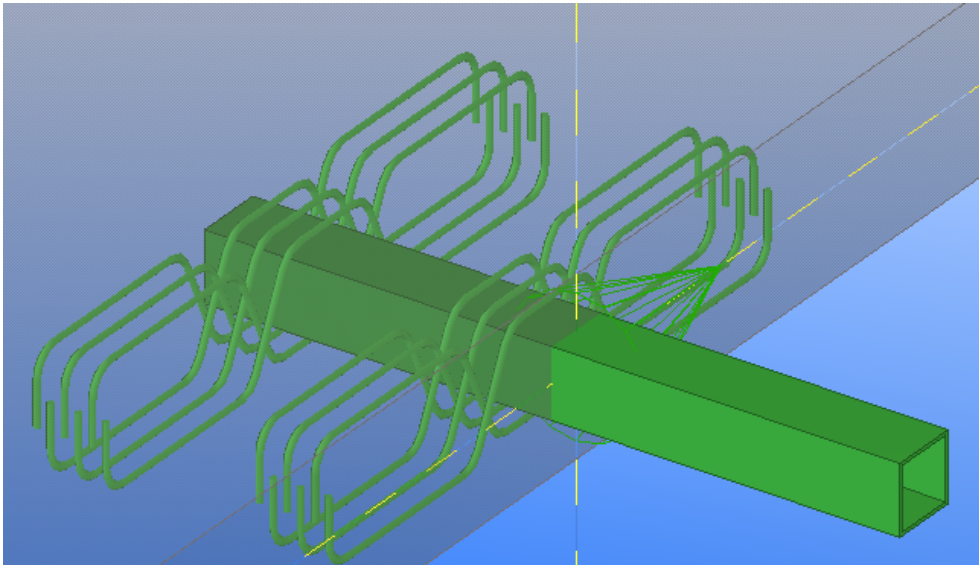
STALA SINGLE TENS Custom Component



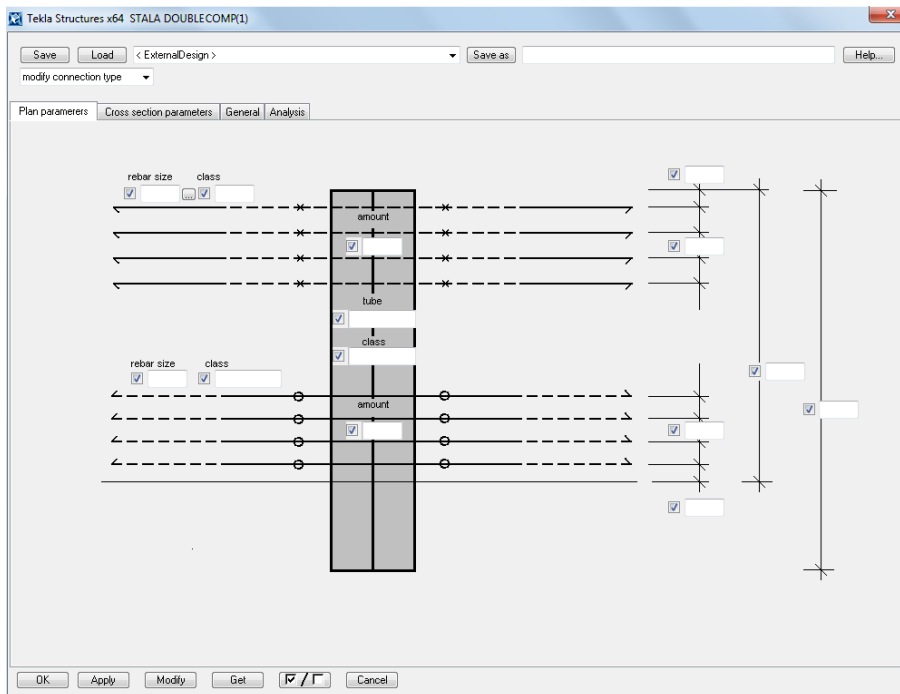


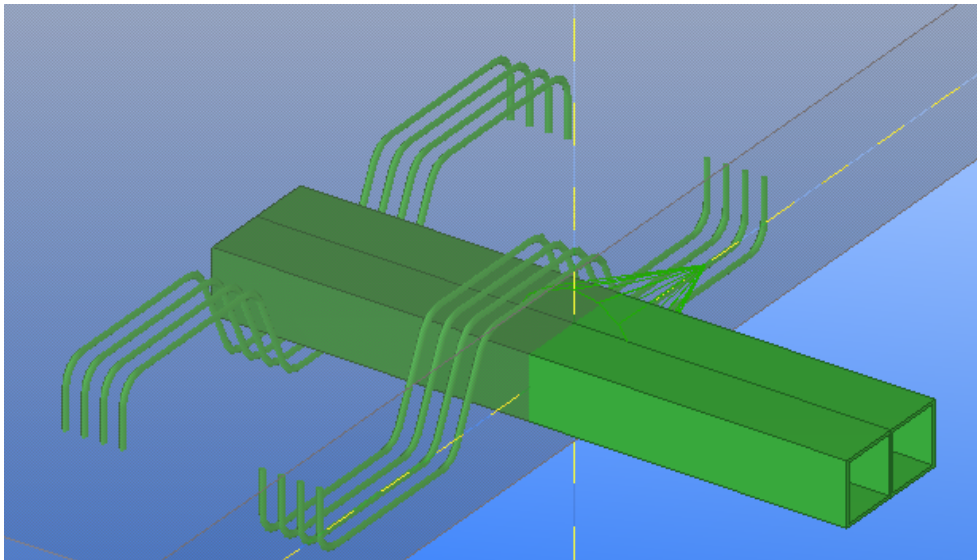
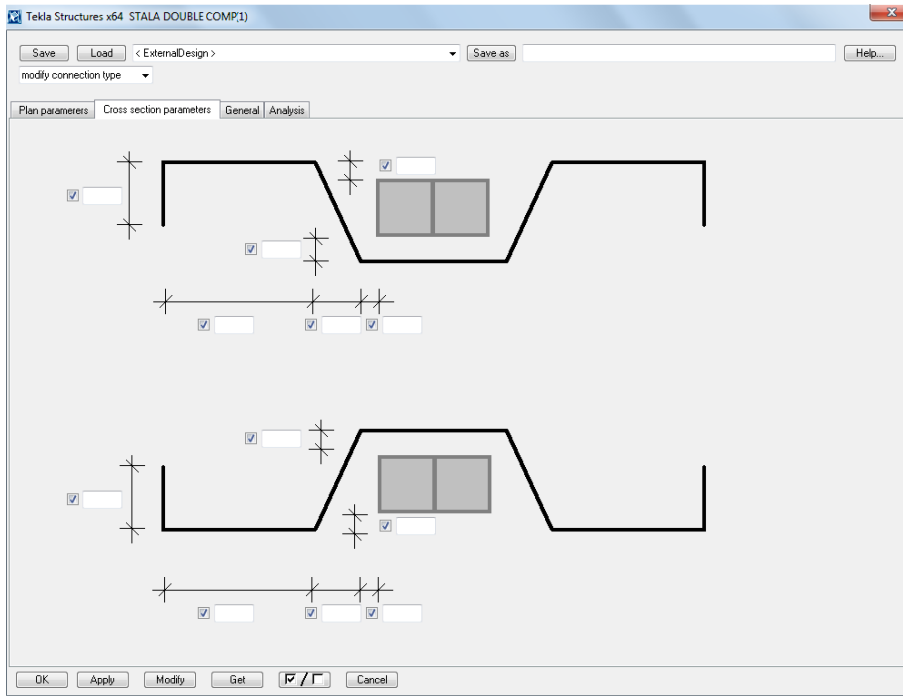
STALA BOTH SINGLE Custom Component



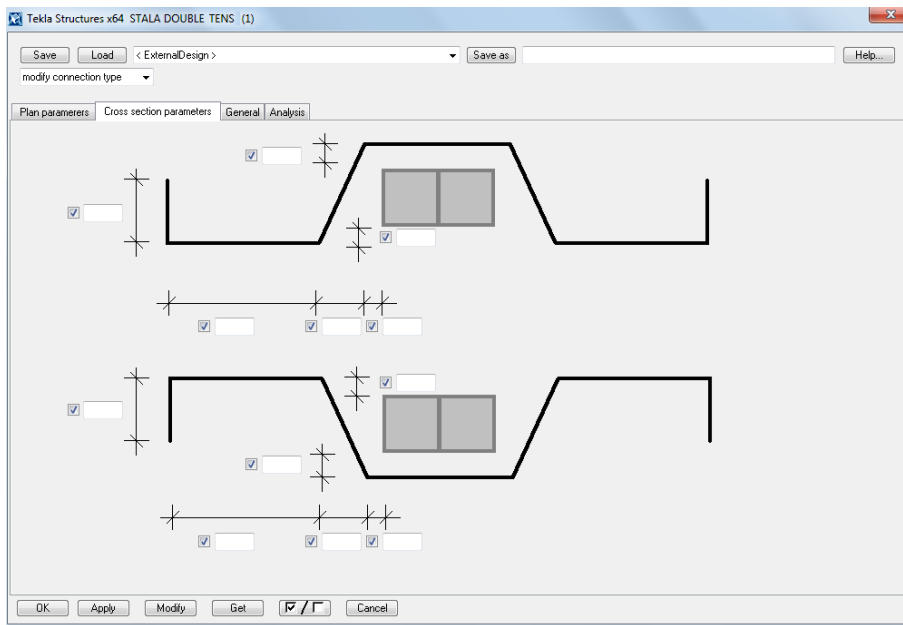
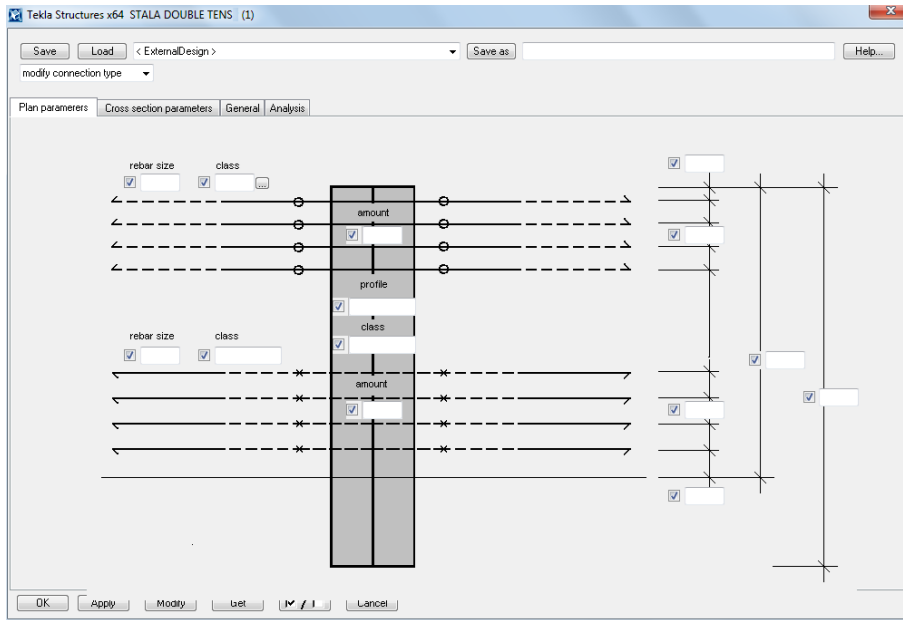


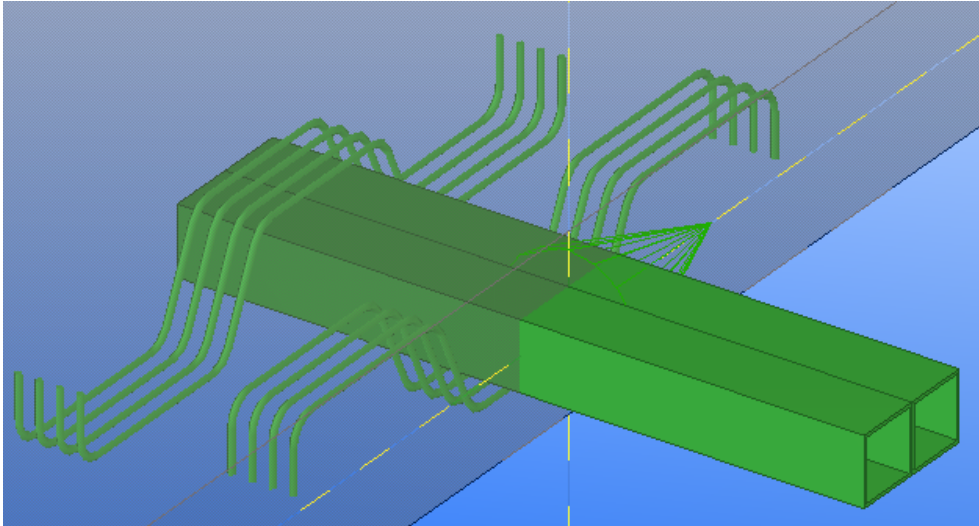
STALA DOUBLE COMP Custom Component



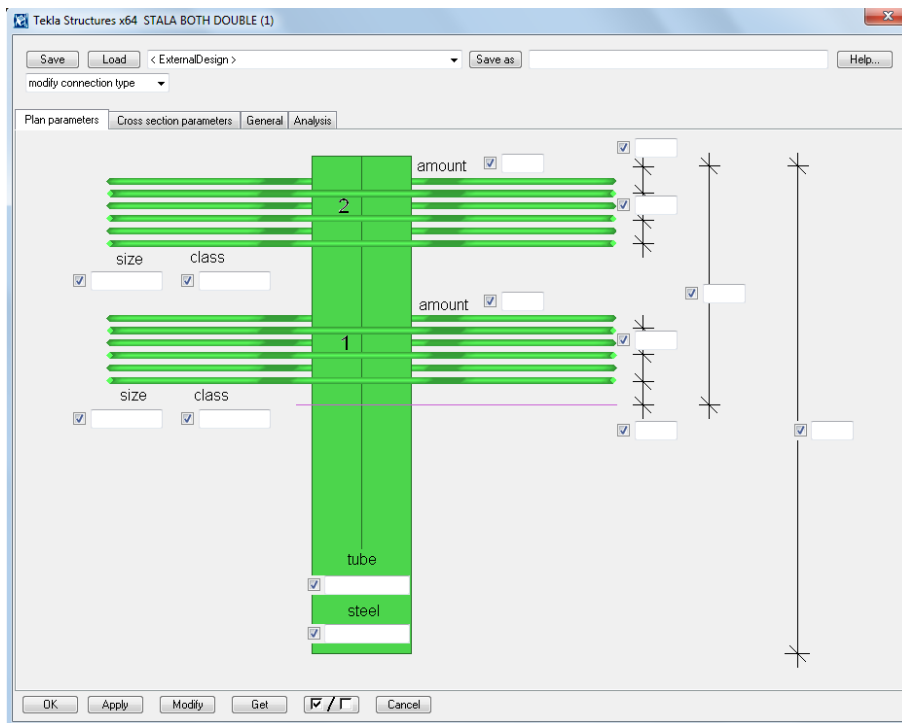


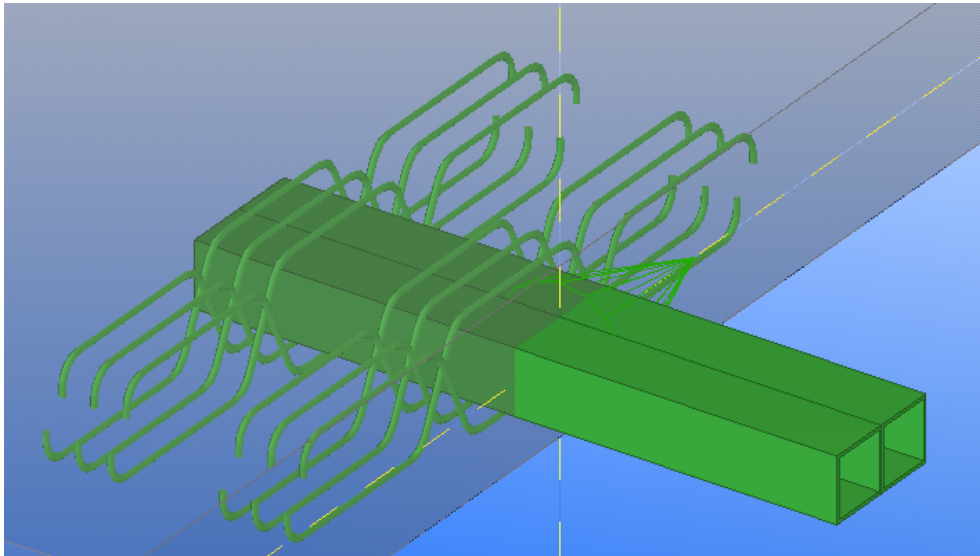
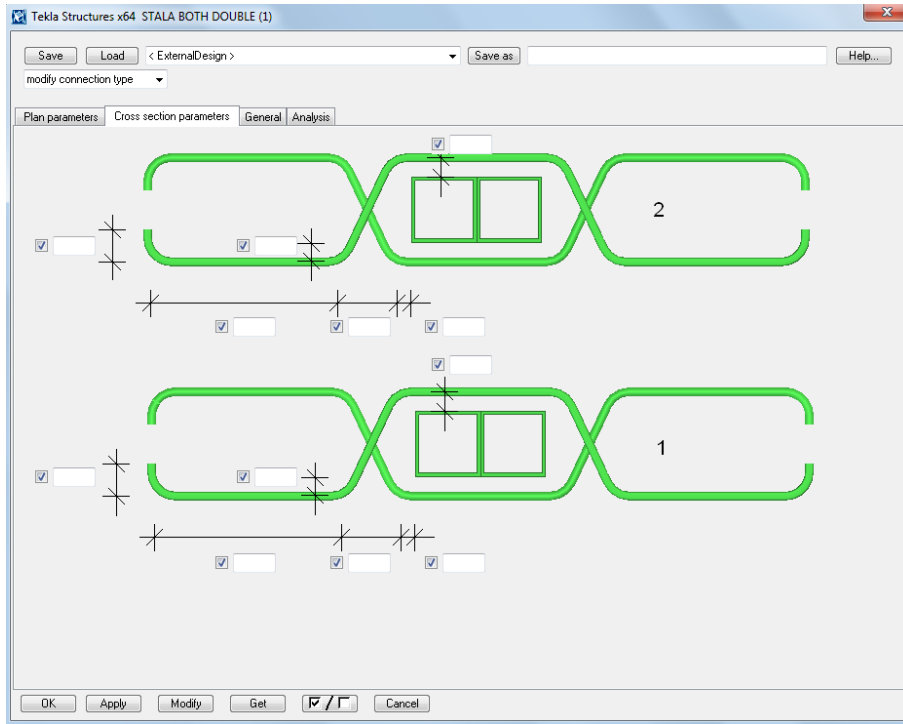
STALA DOUBLE TENS Custom Component





STALA BOTH DOUBLE Custom Component





APPENDIX 2 PROGRAMMING CODES FOR CUSTOM COMPONENTS

Slab Custom Component

```
page("TeklaStructures","")
{
  macro(1, "Slab")
  {
    tab_page("", " Parameters ", 1)
    {
  picture ("Slab")
    parameter("", "P1", distance, number, 1000,180)
    parameter("MinHigh", "P2", distance, number, 15)
    parameter("", "D12", distance, number, 230,10)
    parameter("", "D10", distance, number, 70,120)
    parameter("", "D16", distance, number, 750,10)
    parameter("", "D14", distance, number, 900,120)
    parameter("", "P4", chamfer_type, number, 225,120,100)
    parameter("", "P5", distance, number, 250,200)
    parameter("", "P6", distance, number, 350, 160)
    parameter("", "P7", chamfer_type, number, 735,120,100)
    parameter("", "P8", distance, number, 630,160)
    parameter("", "P9", distance, number, 700,200)
    }
  }
}
```


Drainage Custom Component

```
page("TeklaStructures", "")
{
  detail(1, "Drainage")
  {
    tab_page("", " Parameters ", 1)
    {
      picture ("drainage")
      parameter("", "P1", distance, number, 350,300)
      parameter("", "P2", distance, number, 290,220)
      parameter("", "P4", distance, number, 480,120)
      parameter("", "P7", distance, number, 810,220)
      parameter("", "P12", distance, number, 700,295)
      parameter("", "D1", distance, number, 350,400)
      parameter("", "D5", distance, number, 100,220)
      parameter("", "D13", distance, number, 480,25)
      parameter("", "D25", distance, number, 1010,220)
      parameter("", "P24", distance, number, 860,295)
    }
  }
}
```

STALA SINGLE COMP Custom Component

```
page("TeklaStructures", "")
{
  joint(1, "STALA SINGLE COMP")
  {
    tab_page("", " Plan paramerers ", 1)
    {
      picture ("stala")
      parameter("", "P1", distance, number, 1150,320)
      parameter("", "P2", distance, number, 950,367)
      parameter("", "P3", integer, number, 490,367)
      parameter("", "P4", distance, number, 950,50)
      parameter("", "P5", integer, number, 490,135)
      parameter("", "P6", distance, number, 950,135)

      parameter("", "P13", material, text, 300,290, 100)
      parameter("", "P14", profile, text, 185,290)
      parameter("", "P15", material, text, 300,70,100)
      parameter("", "P16", profile, text, 185,70)
      parameter("", "P19", distance, number, 1040,320)
      parameter("", "D3", distance, number, 950,490)

      parameter("", "P17", profile, text, 450,230,150)

      parameter("", "P18", material, text, 470,290,100)
    }
    tab_page("", " Cross section parameters ", 2)
    {
      picture ("stala2")

      parameter("", "P7", distance, number, 450,350)
      parameter("", "P8", distance, number, 250,350)
      parameter("", "P9", distance, number, 80,80)
      parameter("", "P10", distance, number, 450,800)
      parameter("", "P11", distance, number, 250,800)
      parameter("", "P12", distance, number, 85,640)
      parameter("", "D23", distance, number, 470,235)
      parameter("", "D27", distance, number, 600,350)
      parameter("", "D31", distance, number, 520,30)
      parameter("", "D43", distance, number, 470,480)
      parameter("", "D47", distance, number, 600,800)
      parameter("", "D51", distance, number, 540,675)

    }
  }
}
```

STALA SINGLE TENS Custom Component

```
page("TeklaStructures", "")
{
  joint(1, "STALA SINGLE TENS")
  {
    tab_page("", " Plan and element parameters ", 1)
    {
      picture ("tube element 1")
      parameter("", "D1", distance, number, 1050,170)
      parameter("", "D2", distance, number, 1050,450)

      parameter("", "P5_size", rebar_size, text, 120,330,100)
      parameter("", "P3", material, text, 270,330,100)
      parameter("", "P1", integer, number, 600,200)
      parameter("", "D3", distance, number, 750,350)
      parameter("", "P9", distance, number, 750,269)

      parameter("", "P6_size", rebar_size, text, 120,170,100)
      parameter("", "P4", material, text, 270,170,100)
      parameter("", "P2", integer, number, 600,30)
      parameter("", "P8", distance, number, 750,0)
      parameter("", "P7", distance, number, 750,65)

      parameter("", "P16", profile, text, 380,520,100)
      parameter("", "P17", material, text, 380,580,100)
    }
    tab_page("", " Cross section parameters ", 2)
    {
      picture ("tube element 2")
      parameter("", "D23", distance, number, 700,480)
      parameter("", "D27", distance, number, 400,330)
      parameter("", "D31", distance, number, 650,550)
      parameter("", "P10", distance, number, 560,550)
      parameter("", "P11", distance, number, 350,550)
      parameter("", "P12", distance, number, 70,325)

      parameter("", "D43", distance, number, 385,35)
      parameter("", "D47", distance, number, 700,200)
      parameter("", "D51", distance, number, 650,255)
      parameter("", "P13", distance, number, 560,255)
      parameter("", "P14", distance, number, 350,255)
      parameter("", "P15", distance, number, 70,150)
    }
  }
}
```

STALA BOTH SINGLE Custom Component

```
page("TeklaStructures", "")
{
  joint(1, "STALA BOTH SINGLE")
  {
    tab_page("", " Plan parameters ", 1)
    {

picture ("stala both 1")
  parameter("", "P1", distance, number, 1050,350)
  parameter("", "D1", distance, number, 900,180)
  parameter("", "P13", profile, text, 380,520,120)
  parameter("", "P14", material, text, 380,590,120)

  parameter("", "P2", integer, number, 570,190)
  parameter("", "D3", distance, number, 770,340)
  parameter("", "P3", distance, number, 770,240)
  parameter("", "P15_size", rebar_size, text, 150,340,100)
  parameter("", "P16", material, text, 280,340,100)

  parameter("", "P6", integer, number, 570,30)
  parameter("", "P4", distance, number, 770,0)
  parameter("", "P5", distance, number, 770,94)
  parameter("", "P17_size", rebar_size, text, 150,175,100)
  parameter("", "P18", material, text, 280,175,100)
  }
  tab_page("", " Cross section parameters ", 2)
  {
picture ("stala both 2")
  parameter("", "D43", distance, number, 600,445)
  parameter("", "D51", distance, number, 640,550)
  parameter("", "D59", distance, number, 400,323)
  parameter("", "P7", distance, number, 550,550)
  parameter("", "P8", distance, number, 350,550)
  parameter("", "P9", distance, number, 60,435)

  parameter("", "D83", distance, number, 600,160)
  parameter("", "D91", distance, number, 640,265)
  parameter("", "D99", distance, number, 400,40)
  parameter("", "P10", distance, number, 550,265)
  parameter("", "P11", distance, number, 350,265)
  parameter("", "P12", distance, number, 60,150)
  }
  }
}
```

STALA DOUBLE COMP Custom Component

```
page("TeklaStructures","")
{
  joint(1, "STALA DOUBLE COMP")
  {
    tab_page("", " Plan paramerers ", 1)
    {
      picture ("stalabig3")

        parameter("", "P4", distance, number, 1200,360)
        parameter("", "D11", distance, number, 1120,310)

        parameter("", "P2", integer, number, 520,388)
        parameter("", "P1", distance, number, 1000,388)
        parameter("", "D1", distance, number, 1000,490)
        parameter("", "P15_size", rebar_size, text, 200,320)
        parameter("", "P16", material, text, 300,320,100)

        parameter("", "P5", integer, number, 520,145)
        parameter("", "P6", distance, number, 1000,145)
        parameter("", "P3", distance, number, 1000,50)
        parameter("", "P17_size", rebar_size, text, 190,75)
        parameter("", "P18", material, text, 300,75)

        parameter("", "P13", profile, text, 500,240,100)
        parameter("", "P14", material, text, 500,290,100)

      }
    tab_page("", " Cross section parameters ", 2)
    {
      picture ("stalabig4")
        parameter("", "D33", distance, number, 570,515)
        parameter("", "D29", distance, number, 550,630)
        parameter("", "D25", distance, number, 370,400)
        parameter("", "P7", distance, number, 460,630)
        parameter("", "P8", distance, number, 300,630)
        parameter("", "P9", distance, number, 105,480)

        parameter("", "D53", distance, number, 370,150)
        parameter("", "D49", distance, number, 550,250)
        parameter("", "D45", distance, number, 570,40)
        parameter("", "P10", distance, number, 460,250)
        parameter("", "P11", distance, number, 300,250)
        parameter("", "P12", distance, number, 105,80)

      }
    }
  }
}
```

STALA DOUBLE TENS Custom Component

```
page("TeklaStructures", "")
{
  joint(1, "STALA DOUBLE TENS")
  {
    tab_page("", " Plan paramerers ", 1)
    {
      picture ("stalabig")

        parameter("", "P3", distance, number, 1200,350)
        parameter("", "D11", distance, number, 1120,300)

        parameter("", "P1", integer, number, 520,366)
        parameter("", "P2", distance, number, 1000,366)
        parameter("", "D1", distance, number, 1000,480)
        parameter("", "P15_size", rebar_size, text, 190,295)
        parameter("", "P16", material, text, 300,295,100)

        parameter("", "P5", integer, number, 520,135)
        parameter("", "P6", distance, number,1000,135 )
        parameter("", "P4", distance, number, 1000,40)
        parameter("", "P17_size", rebar_size, text, 190,65)
        parameter("", "P18", material, text, 300,65)

        parameter("", "P13", profile, text, 500,230,100)
        parameter("", "P14", material, text, 500,280,100)

      }
      tab_page("", " Cross section parameters ", 2)
      {
        picture ("stalabig2")
          parameter("", "D53", distance, number, 370,433)
          parameter("", "D49", distance, number, 550,535)
          parameter("", "D45", distance, number, 570,325)
          parameter("", "P10", distance, number, 460,535)
          parameter("", "P11", distance, number, 300,535)
          parameter("", "P12", distance, number, 105,360)

          parameter("", "D33", distance, number, 570,133)
          parameter("", "D29", distance, number, 550,250)
          parameter("", "D25", distance, number, 370,25)
          parameter("", "P7", distance, number, 460,250)
          parameter("", "P8", distance, number, 300,250)
          parameter("", "P9", distance, number, 105,100)

        }
      }
    }
  }
}
```

STALA BOYH DOUBLE Custom Component

```
page("TeklaStructures", "")
{
  joint(1, "STALA BOTH DOUBLE")
  {
    tab_page("", " Plan parameters ", 1)
    {
      picture ("stala both 3")

        parameter("", "P1", distance, number, 1100,350)
        parameter("", "D1", distance, number, 950,180)
        parameter("", "P13", profile, text, 425,540,120)
        parameter("", "P14", material, text, 425,600,120)

        parameter("", "P2", integer, number, 670,190)
        parameter("", "D5", distance, number, 855,350)
        parameter("", "P3", distance, number, 855,238)
        parameter("", "P15_size", rebar_size, text, 100,335,100)
        parameter("", "P16", material, text, 250,335,100)

        parameter("", "P6", integer, number, 670,20)
        parameter("", "P4", distance, number, 855,0)
        parameter("", "P5", distance, number, 855,71)
        parameter("", "P17_size", rebar_size, text, 100,165,100)
        parameter("", "P18", material, text, 250,165,100)

      }
      tab_page("", " Cross section parameters ", 2)
      {
        picture ("stala both 4")
          parameter("", "D45", distance, number,600,272)
          parameter("", "D53", distance, number, 590,515)
          parameter("", "D61", distance, number, 330,410)
          parameter("", "P7", distance, number, 460,515)
          parameter("", "P8", distance, number, 300,515)
          parameter("", "P9", distance, number, 50,410)

          parameter("", "D85", distance, number, 600,0)
          parameter("", "D93", distance, number, 590,225)
          parameter("", "D101", distance, number, 330,125)
          parameter("", "P10", distance, number, 460,225)
          parameter("", "P11", distance, number, 300,225)
          parameter("", "P12", distance, number, 50,125)

        }
      }
    }
  }
}
```

APPENDIX 3 VARIABLES

Slab Custom Component

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	2400.00	2400.00	Length	Parameter	Show	Wight
P2	250.00	250.00	Length	Parameter	Show	MinHigh
P3	= "BALCONY" ...	BALCONY320*290*2400*280*250*2400	Profile	Parameter	Hide	profile
P4			Chamfer type	Parameter	Show	Chamfer left
P5	0.00	0.00	Length	Parameter	Show	Chamfer left X
P6	0.00	0.00	Length	Parameter	Show	Chamfer left Y
P7			Chamfer type	Parameter	Show	Chamfer right
P8	0.00	0.00	Length	Parameter	Show	Chamfer right X
P9	0.00	0.00	Length	Parameter	Show	Chamfer right Y
D1	0.00	0.00	Length	Distance	Hide	D1.Slab.Slab
D2	10.00	10.00	Length	Distance	Hide	D2.Плита.Slab
D3	10.00	10.00	Length	Distance	Hide	D3.Плита.Slab
D4	10.00	10.00	Length	Distance	Hide	D4.Плита.Slab
D5	10.00	10.00	Length	Distance	Hide	D5.Плита.Slab
D6	10.00	10.00	Length	Distance	Hide	D6.Плита.Slab
D7	10.00	10.00	Length	Distance	Hide	D7.Плита.Slab
D8	10.00	10.00	Length	Distance	Hide	D8.Плита.Slab
D9	10.00	10.00	Length	Distance	Hide	D9.Плита.Slab
D10	1000.00	1000.00	Length	Distance	Show	left y
D11	=D10	1000.00	Length	Distance	Hide	D11.Плита.Slab
D12	1000.00	1000.00	Length	Distance	Show	left x
D13	=D12	1000.00	Length	Distance	Hide	D13.Плита.Slab
D14	1000.00	1000.00	Length	Distance	Show	right y
D15	=D14	1000.00	Length	Distance	Hide	D15.Плита.Slab
D16	1000.00	1000.00	Length	Distance	Show	right x
D17	=D16	1000.00	Length	Distance	Hide	D17.Плита.Slab
D18	3200.00	3200.00	Length	Distance	Hide	Length

Drainage Custom Component

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	100.00	100.00	Length	Parameter	Show	ChannelDown
P2	100.00	100.00	Length	Parameter	Show	ChannelLeft
P3	=P("USER_FL...	1000.00	Length	Parameter	Hide	LeftX
P4	100.00	100.00	Length	Parameter	Show	ChannelUp
P5	=P("USER_FL...	1000.00	Length	Parameter	Hide	RightX
P6	=P("USER_FL...	1000.00	Length	Parameter	Hide	RightY
P7	100.00	100.00	Length	Parameter	Show	ChannelRight
P8	=P("USER_FL...	1000.00	Length	Parameter	Hide	RightX
P9	=P(Height,512...	320.00	Length	Parameter	Hide	Parameter9
P10	=P(Width,512...	2400.00	Length	Parameter	Hide	Parameter10
P11	=P("comment...	3200.00	Length	Parameter	Hide	Parameter13
P12	50.00	50.00	Length	Parameter	Show	ChannelDepth
P13	=P9-P12	270.00	Length	Parameter	Hide	Parameter15
P14	=P9-P10/80-P12	240.00	Length	Parameter	Hide	Parameter16
P15	=P9-P11/80-P12	230.00	Length	Parameter	Hide	Parameter17
P16	=P9-P10/80-P...	200.00	Length	Parameter	Hide	Parameter18
P17	= "BALCONY"...	BALCONY270*240*2400*230*200*2400	Profile	Parameter	Hide	Parameter19
P18	=P(Chamfer ty...	0	Chamfer type	Parameter	Hide	ChTypeLeft
P19	=P(Chamfer X,0)	0.00	Length	Parameter	Hide	ChXLeft
P20	=P(Chamfer Y,0)	0.00	Length	Parameter	Hide	ChYLeft
P21	=P(Chamfer ty...	0	Chamfer type	Parameter	Hide	ChTypeRight
P22	=P(Chamfer X,0)	0.00	Length	Parameter	Hide	ChXRight
P23	=P(Chamfer Y,0)	0.00	Length	Parameter	Hide	ChYRight
P24	80.00	80.00	Length	Parameter	Show	diameter
P25	= "D"+P24	D80	Profile	Parameter	Hide	Parameter25
D1	50.00	50.00	Length	Distance	Show	ConcreteDown
D2	=D1	50.00	Length	Distance	Hide	D2.Плиты.Slab

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D3	=D1+P1	150.00	Length	Distance	Hide	D3.Плиты.Slab
D4	=D3	150.00	Length	Distance	Hide	D4.Плиты.Slab
D5	50.00	50.00	Length	Distance	Show	ConcreteLeft
D6	=D5	50.00	Length	Distance	Hide	D6.Плиты.Slab
D7	=D5+P2	150.00	Length	Distance	Hide	D7.Плиты.Slab
D8	=D7	150.00	Length	Distance	Hide	D8.Плиты.Slab
D9	=P3+D5	1050.00	Length	Distance	Hide	D9.Плиты.Slab
D10	=D9	1050.00	Length	Distance	Hide	D10.Плиты.Slab
D11	=D9+P2	1150.00	Length	Distance	Hide	D11.Плиты.Slab
D12	=D11	1150.00	Length	Distance	Hide	D12.Плиты.Slab
D13	50.00	50.00	Length	Distance	Show	ConcreteUp
D14	=D13	50.00	Length	Distance	Hide	D14.Плиты.Slab
D15	=D13+P4	150.00	Length	Distance	Hide	=D13+P4
D16	=D15	150.00	Length	Distance	Hide	D16.Плиты.Slab
D17	=D13+P5	1050.00	Length	Distance	Hide	D17.Плиты.Slab
D18	=D17	1050.00	Length	Distance	Hide	D18.Плиты.Slab
D19	=D17+P4	1150.00	Length	Distance	Hide	D19.Плиты.Slab
D20	=D19	1150.00	Length	Distance	Hide	D20.Плиты.Slab
D21	=P6+D13	1050.00	Length	Distance	Hide	D21.Плиты.Slab
D22	=D21	1050.00	Length	Distance	Hide	D22.Плиты.Slab
D23	=D21+P4	1150.00	Length	Distance	Hide	D23.Плиты.Slab
D24	=D23	1150.00	Length	Distance	Hide	D24.Плиты.Slab
D25	50.00	50.00	Length	Distance	Show	ConcreteRight
D26	=D25	50.00	Length	Distance	Hide	D26.Плиты.Slab
D27	=D25+P7	150.00	Length	Distance	Hide	D27.Плиты.Slab
D28	=D27	150.00	Length	Distance	Hide	D28.Плиты.Slab
D29	=P8+D25	1050.00	Length	Distance	Hide	D29.Плиты.Slab

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D22	=D21	1050.00	Length	Distance	Hide	D22.Плита Slab
D23	=D21+P4	1150.00	Length	Distance	Hide	D23.Плита Slab
D24	=D23	1150.00	Length	Distance	Hide	D24.Плита Slab
D25	50.00	50.00	Length	Distance	Show	ConcreteRight
D26	=D25	50.00	Length	Distance	Hide	D26.Плита Slab
D27	=D25+P7	150.00	Length	Distance	Hide	D27.Плита Slab
D28	=D27	150.00	Length	Distance	Hide	D28.Плита Slab
D29	=P8+D25	1050.00	Length	Distance	Hide	D29.Плита Slab
D30	=D29	1050.00	Length	Distance	Hide	D30.Плита Slab
D31	=D29+P7	1150.00	Length	Distance	Hide	D31.Плита Slab
D32	=D31	1150.00	Length	Distance	Hide	D32.Плита Slab
D33	10.00	10.00	Length	Distance	Hide	D33.Плита Slab
D34	=D33	10.00	Length	Distance	Hide	D34.Плита Slab
D35	=D33	10.00	Length	Distance	Hide	D35.Плита Slab
D36	=D33	10.00	Length	Distance	Hide	D36.Плита Slab
D37	=D33	10.00	Length	Distance	Hide	D37.Плита Slab
D38	=D33	10.00	Length	Distance	Hide	D38.Плита Slab
D39	=D33	10.00	Length	Distance	Hide	D39.Плита Slab
D40	=D33	10.00	Length	Distance	Hide	D40.Плита Slab
D41	=P3	1000.00	Length	Distance	Hide	D41.Плита Slab
D42	=D41	1000.00	Length	Distance	Hide	D42.Плита Slab
D43	=P3	1000.00	Length	Distance	Hide	D43.Плита Slab
D44	=D43	1000.00	Length	Distance	Hide	D44.Плита Slab
D45	=P8	1000.00	Length	Distance	Hide	D45.Плита Slab
D46	=D45	1000.00	Length	Distance	Hide	D46.Плита Slab
D47	=P6	1000.00	Length	Distance	Hide	D47.Плита Slab
D48	=D47	1000.00	Length	Distance	Hide	D48.Плита Slab
D49	0.00	0.00	Length	Distance	Hide	D49.Балка Slab
D50	=D1+P1/2	100.00	Length	Distance	Hide	D50.Балка Slab
D51	=D50	100.00	Length	Distance	Hide	D51.Балка Slab
D52	=D25+P7/2	100.00	Length	Distance	Hide	D52.Балка Slab
D53	=D52	100.00	Length	Distance	Hide	D53.Балка Slab
D54	=P9+10	330.00	Length	Distance	Hide	D54.Балка Slab

STALA SINGLE COMP Custom component

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	1000.00	1000.00	Length	Parameter	Show	Length
P2	30.00	30.00	Length	Parameter	Show	space1
P3	4	4	Number	Parameter	Show	Bar number1
P4	50.00	50.00	Length	Parameter	Show	cover2
P5	4	4	Number	Parameter	Show	bar number 2
P6	30.00	30.00	Length	Parameter	Show	spase2
P7	75.00	75.00	Length	Parameter	Show	reinf 1.4
P8	300.00	300.00	Length	Parameter	Show	reinf 1.5
P9	100.00	100.00	Length	Parameter	Show	reinf1.6
P10	75.00	75.00	Length	Parameter	Show	reinf 2.4
P11	300.00	300.00	Length	Parameter	Show	reinf 2.5
P12	100.00	100.00	Length	Parameter	Show	reinf2.6
P13	A500HW	A500HW	Material	Parameter	Show	Material1
P14	12	12	Profile	Parameter	Show	size1
P15	A500HW	A500HW	Material	Parameter	Show	material2
P16	12	12	Profile	Parameter	Show	size2
P17	CFRHS100x1...	CFRHS100x100x5	Profile	Parameter	Show	tube profil
P18	AISI304	AISI304	Material	Parameter	Show	tube material
P19	500.00	500.00	Length	Parameter	Show	inside length
D1	=P1-P19	500.00	Length	Distance	Hide	outside length
D2	=P1-D1	500.00	Length	Distance	Hide	D2.CFRHS100x1...
D3	50.00	50.00	Length	Distance	Show	cover1
D4	=D3	50.00	Length	Distance	Hide	D4.REBAR.PARV...
D5	=D3	50.00	Length	Distance	Hide	D5.REBAR.PARV...
D6	=D3	50.00	Length	Distance	Hide	D6.REBAR.PARV...
D7	=D3	50.00	Length	Distance	Hide	D7.REBAR.PARV...
D8	=D3	50.00	Length	Distance	Hide	D8.REBAR.PARV...
D9	=D3	50.00	Length	Distance	Hide	D9.REBAR.PARV...
D10	=D3	50.00	Length	Distance	Hide	D10.REBAR.PAR...
D11	=D3	50.00	Length	Distance	Hide	D11.REBAR.PAR...
D12	=(P3-1)*P2+D3	140.00	Length	Distance	Hide	D12.REBAR.PAR...
D13	=D2-P4	450.00	Length	Distance	Hide	D13.REBAR.PAR...
D14	=D13	450.00	Length	Distance	Hide	D14.REBAR.PAR...

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D15	=D13	450.00	Length	Distance	Hide	D15.REBAR.PAR...
D16	=D13	450.00	Length	Distance	Hide	D16.REBAR.PAR...
D17	=D13	450.00	Length	Distance	Hide	D17.REBAR.PAR...
D18	=D13	450.00	Length	Distance	Hide	D18.REBAR.PAR...
D19	=D13	450.00	Length	Distance	Hide	D19.REBAR.PAR...
D20	=D13	450.00	Length	Distance	Hide	D20.REBAR.PAR...
D21	=D13	450.00	Length	Distance	Hide	D21.REBAR.PAR...
D22	=D2-P4-(P5-1)*...	360.00	Length	Distance	Hide	D22.REBAR.PAR...
D23	30.00	30.00	Length	Distance	Show	reinf 1.1
D24	=D23	30.00	Length	Distance	Hide	D24.REBAR.CFR...
D25	=D23	30.00	Length	Distance	Hide	D25.REBAR.CFR...
D26	=D23	30.00	Length	Distance	Hide	D26.REBAR.CFR...
D27	30.00	30.00	Length	Distance	Show	reinf 1.2
D28	=D27	30.00	Length	Distance	Hide	D28.REBAR.CFR...
D29	=D27	30.00	Length	Distance	Hide	D29.REBAR.CFR...
D30	=D27	30.00	Length	Distance	Hide	D30.REBAR.CFR...
D31	30.00	30.00	Length	Distance	Show	reinf 1.3
D32	=D31	30.00	Length	Distance	Hide	D32.REBAR.CFR...
D33	=D31	30.00	Length	Distance	Hide	D33.REBAR.CFR...
D34	=D31	30.00	Length	Distance	Hide	D34.REBAR.CFR...
D35	=P7+D27	105.00	Length	Distance	Hide	D35.REBAR.CFR...
D36	=D35	105.00	Length	Distance	Hide	D36.REBAR.CFR...
D37	=P8+P7+D27	405.00	Length	Distance	Hide	D37.REBAR.CFR...
D38	=D37	405.00	Length	Distance	Hide	D38.REBAR.CFR...
D39	=D37	405.00	Length	Distance	Hide	D39.REBAR.CFR...
D40	=D37	405.00	Length	Distance	Hide	D40.REBAR.CFR...
D41	=P9-D31	70.00	Length	Distance	Hide	D41.REBAR.CFR...
D42	=D41	70.00	Length	Distance	Hide	D42.REBAR.CFR...
D43	30.00	30.00	Length	Distance	Show	reinf2.1
D44	=D43	30.00	Length	Distance	Hide	D44.REBAR.CFR...
D45	=D43	30.00	Length	Distance	Hide	D45.REBAR.CFR...
D46	=D43	30.00	Length	Distance	Hide	D46.REBAR.CFR...
D47	30.00	30.00	Length	Distance	Show	reinf 2.2

D48	=D47	30.00	Length	Distance	Hide	D48.REBAR.CFR...
D49	=D47	30.00	Length	Distance	Hide	D49.REBAR.CFR...
D50	=D47	30.00	Length	Distance	Hide	D50.REBAR.CFR...
D51	30.00	30.00	Length	Distance	Show	reinf 2.3
D52	=D51	30.00	Length	Distance	Hide	D52.REBAR.CFR...
D53	=D51	30.00	Length	Distance	Hide	D53.REBAR.CFR...
D54	=D51	30.00	Length	Distance	Hide	D54.REBAR.CFR...
D55	=P10+D47	105.00	Length	Distance	Hide	D55.REBAR.CFR...
D56	=D55	105.00	Length	Distance	Hide	D56.REBAR.CFR...
D57	=P11+P10+D47	405.00	Length	Distance	Hide	D57.REBAR.CFR...
D58	=D57	405.00	Length	Distance	Hide	D58.REBAR.CFR...
D59	=D57	405.00	Length	Distance	Hide	D59.REBAR.CFR...
D60	=D57	405.00	Length	Distance	Hide	D60.REBAR.CFR...
D61	=P12-D51	70.00	Length	Distance	Hide	D61.REBAR.CFR...
D62	=D61	70.00	Length	Distance	Hide	D62.REBAR.CFR...

STALA SINGLE TENS Custom Component

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	4	4	Number	Parameter	Show	number 1
P2	4	4	Number	Parameter	Show	number 2
P3	A500HW	A500HW	Material	Parameter	Show	class 1
P4	A500HW	A500HW	Material	Parameter	Show	class 2
P5_...	12	12	Rebar size	Parameter	Show	size 1
P6_...	12	12	Rebar size	Parameter	Show	size 2
P7	40.00	40.00	Length	Parameter	Show	Sp b/w bars 2nd
P8	40.00	40.00	Length	Parameter	Show	caver2
P9	40.00	40.00	Length	Parameter	Show	Sp b/w bars 1st
P10	75.00	75.00	Length	Parameter	Show	space1.4
P11	300.00	300.00	Length	Parameter	Show	Parameter11
P12	100.00	100.00	Length	Parameter	Show	Parameter12
P13	75.00	75.00	Length	Parameter	Show	space2.4
P14	300.00	300.00	Length	Parameter	Show	space2.5
P15	100.00	100.00	Length	Parameter	Show	space2.6
P16	CFRHS100x1...	CFRHS100x100x5	Profile	Parameter	Show	Parameter16
P17	AISI304	AISI304	Material	Parameter	Show	Parameter17
D1	500.00	500.00	Length	Distance	Show	Inside length
D2	500.00	500.00	Length	Distance	Show	outside length
D3	40.00	40.00	Length	Distance	Show	caver1
D4	=D3	40.00	Length	Distance	Hide	D4.REBAR.PARV...
D5	=D3	40.00	Length	Distance	Hide	D5.REBAR.PARV...
D6	=D3	40.00	Length	Distance	Hide	D6.REBAR.PARV...
D7	=D3	40.00	Length	Distance	Hide	D7.REBAR.PARV...
D8	=D3	40.00	Length	Distance	Hide	D8.REBAR.PARV...
D9	=D3	40.00	Length	Distance	Hide	D9.REBAR.PARV...
D10	=D3	40.00	Length	Distance	Hide	D10.REBAR.PAR...
D11	=D3	40.00	Length	Distance	Hide	D11.REBAR.PAR...
D12	=D1-P8	460.00	Length	Distance	Hide	D12.REBAR.PAR...
D13	=D12-P7*(P2-1)	340.00	Length	Distance	Hide	D13.REBAR.PAR...
D14	=D13	340.00	Length	Distance	Hide	D14.REBAR.PAR...
D15	=D13	340.00	Length	Distance	Hide	D15.REBAR.PAR...
D16	=D13	340.00	Length	Distance	Hide	D16.REBAR.PAR...

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D17	=D13	340.00	Length	Distance	Hide	D17.REBAR.PAR...
D18	=D13	340.00	Length	Distance	Hide	D18.REBAR.PAR...
D19	=D13	340.00	Length	Distance	Hide	D19.REBAR.PAR...
D20	=D13	340.00	Length	Distance	Hide	D20.REBAR.PAR...
D21	=D13	340.00	Length	Distance	Hide	D21.REBAR.PAR...
D22	=D3+P9*(P1-1)	160.00	Length	Distance	Hide	D22.REBAR.PAR...
D23	30.00	30.00	Length	Distance	Show	space1.1
D24	=D23	30.00	Length	Distance	Hide	D24.REBAR.CFR...
D25	=D23	30.00	Length	Distance	Hide	D25.REBAR.CFR...
D26	=D23	30.00	Length	Distance	Hide	D26.REBAR.CFR...
D27	30.00	30.00	Length	Distance	Show	space1.2
D28	=D27	30.00	Length	Distance	Hide	D28.REBAR.CFR...
D29	=D27	30.00	Length	Distance	Hide	D29.REBAR.CFR...
D30	=D27	30.00	Length	Distance	Hide	D30.REBAR.CFR...
D31	30.00	30.00	Length	Distance	Show	space1.3
D32	=D31	30.00	Length	Distance	Hide	D32.REBAR.CFR...
D33	=D31	30.00	Length	Distance	Hide	D33.REBAR.CFR...
D34	=D31	30.00	Length	Distance	Hide	D34.REBAR.CFR...
D35	=D31+P10	105.00	Length	Distance	Hide	D35.REBAR.CFR...
D36	=D35	105.00	Length	Distance	Hide	D36.REBAR.CFR...
D37	=D35+P11	405.00	Length	Distance	Hide	D37.REBAR.CFR...
D38	=D37	405.00	Length	Distance	Hide	D38.REBAR.CFR...
D39	=D37	405.00	Length	Distance	Hide	D39.REBAR.CFR...
D40	=D37	405.00	Length	Distance	Hide	D40.REBAR.CFR...
D41	=P12-D27	70.00	Length	Distance	Hide	D41.REBAR.CFR...
D42	=D41	70.00	Length	Distance	Hide	D42.REBAR.CFR...
D43	30.00	30.00	Length	Distance	Show	space2.1
D44	=D43	30.00	Length	Distance	Hide	D44.REBAR.CFR...
D45	=D43	30.00	Length	Distance	Hide	D45.REBAR.CFR...
D46	=D43	30.00	Length	Distance	Hide	D46.REBAR.CFR...
D47	30.00	30.00	Length	Distance	Show	space2.2
D48	=D47	30.00	Length	Distance	Hide	D48.REBAR.CFR...
D49	=D47	30.00	Length	Distance	Hide	D49.REBAR.CFR...

D50	=D47	30.00	Length	Distance	Hide	D50.REBAR.CFR...
D51	30.00	30.00	Length	Distance	Show	space2.3
D52	=D51	30.00	Length	Distance	Hide	D52.REBAR.CFR...
D53	=D51	30.00	Length	Distance	Hide	D53.REBAR.CFR...
D54	=D51	30.00	Length	Distance	Hide	D54.REBAR.CFR...
D55	=P13+D51	105.00	Length	Distance	Hide	D55.REBAR.CFR...
D56	=D55	105.00	Length	Distance	Hide	D56.REBAR.CFR...
D57	=D55+P14	405.00	Length	Distance	Hide	D57.REBAR.CFR...
D58	=D57	405.00	Length	Distance	Hide	D58.REBAR.CFR...
D59	=D57	405.00	Length	Distance	Hide	D59.REBAR.CFR...
D60	=D57	405.00	Length	Distance	Hide	D60.REBAR.CFR...
D61	=P15-D47	70.00	Length	Distance	Hide	D61.REBAR.CFR...
D62	=D61	70.00	Length	Distance	Hide	D62.REBAR.CFR...

STALA BOTH SINGLE Custom Component

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	1000.00	1000.00	Length	Parameter	Show	length
P2	3	3	Number	Parameter	Show	number1
P3	40.00	40.00	Length	Parameter	Show	space1
P4	40.00	40.00	Length	Parameter	Show	cover2
P5	40.00	40.00	Length	Parameter	Show	space2
P6	3	3	Number	Parameter	Show	number2
P7	75.00	75.00	Length	Parameter	Show	14
P8	300.00	300.00	Length	Parameter	Show	15
P9	100.00	100.00	Length	Parameter	Show	16
P10	75.00	75.00	Length	Parameter	Show	24
P11	300.00	300.00	Length	Parameter	Show	25
P12	100.00	100.00	Length	Parameter	Show	26
P13	CFRHS100x1...	CFRHS100x100x5	Profile	Parameter	Show	tube prof
P14	AISI304	AISI304	Material	Parameter	Show	tube mat
P15...	12	12	Rebar size	Parameter	Show	bar sizq1
P16	A500Hw	A500Hw	Material	Parameter	Show	bar mat1
P17...	12	12	Rebar size	Parameter	Show	barsize2
P18	A500Hw	A500Hw	Material	Parameter	Show	bar mat2
D1	500.00	500.00	Length	Distance	Show	inside length
D2	=P1-D1	500.00	Length	Distance	Hide	D2.CFRHS100x1...
D3	40.00	40.00	Length	Distance	Show	cover1
D4	=D3+P3/2	60.00	Length	Distance	Hide	D4.REBAR.PARV...
D5	=D4	60.00	Length	Distance	Hide	D5.REBAR.PARV...
D6	=D4	60.00	Length	Distance	Hide	D6.REBAR.PARV...
D7	=D4	60.00	Length	Distance	Hide	D7.REBAR.PARV...
D8	=D4	60.00	Length	Distance	Hide	D8.REBAR.PARV...
D9	=D4	60.00	Length	Distance	Hide	D9.REBAR.PARV...
D10	=D4	60.00	Length	Distance	Hide	D10.REBAR.PAR...
D11	=D4	60.00	Length	Distance	Hide	D11.REBAR.PAR...
D12	=D4	60.00	Length	Distance	Hide	D12.REBAR.PAR...
D13	=D3+P3*(P2-1)	120.00	Length	Distance	Hide	D13.REBAR.PAR...
D14	=D13	120.00	Length	Distance	Hide	D14.REBAR.PAR...
D15	=D13	120.00	Length	Distance	Hide	D15.REBAR.PAR...

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D16	=D13	120.00	Length	Distance	Hide	D16.REBAR.PAR...
D17	=D13	120.00	Length	Distance	Hide	D17.REBAR.PAR...
D18	=D13	120.00	Length	Distance	Hide	D18.REBAR.PAR...
D19	=D13	120.00	Length	Distance	Hide	D19.REBAR.PAR...
D20	=D13	120.00	Length	Distance	Hide	D20.REBAR.PAR...
D21	=D13	120.00	Length	Distance	Hide	D21.REBAR.PAR...
D22	=D13+P3/2	140.00	Length	Distance	Hide	D22.REBAR.PAR...
D23	=D1-P4	460.00	Length	Distance	Hide	D23.REBAR.PAR...
D24	=D1-P4-(P6-1)*...	380.00	Length	Distance	Hide	D24.REBAR.PAR...
D25	=D24	380.00	Length	Distance	Hide	D25.REBAR.PAR...
D26	=D24	380.00	Length	Distance	Hide	D26.REBAR.PAR...
D27	=D24	380.00	Length	Distance	Hide	D27.REBAR.PAR...
D28	=D24	380.00	Length	Distance	Hide	D28.REBAR.PAR...
D29	=D24	380.00	Length	Distance	Hide	D29.REBAR.PAR...
D30	=D24	380.00	Length	Distance	Hide	D30.REBAR.PAR...
D31	=D24	380.00	Length	Distance	Hide	D31.REBAR.PAR...
D32	=D24	380.00	Length	Distance	Hide	D32.REBAR.PAR...
D33	=D1-P4-P5/2	440.00	Length	Distance	Hide	D33.REBAR.PAR...
D34	=D33	440.00	Length	Distance	Hide	D34.REBAR.PAR...
D35	=D33	440.00	Length	Distance	Hide	D35.REBAR.PAR...
D36	=D33	440.00	Length	Distance	Hide	D36.REBAR.PAR...
D37	=D33	440.00	Length	Distance	Hide	D37.REBAR.PAR...
D38	=D33	440.00	Length	Distance	Hide	D38.REBAR.PAR...
D39	=D33	440.00	Length	Distance	Hide	D39.REBAR.PAR...
D40	=D33	440.00	Length	Distance	Hide	D40.REBAR.PAR...
D41	=D33	440.00	Length	Distance	Hide	D41.REBAR.PAR...
D42	=D24-P5/2	360.00	Length	Distance	Hide	D42.REBAR.PAR...
D43	30.00	30.00	Length	Distance	Show	11
D44	=D43	30.00	Length	Distance	Hide	D44.REBAR.CFR...
D45	=D43	30.00	Length	Distance	Hide	D45.REBAR.CFR...
D46	=D43	30.00	Length	Distance	Hide	D46.REBAR.CFR...
D47	=D43	30.00	Length	Distance	Hide	D47.REBAR.CFR...
D48	=D43	30.00	Length	Distance	Hide	D48.REBAR.CFR...

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D49	=D43	30.00	Length	Distance	Hide	D49.REBAR.CFR...
D50	=D43	30.00	Length	Distance	Hide	D50.REBAR.CFR...
D51	30.00	30.00	Length	Distance	Show	12
D52	=D51	30.00	Length	Distance	Hide	D52.REBAR.CFR...
D53	=D51	30.00	Length	Distance	Hide	D53.REBAR.CFR...
D54	=D51	30.00	Length	Distance	Hide	D54.REBAR.CFR...
D55	=D51	30.00	Length	Distance	Hide	D55.REBAR.CFR...
D56	=D51	30.00	Length	Distance	Hide	D56.REBAR.CFR...
D57	=D51	30.00	Length	Distance	Hide	D57.REBAR.CFR...
D58	=D51	30.00	Length	Distance	Hide	D58.REBAR.CFR...
D59	30.00	30.00	Length	Distance	Show	13
D60	=D59	30.00	Length	Distance	Hide	D60.REBAR.CFR...
D61	=D59	30.00	Length	Distance	Hide	D61.REBAR.CFR...
D62	=D59	30.00	Length	Distance	Hide	D62.REBAR.CFR...
D63	=D59	30.00	Length	Distance	Hide	D63.REBAR.CFR...
D64	=D59	30.00	Length	Distance	Hide	D64.REBAR.CFR...
D65	=D59	30.00	Length	Distance	Hide	D65.REBAR.CFR...
D66	=D59	30.00	Length	Distance	Hide	D66.REBAR.CFR...
D67	=P7+D51	105.00	Length	Distance	Hide	D67.REBAR.CFR...
D68	=D67	105.00	Length	Distance	Hide	D68.REBAR.CFR...
D69	=D67	105.00	Length	Distance	Hide	D69.REBAR.CFR...
D70	=D67	105.00	Length	Distance	Hide	D70.REBAR.CFR...
D71	=P8+P7+D51	405.00	Length	Distance	Hide	D71.REBAR.CFR...
D72	=D71	405.00	Length	Distance	Hide	D72.REBAR.CFR...
D73	=D71	405.00	Length	Distance	Hide	D73.REBAR.CFR...
D74	=D71	405.00	Length	Distance	Hide	D74.REBAR.CFR...
D75	=D71	405.00	Length	Distance	Hide	D75.REBAR.CFR...
D76	=D71	405.00	Length	Distance	Hide	D76.REBAR.CFR...
D77	=D71	405.00	Length	Distance	Hide	D77.REBAR.CFR...
D78	=D71	405.00	Length	Distance	Hide	D78.REBAR.CFR...
D79	=P9-D59	70.00	Length	Distance	Hide	D79.REBAR.CFR...
D80	=D79	70.00	Length	Distance	Hide	D80.REBAR.CFR...
D81	=D79	70.00	Length	Distance	Hide	D81.REBAR.CFR...

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D82	=D79	70.00	Length	Distance	Hide	D82.REBAR.CFR...
D83	30.00	30.00	Length	Distance	Show	21
D84	=D83	30.00	Length	Distance	Hide	D84.REBAR.CFR...
D85	=D83	30.00	Length	Distance	Hide	D85.REBAR.CFR...
D86	=D83	30.00	Length	Distance	Hide	D86.REBAR.CFR...
D87	=D83	30.00	Length	Distance	Hide	D87.REBAR.CFR...
D88	=D83	30.00	Length	Distance	Hide	D88.REBAR.CFR...
D89	=D83	30.00	Length	Distance	Hide	D89.REBAR.CFR...
D90	=D83	30.00	Length	Distance	Hide	D90.REBAR.CFR...
D91	30.00	30.00	Length	Distance	Show	22
D92	=D91	30.00	Length	Distance	Hide	D92.REBAR.CFR...
D93	=D91	30.00	Length	Distance	Hide	D93.REBAR.CFR...
D94	=D91	30.00	Length	Distance	Hide	D94.REBAR.CFR...
D95	=D91	30.00	Length	Distance	Hide	D95.REBAR.CFR...
D96	=D91	30.00	Length	Distance	Hide	D96.REBAR.CFR...
D97	=D91	30.00	Length	Distance	Hide	D97.REBAR.CFR...
D98	=D91	30.00	Length	Distance	Hide	D98.REBAR.CFR...
D99	30.00	30.00	Length	Distance	Show	23
D100	=D99	30.00	Length	Distance	Hide	D100.REBAR.CF...
D101	=D99	30.00	Length	Distance	Hide	D101.REBAR.CF...
D102	=D99	30.00	Length	Distance	Hide	D102.REBAR.CF...
D103	=D99	30.00	Length	Distance	Hide	D103.REBAR.CF...
D104	=D99	30.00	Length	Distance	Hide	D104.REBAR.CF...
D105	=D99	30.00	Length	Distance	Hide	D105.REBAR.CF...
D106	=D99	30.00	Length	Distance	Hide	D106.REBAR.CF...
D107	=P10+D91	105.00	Length	Distance	Hide	D107.REBAR.CF...
D108	=D107	105.00	Length	Distance	Hide	D108.REBAR.CF...
D109	=D107	105.00	Length	Distance	Hide	D109.REBAR.CF...
D110	=D107	105.00	Length	Distance	Hide	D110.REBAR.CF...
D111	=P11+P10+D91	405.00	Length	Distance	Hide	D111.REBAR.CF...
D112	=D111	405.00	Length	Distance	Hide	D112.REBAR.CF...
D113	=D111	405.00	Length	Distance	Hide	D113.REBAR.CF...
D114	=D111	405.00	Length	Distance	Hide	D114.REBAR.CF...

D115	=D111	405.00	Length	Distance	Hide	D115.REBAR.CF...
D116	=D111	405.00	Length	Distance	Hide	D116.REBAR.CF...
D117	=D111	405.00	Length	Distance	Hide	D117.REBAR.CF...
D118	=D111	405.00	Length	Distance	Hide	D118.REBAR.CF...
D119	=P12-D99	70.00	Length	Distance	Hide	D119.REBAR.CF...
D120	=D119	70.00	Length	Distance	Hide	D120.REBAR.CF...
D121	=D119	70.00	Length	Distance	Hide	D121.REBAR.CF...
D122	=D119	70.00	Length	Distance	Hide	D122.REBAR.CF...

STALA DOUBLE COMP Custom Component

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	30.00	30.00	Length	Parameter	Show	space1
P2	4	4	Number	Parameter	Show	number1
P3	50.00	50.00	Length	Parameter	Show	cover2
P4	1000.00	1000.00	Length	Parameter	Show	length
P5	4	4	Number	Parameter	Show	number2
P6	30.00	30.00	Length	Parameter	Show	space2
P7	75.00	75.00	Length	Parameter	Show	rein1.4
P8	300.00	300.00	Length	Parameter	Show	rein1.5
P9	100.00	100.00	Length	Parameter	Show	rein1.6
P10	75.00	75.00	Length	Parameter	Show	rein2.4
P11	300.00	300.00	Length	Parameter	Show	rein2.5
P12	100.00	100.00	Length	Parameter	Show	rein2.6
P13	P100*5	P100*5	Profile	Parameter	Show	tube profil
P14	AISI304	AISI304	Material	Parameter	Show	tube material
P15...	12	12	Rebar size	Parameter	Show	reinsize1
P16	A500HW	A500HW	Material	Parameter	Show	reinmat1
P17...	12	12	Rebar size	Parameter	Show	reinsize2
P18	A500HW	A500HW	Material	Parameter	Show	reinmat2
D1	50.00	50.00	Length	Distance	Show	cover1
D2	=D1	50.00	Length	Distance	Hide	D2.REBAR.PARV...
D3	=D1	50.00	Length	Distance	Hide	D3.REBAR.PARV...
D4	=D1	50.00	Length	Distance	Hide	D4.REBAR.PARV...
D5	=D1	50.00	Length	Distance	Hide	D5.REBAR.PARV...
D6	=D1	50.00	Length	Distance	Hide	D6.REBAR.PARV...
D7	=D1	50.00	Length	Distance	Hide	D7.REBAR.PARV...
D8	=D1	50.00	Length	Distance	Hide	D8.REBAR.PARV...
D9	=D1	50.00	Length	Distance	Hide	D9.REBAR.PARV...
D10	=(P2-1)*P1+D1	140.00	Length	Distance	Hide	D10.REBAR.PAR...
D11	500.00	500.00	Length	Distance	Show	inside length
D12	=D11	500.00	Length	Distance	Hide	D12.STALA.PARV...
D13	=P4-D11	500.00	Length	Distance	Hide	D13.STALA.PARV...
D14	=D13	500.00	Length	Distance	Hide	D14.STALA.PARV...
D15	=D11-P3	450.00	Length	Distance	Hide	D15.REBAR.PAR...

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D15	=D11-P3	450.00	Length	Distance	Hide	D15.REBAR.PAR...
D16	=D11-P3-P6*(...	360.00	Length	Distance	Hide	D16.REBAR.PAR...
D17	=D16	360.00	Length	Distance	Hide	D17.REBAR.PAR...
D18	=D16	360.00	Length	Distance	Hide	D18.REBAR.PAR...
D19	=D16	360.00	Length	Distance	Hide	D19.REBAR.PAR...
D20	=D16	360.00	Length	Distance	Hide	D20.REBAR.PAR...
D21	=D16	360.00	Length	Distance	Hide	D21.REBAR.PAR...
D22	=D16	360.00	Length	Distance	Hide	D22.REBAR.PAR...
D23	=D16	360.00	Length	Distance	Hide	D23.REBAR.PAR...
D24	=D16	360.00	Length	Distance	Hide	D24.REBAR.PAR...
D25	30.00	30.00	Length	Distance	Show	reinf1.1
D26	=D25	30.00	Length	Distance	Hide	D26.REBAR.STALA
D27	=D25	30.00	Length	Distance	Hide	D27.REBAR.STALA
D28	=D25	30.00	Length	Distance	Hide	D28.REBAR.STALA
D29	30.00	30.00	Length	Distance	Show	reinf1.2
D30	=D29	30.00	Length	Distance	Hide	D30.REBAR.STALA
D31	=D29	30.00	Length	Distance	Hide	D31.REBAR.STALA
D32	=D29	30.00	Length	Distance	Hide	D32.REBAR.STALA
D33	30.00	30.00	Length	Distance	Show	reinf1.3
D34	=D33	30.00	Length	Distance	Hide	D34.REBAR.STALA
D35	=D33	30.00	Length	Distance	Hide	D35.REBAR.STALA
D36	=D33	30.00	Length	Distance	Hide	D36.REBAR.STALA
D37	=P7+D29	105.00	Length	Distance	Hide	D37.REBAR.STALA
D38	=D37	105.00	Length	Distance	Hide	D38.REBAR.STALA
D39	=P8+D29+P7	405.00	Length	Distance	Hide	D39.REBAR.STALA
D40	=D39	405.00	Length	Distance	Hide	D40.REBAR.STALA
D41	=D39	405.00	Length	Distance	Hide	D41.REBAR.STALA
D42	=D39	405.00	Length	Distance	Hide	D42.REBAR.STALA
D43	=P9-D33	70.00	Length	Distance	Hide	D43.REBAR.STALA
D44	=D43	70.00	Length	Distance	Hide	D44.REBAR.STALA
D45	30.00	30.00	Length	Distance	Show	reinf2.1
D46	=D45	30.00	Length	Distance	Hide	D46.REBAR.STALA
D47	=D45	30.00	Length	Distance	Hide	D47.REBAR.STALA

D48	=D45	30.00	Length	Distance	Hide	D48.REBAR.STALA
D49	30.00	30.00	Length	Distance	Show	reinf2.2
D50	=D49	30.00	Length	Distance	Hide	D50.REBAR.STALA
D51	=D49	30.00	Length	Distance	Hide	D51.REBAR.STALA
D52	=D49	30.00	Length	Distance	Hide	D52.REBAR.STALA
D53	30.00	30.00	Length	Distance	Show	reinf2.3
D54	=D53	30.00	Length	Distance	Hide	D54.REBAR.STALA
D55	=D53	30.00	Length	Distance	Hide	D55.REBAR.STALA
D56	=D53	30.00	Length	Distance	Hide	D56.REBAR.STALA
D57	=P10+D49	105.00	Length	Distance	Hide	D57.REBAR.STALA
D58	=D57	105.00	Length	Distance	Hide	D58.REBAR.STALA
D59	=P11+P10+D49	405.00	Length	Distance	Hide	D59.REBAR.STALA
D60	=D59	405.00	Length	Distance	Hide	D60.REBAR.STALA
D61	=D59	405.00	Length	Distance	Hide	D61.REBAR.STALA
D62	=D59	405.00	Length	Distance	Hide	D62.REBAR.STALA
D63	=P12-D53	70.00	Length	Distance	Hide	D63.REBAR.STALA
D64	=D63	70.00	Length	Distance	Hide	D64.REBAR.STALA

STALA DOUBLE TENS Custom Component

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	4	4	Number	Parameter	Show	number1
P2	30.00	30.00	Length	Parameter	Show	space1
P3	1000.00	1000.00	Length	Parameter	Show	length
P4	50.00	50.00	Length	Parameter	Show	cover2
P5	4	4	Number	Parameter	Show	number2
P6	30.00	30.00	Length	Parameter	Show	space2
P7	75.00	75.00	Length	Parameter	Show	1.4
P8	300.00	300.00	Length	Parameter	Show	1.5
P9	100.00	100.00	Length	Parameter	Show	1.6
P10	75.00	75.00	Length	Parameter	Show	24
P11	300.00	300.00	Length	Parameter	Show	2.5
P12	100.00	100.00	Length	Parameter	Show	2.6
P13	P100*5	P100*5	Profile	Parameter	Show	tube profile
P14	A500HW	A500HW	Material	Parameter	Show	tube material
P15...	12	12	Rebar size	Parameter	Show	barsize1
P16	A500HW	A500HW	Material	Parameter	Show	barmater1
P17...	12	12	Rebar size	Parameter	Show	barsize2
P18	A500HW	A500HW	Material	Parameter	Show	barmat2
D1	50.00	50.00	Length	Distance	Show	cover1
D2	=D1	50.00	Length	Distance	Hide	D2.REBAR.PARV...
D3	=D1	50.00	Length	Distance	Hide	D3.REBAR.PARV...
D4	=D1	50.00	Length	Distance	Hide	D4.REBAR.PARV...
D5	=D1	50.00	Length	Distance	Hide	D5.REBAR.PARV...
D6	=D1	50.00	Length	Distance	Hide	D6.REBAR.PARV...
D7	=D1	50.00	Length	Distance	Hide	D7.REBAR.PARV...
D8	=D1	50.00	Length	Distance	Hide	D8.REBAR.PARV...
D9	=D1	50.00	Length	Distance	Hide	D9.REBAR.PARV...
D10	=D1+(P1-1)*P2	140.00	Length	Distance	Hide	D10.REBAR.PAR...
D11	500.00	500.00	Length	Distance	Show	inside length
D12	=D11	500.00	Length	Distance	Hide	D12.STALA.PARV...
D13	=P3-D11	500.00	Length	Distance	Hide	outside length
D14	=D13	500.00	Length	Distance	Hide	D14.STALA.PARV...
D15	=D11-P4	450.00	Length	Distance	Hide	D15.REBAR.PAR...

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D16	=D11-(P5-1)*P...	360.00	Length	Distance	Hide	D16.REBAR.PAR...
D17	=D16	360.00	Length	Distance	Hide	D17.REBAR.PAR...
D18	=D16	360.00	Length	Distance	Hide	D18.REBAR.PAR...
D19	=D16	360.00	Length	Distance	Hide	D19.REBAR.PAR...
D20	=D16	360.00	Length	Distance	Hide	D20.REBAR.PAR...
D21	=D16	360.00	Length	Distance	Hide	D21.REBAR.PAR...
D22	=D16	360.00	Length	Distance	Hide	D22.REBAR.PAR...
D23	=D16	360.00	Length	Distance	Hide	D23.REBAR.PAR...
D24	=D16	360.00	Length	Distance	Hide	D24.REBAR.PAR...
D25	30.00	30.00	Length	Distance	Show	1.1
D26	=D25	30.00	Length	Distance	Hide	D26.REBAR.STALA
D27	=D25	30.00	Length	Distance	Hide	D27.REBAR.STALA
D28	=D25	30.00	Length	Distance	Hide	D28.REBAR.STALA
D29	30.00	30.00	Length	Distance	Show	1.2
D30	=D29	30.00	Length	Distance	Hide	D30.REBAR.STALA
D31	=D29	30.00	Length	Distance	Hide	D31.REBAR.STALA
D32	=D29	30.00	Length	Distance	Hide	D32.REBAR.STALA
D33	30.00	30.00	Length	Distance	Show	1.3
D34	=D33	30.00	Length	Distance	Hide	D34.REBAR.STALA
D35	=D33	30.00	Length	Distance	Hide	D35.REBAR.STALA
D36	=D33	30.00	Length	Distance	Hide	D36.REBAR.STALA
D37	=P7+D29	105.00	Length	Distance	Hide	D37.REBAR.STALA
D38	=D37	105.00	Length	Distance	Hide	D38.REBAR.STALA
D39	=P8+P7+D29	405.00	Length	Distance	Hide	D39.REBAR.STALA
D40	=D39	405.00	Length	Distance	Hide	D40.REBAR.STALA
D41	=D39	405.00	Length	Distance	Hide	D41.REBAR.STALA
D42	=D39	405.00	Length	Distance	Hide	D42.REBAR.STALA
D43	=P9-D33	70.00	Length	Distance	Hide	D43.REBAR.STALA
D44	=D43	70.00	Length	Distance	Hide	D44.REBAR.STALA
D45	30.00	30.00	Length	Distance	Show	21
D46	=D45	30.00	Length	Distance	Hide	D46.REBAR.STALA
D47	=D45	30.00	Length	Distance	Hide	D47.REBAR.STALA
D48	=D45	30.00	Length	Distance	Hide	D48.REBAR.STALA

D49	30.00	30.00	Length	Distance	Show	22
D50	=D49	30.00	Length	Distance	Hide	D50.REBAR.STALA
D51	=D49	30.00	Length	Distance	Hide	D51.REBAR.STALA
D52	=D49	30.00	Length	Distance	Hide	D52.REBAR.STALA
D53	30.00	30.00	Length	Distance	Show	2.3
D54	=D53	30.00	Length	Distance	Hide	D54.REBAR.STALA
D55	=D53	30.00	Length	Distance	Hide	D55.REBAR.STALA
D56	=D53	30.00	Length	Distance	Hide	D56.REBAR.STALA
D57	=P10+D49	105.00	Length	Distance	Hide	D57.REBAR.STALA
D58	=D57	105.00	Length	Distance	Hide	D58.REBAR.STALA
D59	=P11+P10+D49	405.00	Length	Distance	Hide	D59.REBAR.STALA
D60	=D59	405.00	Length	Distance	Hide	D60.REBAR.STALA
D61	=D59	405.00	Length	Distance	Hide	D61.REBAR.STALA
D62	=D59	405.00	Length	Distance	Hide	D62.REBAR.STALA
D63	=P12-D53	70.00	Length	Distance	Hide	D63.REBAR.STALA
D64	=D63	70.00	Length	Distance	Hide	D64.REBAR.STALA

STALA BOTH DOUBLE Custom Component

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
P1	1000.00	1000.00	Length	Parameter	Show	Length
P2	3	3	Number	Parameter	Show	Number 1
P3	50.00	50.00	Length	Parameter	Show	Space1
P4	50.00	50.00	Length	Parameter	Show	cover2
P5	50.00	50.00	Length	Parameter	Show	space2
P6	3	3	Number	Parameter	Show	number2
P7	75.00	75.00	Length	Parameter	Show	14
P8	300.00	300.00	Length	Parameter	Show	15
P9	50.00	50.00	Length	Parameter	Show	16
P10	75.00	75.00	Length	Parameter	Show	24
P11	300.00	300.00	Length	Parameter	Show	25
P12	50.00	50.00	Length	Parameter	Show	26
P13	P100*5	P100*5	Profile	Parameter	Show	tube profile
P14	S235J0	S235J0	Material	Parameter	Show	tube mat
P15...	12	12	Rebar size	Parameter	Show	bar size1
P16	A500HW	A500HW	Material	Parameter	Show	mater bar1
P17...	12	12	Rebar size	Parameter	Show	bar size2
P18	A500HW	A500HW	Material	Parameter	Show	mat bar2
D1	500.00	500.00	Length	Distance	Show	Iside length
D2	=D1	500.00	Length	Distance	Hide	D2.STALA.PARV...
D3	=P1-D1	500.00	Length	Distance	Hide	D3.STALA.PARV...
D4	=D3	500.00	Length	Distance	Hide	D4.STALA.PARV...
D5	50.00	50.00	Length	Distance	Show	cover1
D6	=D5	50.00	Length	Distance	Hide	D6.REBAR.PARV...
D7	=D5	50.00	Length	Distance	Hide	D7.REBAR.PARV...
D8	=D5	50.00	Length	Distance	Hide	D8.REBAR.PARV...
D9	=D5	50.00	Length	Distance	Hide	D9.REBAR.PARV...
D10	=D5	50.00	Length	Distance	Hide	D10.REBAR.PAR...
D11	=D5	50.00	Length	Distance	Hide	D11.REBAR.PAR...
D12	=D5	50.00	Length	Distance	Hide	D12.REBAR.PAR...
D13	=D5	50.00	Length	Distance	Hide	D13.REBAR.PAR...
D14	=D5+P3/2	75.00	Length	Distance	Hide	D14.REBAR.PAR...
D15	=D14	75.00	Length	Distance	Hide	D15.REBAR.PAR...

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D16	=D14	75.00	Length	Distance	Hide	D16.REBAR.PAR...
D17	=D14	75.00	Length	Distance	Hide	D17.REBAR.PAR...
D18	=D14	75.00	Length	Distance	Hide	D18.REBAR.PAR...
D19	=D14	75.00	Length	Distance	Hide	D19.REBAR.PAR...
D20	=D14	75.00	Length	Distance	Hide	D20.REBAR.PAR...
D21	=D14	75.00	Length	Distance	Hide	D21.REBAR.PAR...
D22	=D14	75.00	Length	Distance	Hide	D22.REBAR.PAR...
D23	=D5+(P2-1)*P3	150.00	Length	Distance	Hide	D23.REBAR.PAR...
D24	=D23+P3/2	175.00	Length	Distance	Hide	D24.REBAR.PAR...
D25	=D1-P4	450.00	Length	Distance	Hide	D25.REBAR.PAR...
D26	=D25-P5/2	425.00	Length	Distance	Hide	D26.REBAR.PAR...
D27	=D1-P4-(P6-1)*...	350.00	Length	Distance	Hide	D27.REBAR.PAR...
D28	=D27	350.00	Length	Distance	Hide	D28.REBAR.PAR...
D29	=D27	350.00	Length	Distance	Hide	D29.REBAR.PAR...
D30	=D27	350.00	Length	Distance	Hide	D30.REBAR.PAR...
D31	=D27	350.00	Length	Distance	Hide	D31.REBAR.PAR...
D32	=D27	350.00	Length	Distance	Hide	D32.REBAR.PAR...
D33	=D27	350.00	Length	Distance	Hide	D33.REBAR.PAR...
D34	=D27	350.00	Length	Distance	Hide	D34.REBAR.PAR...
D35	=D27	350.00	Length	Distance	Hide	D35.REBAR.PAR...
D36	=D27-P5/2	325.00	Length	Distance	Hide	D36.REBAR.PAR...
D37	=D36	325.00	Length	Distance	Hide	D37.REBAR.PAR...
D38	=D36	325.00	Length	Distance	Hide	D38.REBAR.PAR...
D39	=D36	325.00	Length	Distance	Hide	D39.REBAR.PAR...
D40	=D36	325.00	Length	Distance	Hide	D40.REBAR.PAR...
D41	=D36	325.00	Length	Distance	Hide	D41.REBAR.PAR...
D42	=D36	325.00	Length	Distance	Hide	D42.REBAR.PAR...
D43	=D36	325.00	Length	Distance	Hide	D43.REBAR.PAR...
D44	=D36	325.00	Length	Distance	Hide	D44.REBAR.PAR...
D45	30.00	30.00	Length	Distance	Show	11
D46	=D45	30.00	Length	Distance	Hide	D46.REBAR.STALA
D47	=D45	30.00	Length	Distance	Hide	D47.REBAR.STALA
D48	=D45	30.00	Length	Distance	Hide	D48.REBAR.STALA

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D49	=D45	30.00	Length	Distance	Hide	D49.REBAR.STALA
D50	=D45	30.00	Length	Distance	Hide	D50.REBAR.STALA
D51	=D45	30.00	Length	Distance	Hide	D51.REBAR.STALA
D52	=D45	30.00	Length	Distance	Hide	D52.REBAR.STALA
D53	30.00	30.00	Length	Distance	Show	12
D54	=D53	30.00	Length	Distance	Hide	D54.REBAR.STALA
D55	=D53	30.00	Length	Distance	Hide	D55.REBAR.STALA
D56	=D53	30.00	Length	Distance	Hide	D56.REBAR.STALA
D57	=D53	30.00	Length	Distance	Hide	D57.REBAR.STALA
D58	=D53	30.00	Length	Distance	Hide	D58.REBAR.STALA
D59	=D53	30.00	Length	Distance	Hide	D59.REBAR.STALA
D60	=D53	30.00	Length	Distance	Hide	D60.REBAR.STALA
D61	30.00	30.00	Length	Distance	Show	13
D62	=D61	30.00	Length	Distance	Hide	D62.REBAR.STALA
D63	=D61	30.00	Length	Distance	Hide	D63.REBAR.STALA
D64	=D61	30.00	Length	Distance	Hide	D64.REBAR.STALA
D65	=D61	30.00	Length	Distance	Hide	D65.REBAR.STALA
D66	=D61	30.00	Length	Distance	Hide	D66.REBAR.STALA
D67	=D61	30.00	Length	Distance	Hide	D67.REBAR.STALA
D68	=D61	30.00	Length	Distance	Hide	D68.REBAR.STALA
D69	=P7+D53	105.00	Length	Distance	Hide	D69.REBAR.STALA
D70	=D69	105.00	Length	Distance	Hide	D70.REBAR.STALA
D71	=D69	105.00	Length	Distance	Hide	D71.REBAR.STALA
D72	=D69	105.00	Length	Distance	Hide	D72.REBAR.STALA
D73	=P8+P7+D53	405.00	Length	Distance	Hide	D73.REBAR.STALA
D74	=D73	405.00	Length	Distance	Hide	D74.REBAR.STALA
D75	=D73	405.00	Length	Distance	Hide	D75.REBAR.STALA
D76	=D73	405.00	Length	Distance	Hide	D76.REBAR.STALA
D77	=D73	405.00	Length	Distance	Hide	D77.REBAR.STALA
D78	=D73	405.00	Length	Distance	Hide	D78.REBAR.STALA
D79	=D73	405.00	Length	Distance	Hide	D79.REBAR.STALA
D80	=D73	405.00	Length	Distance	Hide	D80.REBAR.STALA
D81	=P9-D61	20.00	Length	Distance	Hide	D81.REBAR.STALA

Name	Formula	Value	Value type	Variable type	Visibility	Label in dialog box
D82	=D81	20.00	Length	Distance	Hide	D82.REBAR.STALA
D83	=D81	20.00	Length	Distance	Hide	D83.REBAR.STALA
D84	=D81	20.00	Length	Distance	Hide	D84.REBAR.STALA
D85	30.00	30.00	Length	Distance	Show	21
D86	=D85	30.00	Length	Distance	Hide	D86.REBAR.STALA
D87	=D85	30.00	Length	Distance	Hide	D87.REBAR.STALA
D88	=D85	30.00	Length	Distance	Hide	D88.REBAR.STALA
D89	=D85	30.00	Length	Distance	Hide	D89.REBAR.STALA
D90	=D85	30.00	Length	Distance	Hide	D90.REBAR.STALA
D91	=D85	30.00	Length	Distance	Hide	D91.REBAR.STALA
D92	=D85	30.00	Length	Distance	Hide	D92.REBAR.STALA
D93	30.00	30.00	Length	Distance	Show	22
D94	=D93	30.00	Length	Distance	Hide	D94.REBAR.STALA
D95	=D93	30.00	Length	Distance	Hide	D95.REBAR.STALA
D96	=D93	30.00	Length	Distance	Hide	D96.REBAR.STALA
D97	=D93	30.00	Length	Distance	Hide	D97.REBAR.STALA
D98	=D93	30.00	Length	Distance	Hide	D98.REBAR.STALA
D99	=D93	30.00	Length	Distance	Hide	D99.REBAR.STALA
D100	=D93	30.00	Length	Distance	Hide	D100.REBAR.ST...
D101	30.00	30.00	Length	Distance	Show	23
D102	=D101	30.00	Length	Distance	Hide	D102.REBAR.ST...
D103	=D101	30.00	Length	Distance	Hide	D103.REBAR.ST...
D104	=D101	30.00	Length	Distance	Hide	D104.REBAR.ST...
D105	=D101	30.00	Length	Distance	Hide	D105.REBAR.ST...
D106	=D101	30.00	Length	Distance	Hide	D106.REBAR.ST...
D107	=D101	30.00	Length	Distance	Hide	D107.REBAR.ST...
D108	=D101	30.00	Length	Distance	Hide	D108.REBAR.ST...
D109	=P10+D93	105.00	Length	Distance	Hide	D109.REBAR.ST...
D110	=D109	105.00	Length	Distance	Hide	D110.REBAR.ST...
D111	=D109	105.00	Length	Distance	Hide	D111.REBAR.ST...
D112	=D109	105.00	Length	Distance	Hide	D112.REBAR.ST...
D113	=P11+P10+D93	405.00	Length	Distance	Hide	D113.REBAR.ST...
D114	=D113	405.00	Length	Distance	Hide	D114.REBAR.ST...

D115	=D113	405.00	Length	Distance	Hide	D115.REBAR.ST...
D116	=D113	405.00	Length	Distance	Hide	D116.REBAR.ST...
D117	=D113	405.00	Length	Distance	Hide	D117.REBAR.ST...
D118	=D113	405.00	Length	Distance	Hide	D118.REBAR.ST...
D119	=D113	405.00	Length	Distance	Hide	D119.REBAR.ST...
D120	=D113	405.00	Length	Distance	Hide	D120.REBAR.ST...
D121	=P12-D101	20.00	Length	Distance	Hide	D121.REBAR.ST...
D122	=D121	20.00	Length	Distance	Hide	D122.REBAR.ST...
D123	=D121	20.00	Length	Distance	Hide	D123.REBAR.ST...
D124	=D121	20.00	Length	Distance	Hide	D124.REBAR.ST...