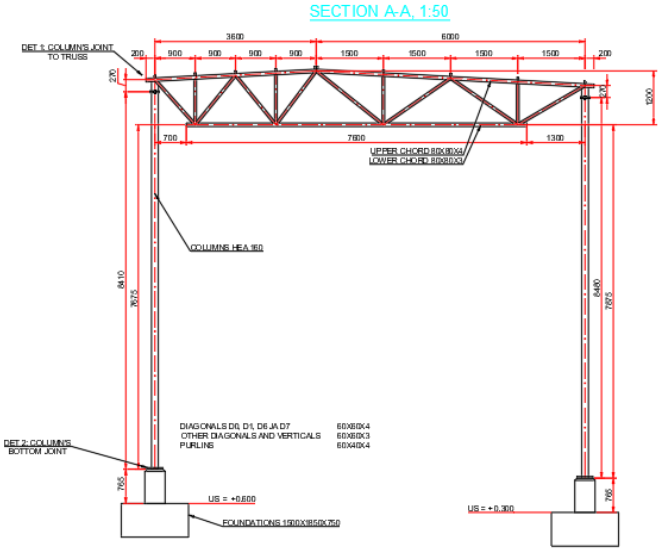
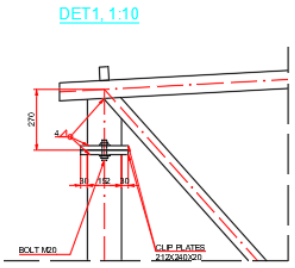
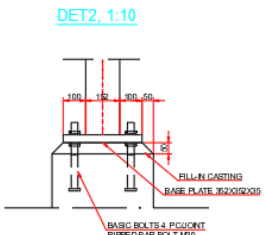
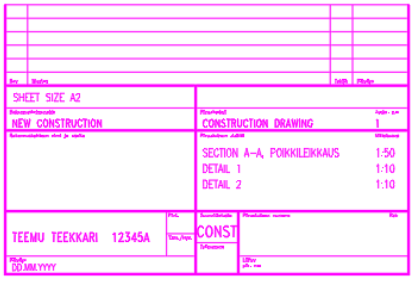
ENG-A2001 Computer-aided Tools in Engineering









AutoCAD assignment 2

Instructions

Contents

Exercise Overview

Each student receives their own starting

Obligatory criteria:

- The layers are named according to these instructions
- Objects are drawn on the layers set for them
- If a specific drawing technique has been requested, it must be used (e.g. polyline)

Assignment

Draw the cross section according to the instructions and model images given on the drawing template given separately (Figure 1). Cross section of the hall must be drawn in the area given to it, details you can create according to your taste in either model or paper space.

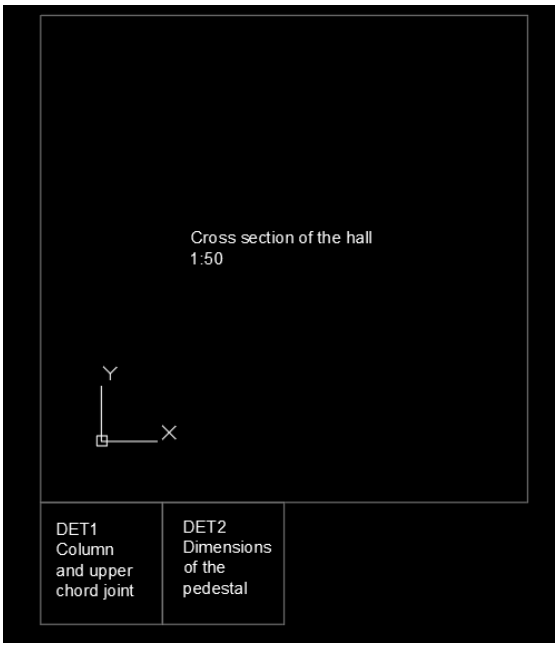


Figure 1. Template

Arrange the cross section, details, and caption to paper space, set sheet size to A2 and print pdf.

Instructions for completing the task have been given step by step. The purpose of the task is to focus on drawing techniques and proper drawing order. There are many ways of implementation for this exercise, and this material only gives you one of the ways to draw the cross section effectively.

IMPORTANT! Failure to meet any of the dimensional requirements will certainly result in worse points. Use layers and techniques as instructed.

1. Download AC_EX2_Template_2020.dwg from MyCourses and name it your own student ID. You can delete the texts in the template.
2. Assignment is drawn in scale of 1:1.
3. Follow the dimensions given in your personal initial data.
    - For example, note that panes of roof may not be at same height, therefore it is recommended to draw the centerlines of the profiles and after that, make sure the dimensions match the initial values.
4. Use layers as instructed later in this material.
    - Draw the objects needed for the cross section of the hall to correct layers.
    - There is no need to draw (another pdf), however it might help in perceiving the hall as a whole.
5. Import caption to your drawing from the file EX_AC_CAPTION_2020.dwg (can be found from MyCourses) and fill in the personal information on the caption.
    - Copy the whole table from the file mentioned above and import it into your own drawing as a block, so that its' fields can be filled with personal information. Caption can be imported with the **Xref** command, by changing the **Bind** setting to **Insert** in **File References** list, and by using the **Insert**. Fields can be changed by selecting the caption and opening the properties window. Therefore, one's own information must not be "glued" (written with text commands) on top of the caption but must be filled in fields in the table.
6. Hatch the footings with solid pattern and index color 99.
7. Create your own Plot Style using **AC_Plot_Style.ctb** as the basis and set the screening of the index color 99 to match the two last digits of your student ID. Set color 99 to print in red (index color 1).
8. Check your drawing with the checker, that is made for this exercise, and after you have gotten the necessary points, you can set the drawing on A2 print sheet, the scale of cross section is 1:50.
    - **THE FILES AND INSTRUCTIONS REQUIRED FOR USING THE CHECKER ARE AVAILABLE IN MYCOURSES.**

Grading focuses on the used layers, correct dimensions of the objects, and drawing techniques. **Important!** Failure to meet any of the dimensional requirements will certainly result in worse points. Use layers and techniques as instructed. Use layers and techniques provided in this material. Open up the AutoCAD and start drawing!

You can find plenty of helpful tutorial videos on the internet, especially on YouTube, for using the different commands. In addition, MyCourses provides a guide that includes many useful commands and functions.

Return: **you will return <u>five</u> files** (dwg, pdf, ctb, txt file from checker, initial), more detailed instruction in MyCourses. Name the files to be returned as studentid_2.dwg, studentid_2.pdf, studentid_2.ctb, and studentid_2.txt (for example, 12345A_2.dwg)

Assignment is returned on week 39 during your own exercise sessions in MyCourses return folder.

Make sure that the obligatory criteria are met.

Have an assistant present approve your assignment if possible.

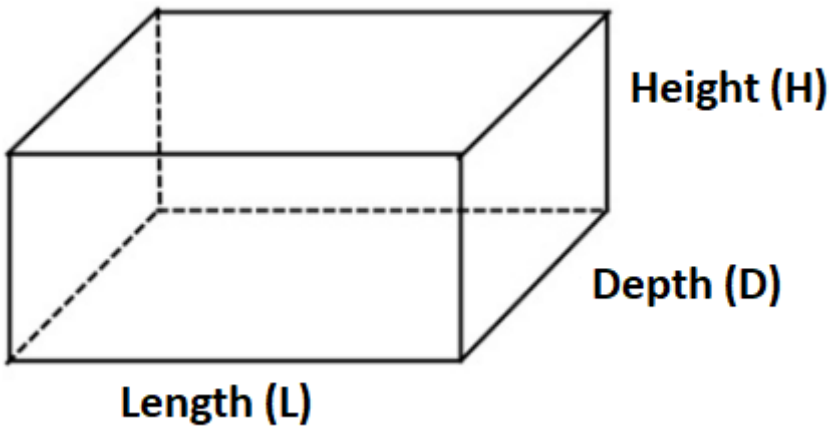
Concepts needed in the assignment

Dimensions in drawings

In structural drawings, the dimensions are given in millimeters, unless otherwise mentioned. An exception to this is the marking of the altitude position. Altitude position is given in meters and means the height of a point above the sea level. For example, +1.700 means that the point is 1.7 meters (1700 mm) above sea level.

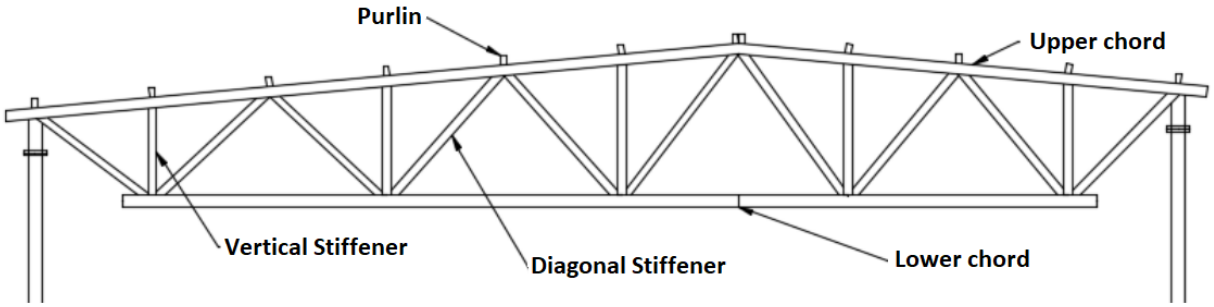
Explanations of components

Footings are the lowest part of the structure, often cast from concrete, which's task is to divide the weight of the building on the ground so that the building wont sink. Footing can be continuous, or as in the case of the assignment, an individual one. The dimensions of an individual footing are given like any other common cuboid dimensions: L x D x H, where L is length, D is depth and H is height.



Lower chord and **upper chord** form the truss frame. The truss can be raised or stiffened by placing **stiffeners** between the chords.

Purlins are structures parallel to the length of the building (perpendicular to the truss), which's function is to direct the weight of roof structure to the truss. In the case of the assignment, the purlins are steel profiles on top of upper chord, that run parallel to ridge line of the building.



HEA profile is a DIA standardized (steel) profile commonly used in Europe. Like in many other profiles, the number in the name indicates the size of the profile. In case of a HEA beam, the dimensions should be looked from the tables, that often contain information about height, (flange) width, flange and web material thicknesses, radii of curvature, and other important information about the profiles. Note that HEA profile is not a "square", **height and flange width are not equal**. Think which way around the profile is in the assignment (bolts of the details and dimensions help).

Example: HEA200 profile has flange width b = 200 mm and height h = 190 mm

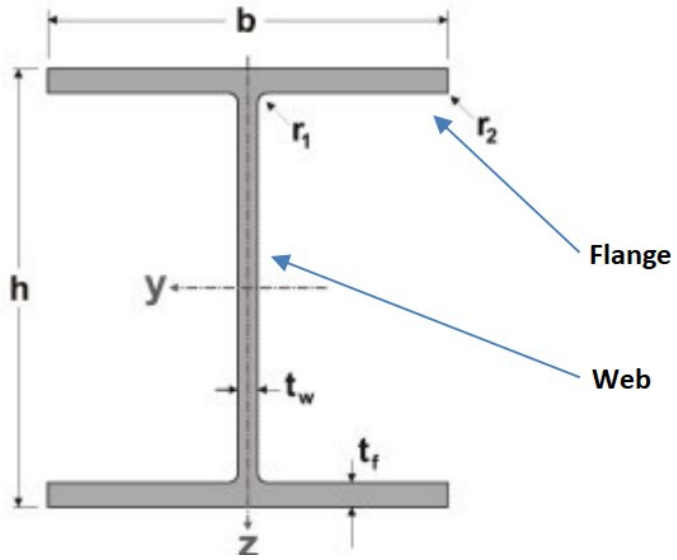


Image: Montanstahl AG

Hollow Structural Sections (HSS) are, as the name implies, hollow (steel) profiles. The main dimensions of the profile is expressed in the name in the form H x B x T, where H is the external height (or diameter), B is the external width and the T is the wall thickness or material thickness. In case of Circular Hollow Section (CHS), the width is not mentioned. The profile name may be preceded by an indication of the method of manufacturing, for example CF (Cold Formed).

Example:

CFRHS 120x80x5 is cold formed rectangular hollow profile with an external height of 120 mm, an external width of 80 mm and wall thickness 5 mm.

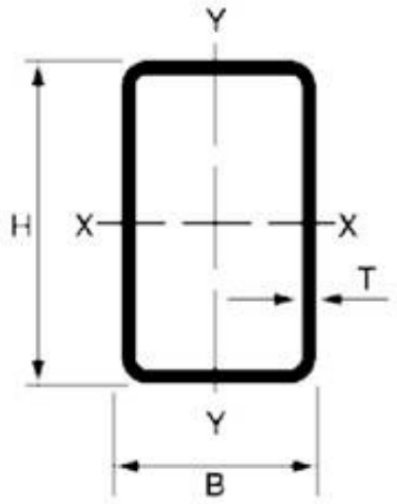
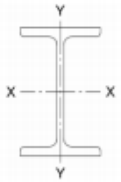


Image: steel4builders.co.uk

Different profiles

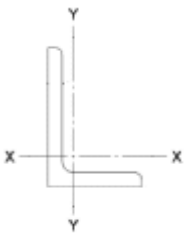
There are numerous profiles in different shapes and different manufacturing methods. The shapes are, for example, H, T and L profiles as well as various channels and housing structures. The manufacturing methods are such as cold rolling, hot rolling, cold/hot forming, and welding. In addition, steel profiles often include the steel grade, such as the S235HW used at the assignment.

Examples of different profiles

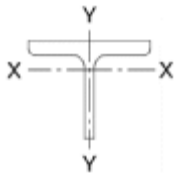


I profile. Also called H profile or W profile (wide flange)

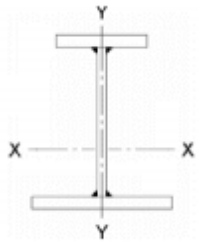
Channel or U profile



L profile



T profile



Monosymmetric W profile

CHS profile (Circular Hollow Section)

Checking the basic settings before drawing

Enter the **UNITS (UN)** command.

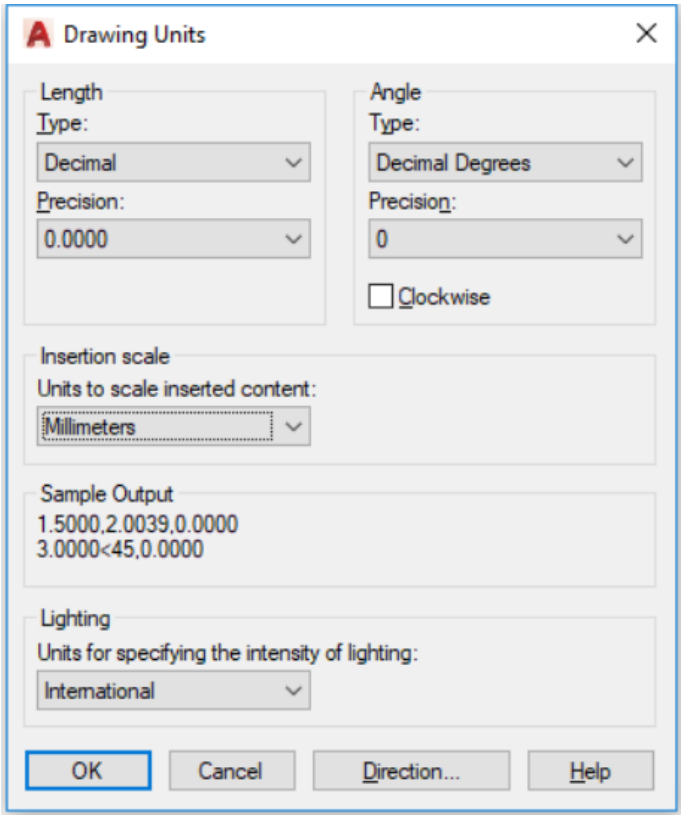


Figure 2. Drawing units

After the command, Drawing units dialog box will open (Figure 2). Make sure that you are using millimeters as **Insertion Scale**. Finally press OK.

Check the Insertion scale from the options also. Enter the **OPTIONS (OP)** command and select the **User Preferences** tab. Under the **Insertion Scale** menu, set both **Source Content Units** and **Target Drawing Units** to millimeters, as shown in Figure 3.

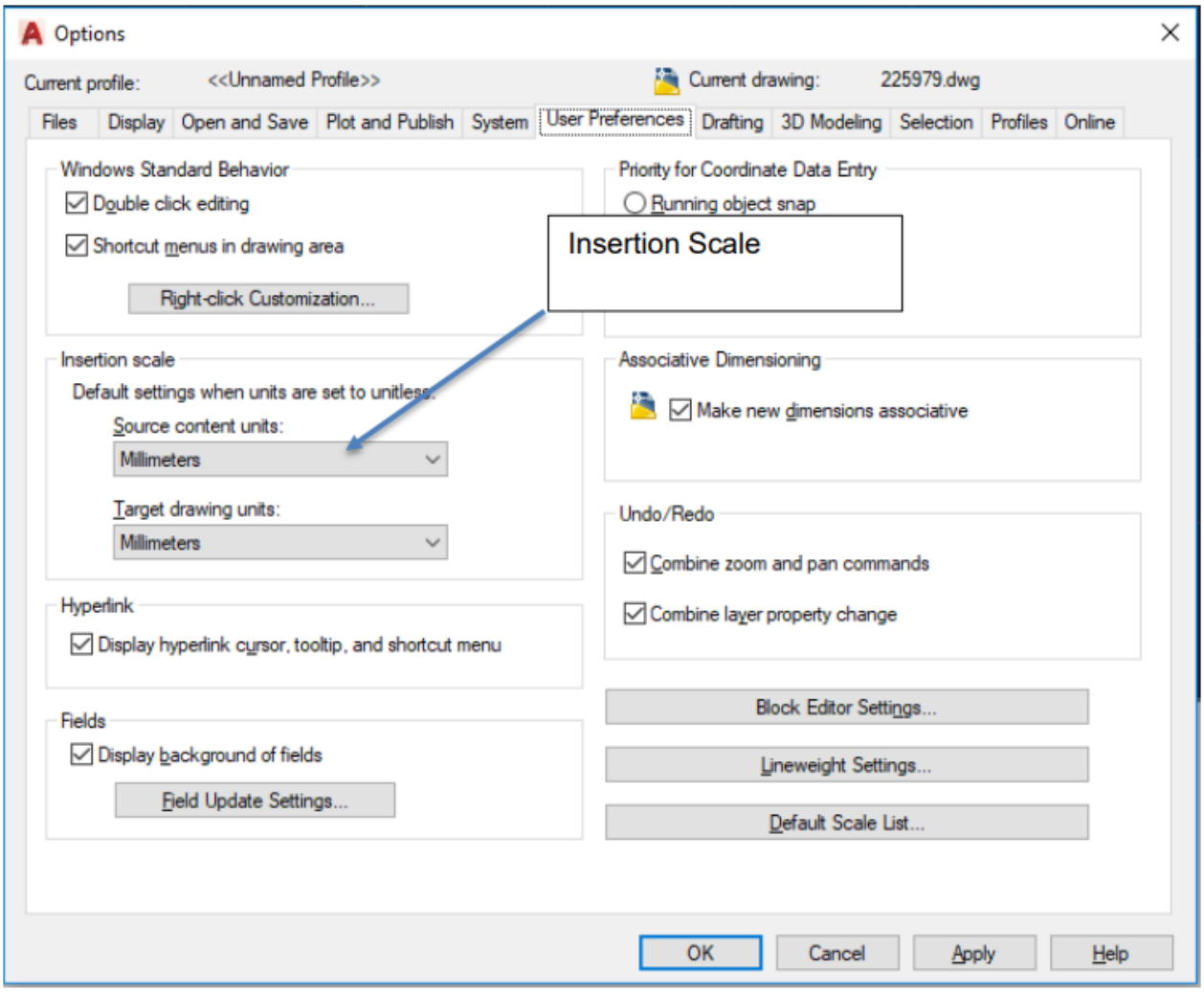


Figure 3. Insertion Scale in options

Make sure that you are drawing on a 1:1 scale in Model Space. This can be checked and changed from the status bar in the bottom right of the drawing window

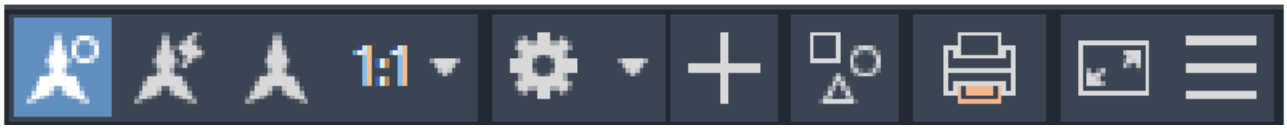


Figure 4. Checking the scale

Layers

Create layers according to the table below. The colors of the layers do not matter as long as they are named according to the table.

The layers in table must be found in the drawing.

Name	Color Index	Color	Linetype
FOOTINGS	magenta / 6		Continous
PEDESTALS	magenta / 6		Continous
STEEL COLUMNS	red / 1		Continous
STEEL PLATES	red / 1		Continous
TRUSS	white / 7		Continous
CENTER LINES	cyan / 4		ACAD_ISO11W100
DIMENSIONS	green / 3		Continous
TITLES	cyan / 4		Continuous
TEXTS	cyan / 4		Continuous
INFOTABLE	magenta / 6		Continuous
PURLINS	white / 7		Continuous

Table 1. Required layers

You can access the **Layer Properties Manager**, where you can create and edit layers, menu with the **LAYER** command or by clicking the **Layer Properties** icon in the **Home** tab of ribbon menu in the top of your screen.

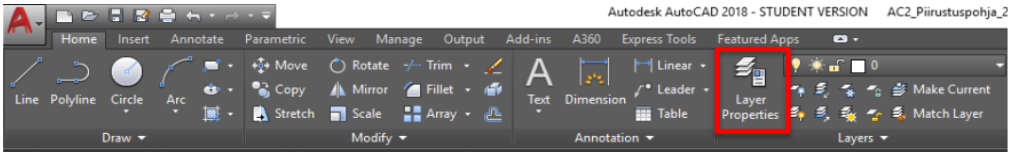


Figure 5.

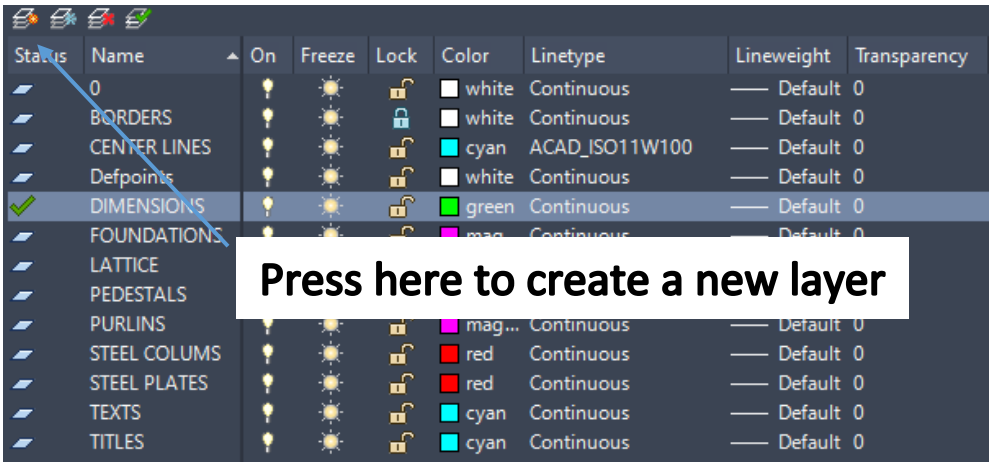


Figure 6. Layer view in the Layer Properties Manager

Do not draw anything on the "0" layer.

Dimensioning settings

Change the dimensioning settings so that the dimensions during drawing are given to four decimal places **unless they are integers**.

This will make the drawing much easier since possible mistakes with dimensions can be found much easier. **Note! The checker only accepts precise dimensions, there is no tolerances.**

When you draw accurately from the beginning and check your work after every drawing phase, you save time and achieve acceptable quality.

Guide to create a dimensioning style

1. Go to the Annotate tab in AutoCad (Figure 7)
2. Select the newly created layer DIMESIONS as the **Dim Layer Override** value.
3. Click the **Dimensions Style** scroll menu and select **Manage Dimension Styles**.
4. In the window that opens, press **New…** and create a new style “STRU_DIMENSIONS”. Keep

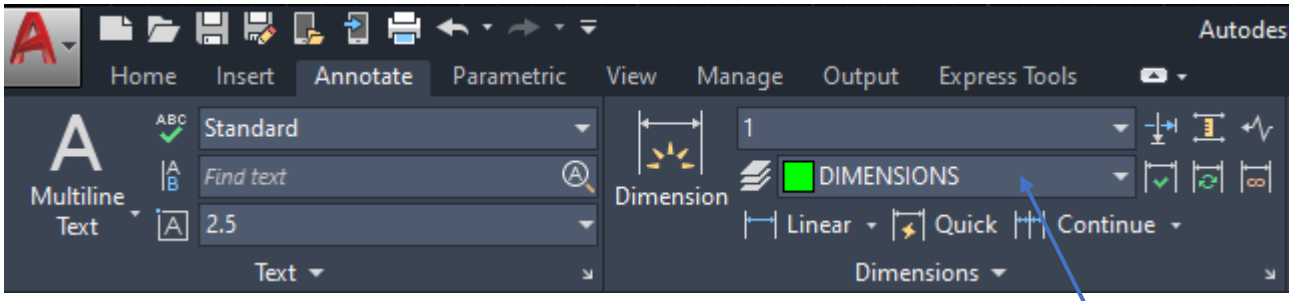


Figure 7. Annotate view

Dim Layer Override and Dimension Style menu above.

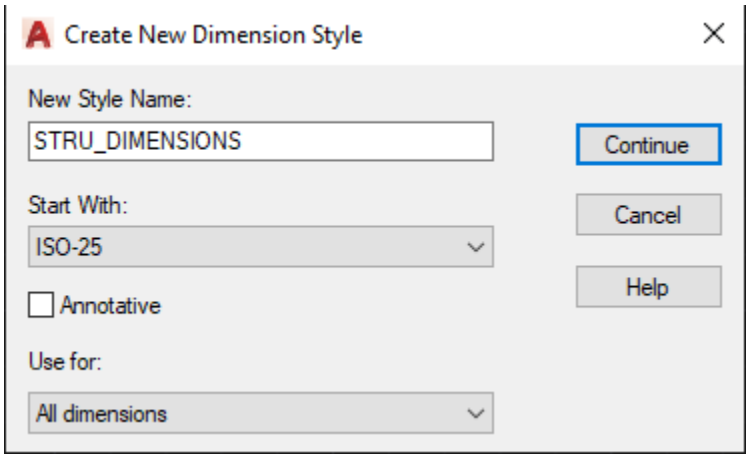


Figure 8. Creating a new dimension style

5. **New Dimension Style: STRU_DIMENSIONS** window will open. Select the **Fit** tab and change **Scale for dimensions features** menu’s settings as shown in

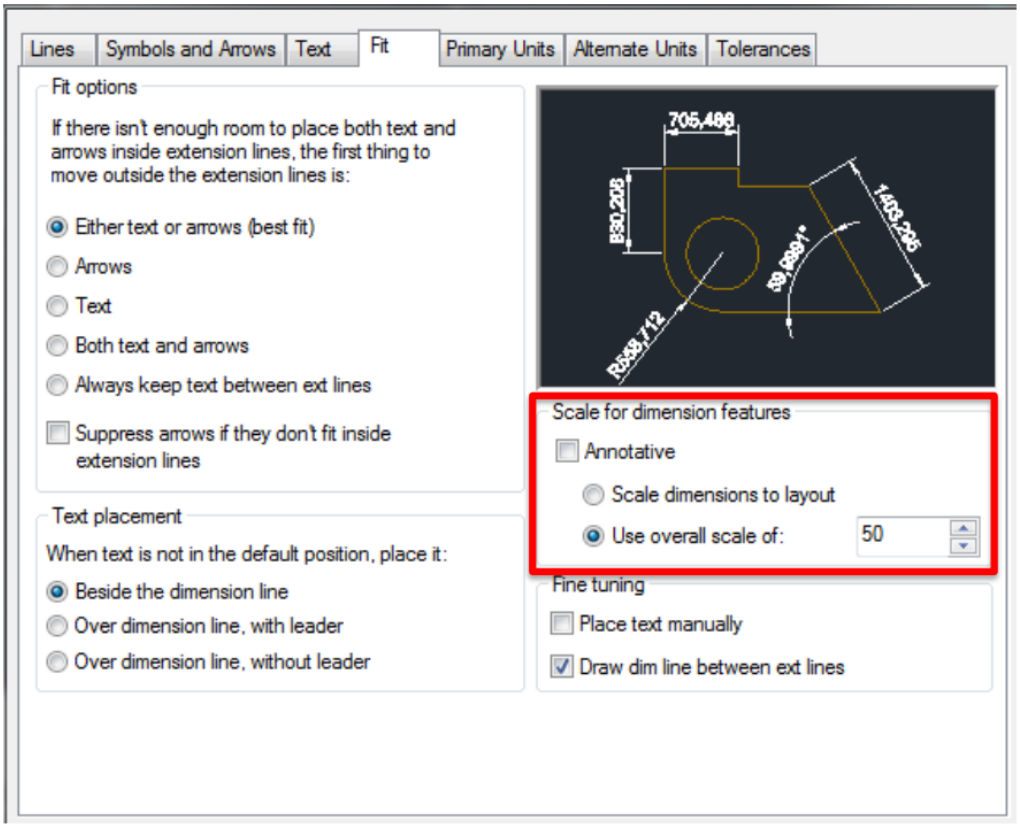


Figure 9. Changing the dimension scale

6. Next, go to the **Primary Units** tab. Replace the precision for both Linear Dimensions and Angular Dimensions to value 0.0000.
7. When you are done with the previous steps, press OK and then select the created layer from the list. Press **Set Current** and **Close**.

Drawing Instructions

Next, we will go through the drawing step by step. At the beginning the instructions are more detailed, but the number of hints decrease step by step.

Footings

1. Select **"Footings"** as the layer.
2. According to your model drawing, draw two footings of the correct size using **POLYLINE** or **RECTANG** commands. Hint! Create one footing and then copy it.
3. To make the drawing easier, place the left footing so that its' center line is on the Y-axis and the lower surface of the footing is at the 0-point of the Y-axis (). Placing the footing on the origin makes it easier to set other objects to the right line, and it will be easier to read the coordinates.

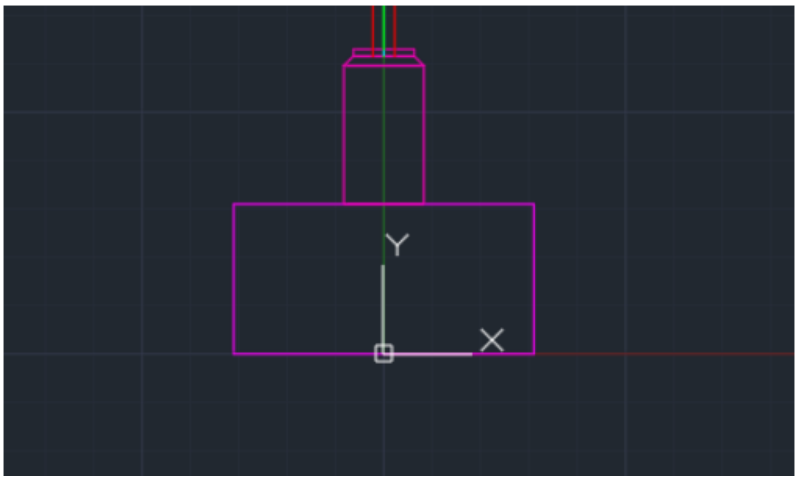


Figure 10. Placing the left footing in the drawing space

4. Position the right footing according to the initial values of your model drawing to the right distance from the left footing. Make sure that the dimensions between the footings are correct in your drawing (Figure 11, Dimlin can be helpful).
5. Also check the height difference of the footings in the Y direction (Figure 11).

Figure 11. Checking the distances between the footingss (NOTE! Check the dimensions from your model)

Save and use the checker before proceeding to the next section!

Pedestals

1. Select “Pedestals” as the layer
2. Check the width of your pedestals from your model drawing (Detail 2).
3. Draw a pedestal according to your model drawing and detail 2 using **RECTANG** and **POLYLINE** commands.
4. Create a block out of the pedestal: select all of the objects in pedestal and use the **BLOCK** command.
5. Give the block a name, select **Specify On-screen** from the **Base point** menu and make sure, that millimeters is selected in **Block unit** menu.
6. Press **OK** and specify the middle point of the lower surface as the insertion point (check the snap settings).
7. Add the pedestal to the other side as well with the **INSERT** command.

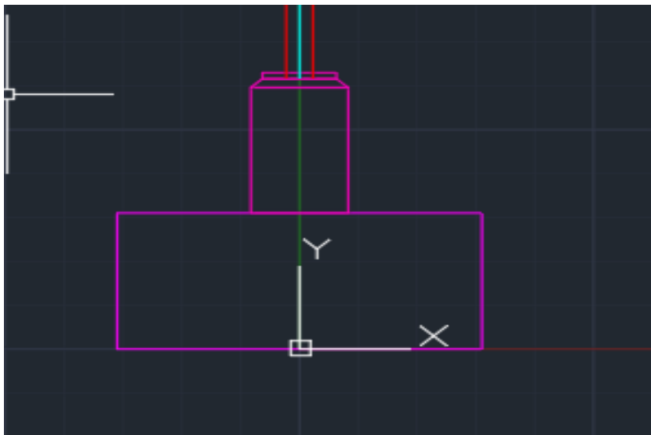


Figure 12. Footing + Pedestal

Note! The fill-in casting is not part of the pedestal assembly. However, it is recommended that you include it.

Save and use the checker before proceeding to the next section!

Center lines

After the footings and pedestals, draw center lines on the center lines layer to ease the drawing. Draw according to your initial values.

It is a good idea to draw the lines too long and later trim them to the correct length. There is an example below on how to use center lines for drawing.

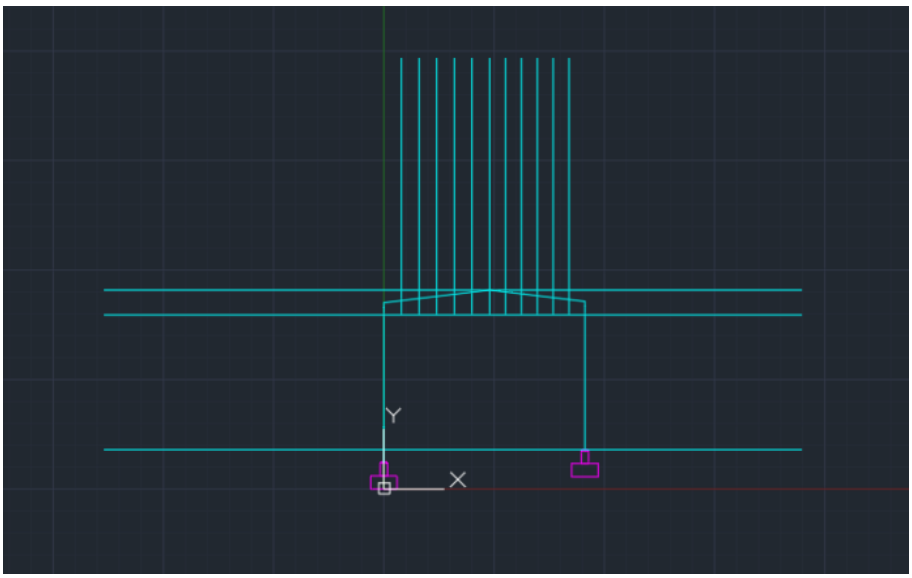


Figure 13. Drawing the center lines

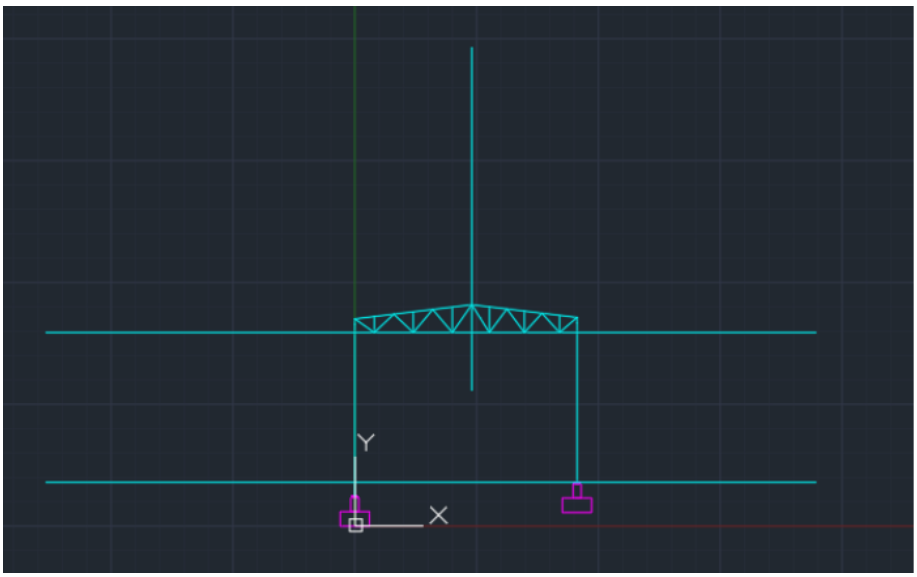


Figure 14. Trimmed center lines

Center lines should be used especially when drawing columns and truss.

Check that the center lines of stiffeners of the truss meet at the same point. The misalignment of the center lines produces problems when creating a BIM model from the cross section of the hall with TEKLA or FEM analyzes with RFEM program.

Save and use the checker before proceeding to the next section!

Columns and steel plates

Draw the columns on the **Columns** layer and the steel plates at the top of the pillars on the **Steel Plates** layer.

Use the **RECTANG** command to draw the steel plates to the correct size. If you used line to draw the plates, you can change them to a single polyline object with the **JOIN** command.

Hint! Use the **OFFSET** command to draw the columns.

Table for I profiles

Profile	Identification	h	b	tw	tf	r
HEA	100	**96**	100	5	6	12
HEA	120	**114**	120	5	8	12
HEA	160	**152**	160	6	9	15
HEA	200	**190**	200	6.5	10	18
HEA	300	**290**	300	8.5	14	27
HEA	250	**240**	250	7.5	12	22.5
HEB	200	**200**	200	9	15	18
HEB	300	**300**	300	11	19	27

Table 2. Dimensions of the steel profiles for columns

You can get general information about the columns from your model drawing, e.g. the pillar HEA120 is drawn with a width of 114. This can also be seen from the model drawing by looking at detail 2.

Select the correct width and draw the columns correct width and length.

Remember that there **is a total of 4 steel plates** in the joints between the column and the steel plates.

You will find the right dimensions for drawing the columns and steel plates in your model drawing.

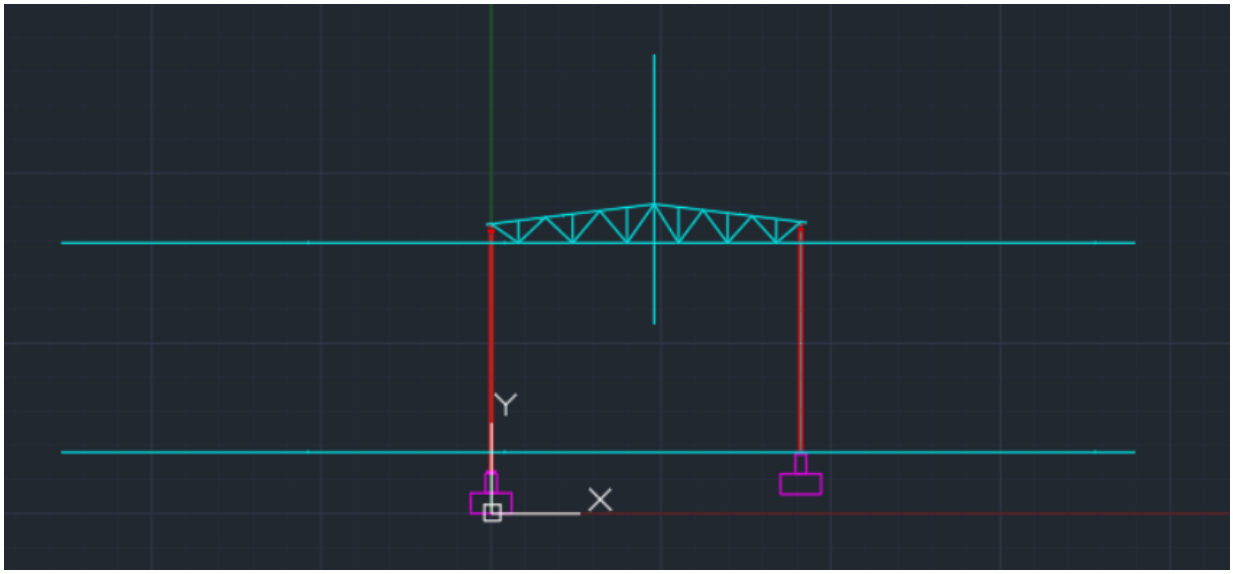


Figure 15. Columns and plates drawn

Save and use the checker before proceeding to the next section!

Structures of the roof

Use the center lines to draw the truss structure.

NOTE!
Figure 16 is there as a reminder for the widening of the upper chords. You can create the widening by selecting the desired object and placing the cursor on top of the point to be extended. AutoCAD will suggest you the options **STRETCH** and **LENGTHEN**. Use the **LENGHTEN** command to widen the upper chords, so that the angle of the structure (lengthened line) will not change.

Hint!
If you drew the center lines before the columns and truss, you can use them to your advantage.

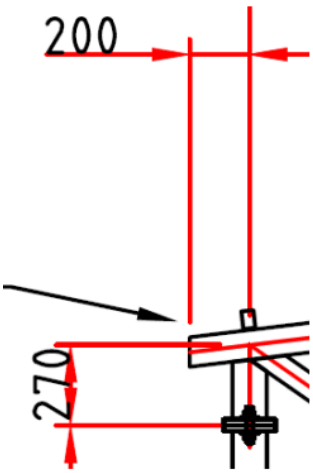


Figure 16. Widening of the upper chord (200 mm)

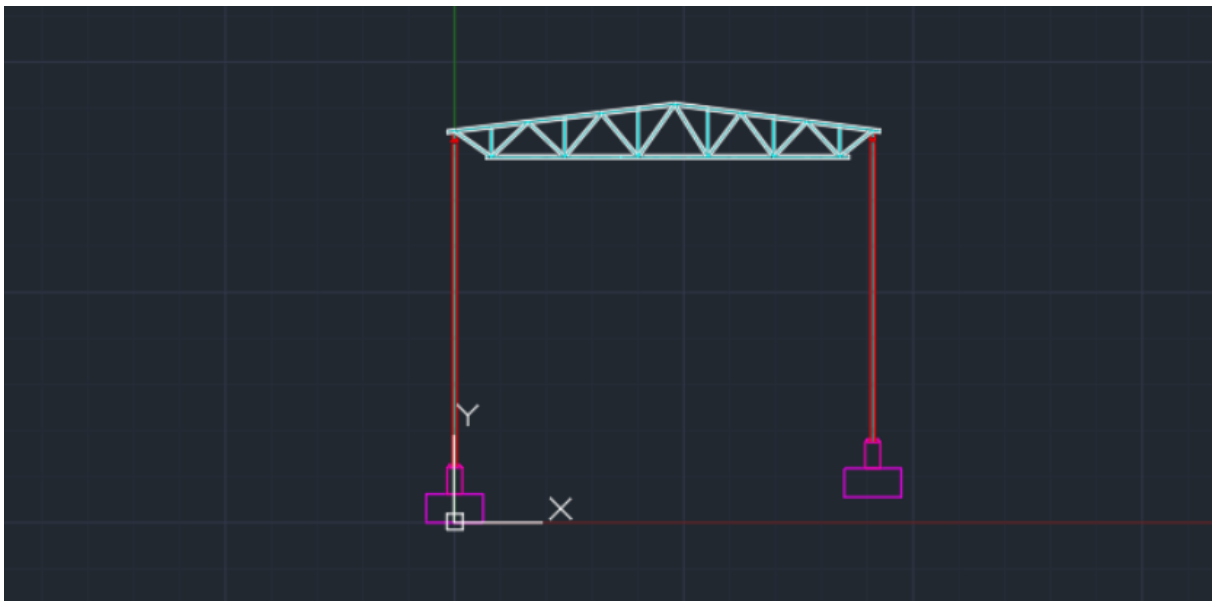


Figure 17. Finished roof structures

Save and use the checker before proceeding to the next section!

Dimensions

Dimension the drawing according to the model drawing using the dimension style, that was created → draw **DIMENSIONS** layer.

You can on the created dimension layer and style settings in the Annotate menu.

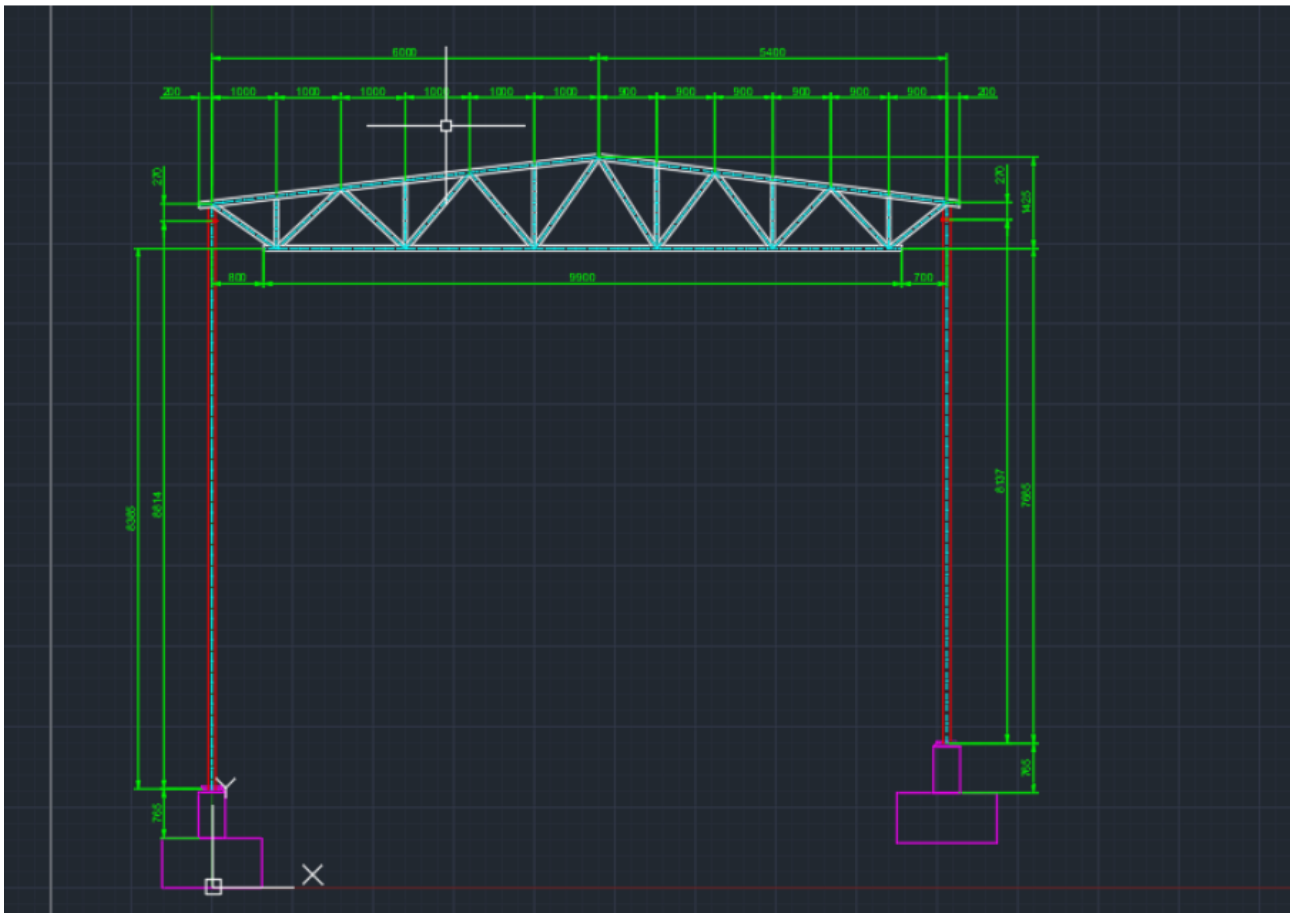


Figure 18. Finished dimensioning

Save and use the checker before proceeding to the next section!

Checking

Cross section is now almost finished. Only the titles and texts are missing. At this point, it is recommended to check the final dimensions of the assignment. Also check that the objects are on the correct layers.

Details

NOTE! In the model drawing, the details are done in more detail than necessary. In your drawing, the details will be drawn with less precision than in the model drawing. Bolts can be ignored, only the dimensions have to be included in details.

Ways to create a detail drawing:

a. Directly to paper space.
b. To model space using separate sub-copies. If you create drawings to model space, take advantage of the drawing areas provided in template.

Dimensioning of the details is done to the **Dimensions** layer. However, be sure to change the scaling value correct. Details are laid out on the sheet at a scale of 1:10. To change the scaling, first open properties menu with the **PROPERTIES (CH)** command. In the window that opens, you can change settings for selected dimension objects (Figure 19).

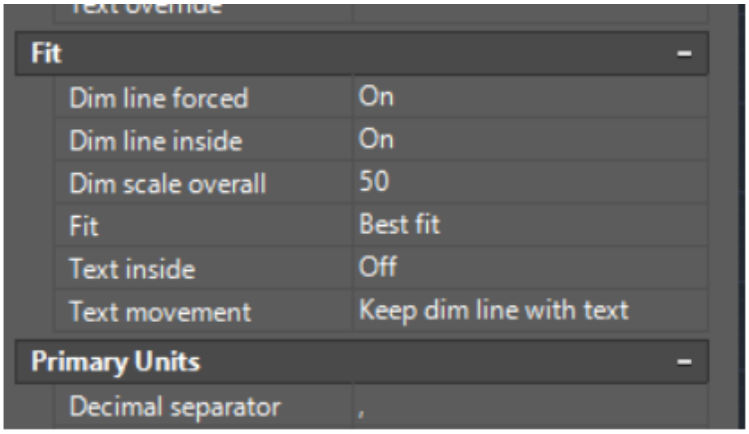


Figure 19. Fit menu of the properties window

Texts, titles, and leaders

Create the texts and titles according to the model drawing in your drawing. See the corrects sizes for titles and texts at different scales from the table below.

Excluding the titles, all of the texts will be drawn on the Texts layer. Titles will be drawn on the Titles layer.

Following RT 15-10635*:

Scale	Normal 2.5 mm on paper	Title 5.0 mm	Extra large 7.0 mm
1:5	12.5 pixels on screen	25	35
1:10	25	50	70
1:20	50	100	140
1:50	125	250	350
1:100	250	500	700
1:200	500	1000	1400
1:500	1250	2500	3500

Table 3. Text and title sizes

*RT 15-10635 is a Finnish presentation instruction material based on multiple standards published by the Building Information Footing (Rakennustietosäätiö).

Purlins

Set the Purlins layer to current and draw a sufficient number of purlins on the roof structures. The longitudinal direction of the purlins is in a direction perpendicular to the drawing plane.

Hatching the footings

Hatch the footings with **solid** pattern and **index color 99.**

Page Setup

- Enter Paper Space → Layout 1
- Correct sheet size:
    a. **CTRL + p** hotkey to open the sheet settings. Alternatively, you can change the settings in Page Setup Manager just in exercise 1.
    b. Select **AutoCAD PDF (High Quality Print)** as printer
    c. Select sheet size of **ISO FULL BLEED A2 (594 x 420 mm)**
    d. Make sure that the drawing orientation is **LANDSCAPE**
    e. **Make sure that the plot scale is 1:1**
- Press **Apply to Layout** and cancel → Sheet will now match the new settings
- You can view the printout from the **Preview** button.
- Paper space has one **VIEWPORT** (view to model space)
- Create separate viewports for the details and arrange them on the paper according to the model drawing.
- Import the infotable to paper space. Use the **OPEN or XREF** command and search the file "HT_AC_CAPTION_2020.dwg**"** from your computer. There are some fields in Finnish, you don't have to care about these.
    a. Import infotable as a block, so you can fill it with your personal information
    b. Place infotable block as shown in Figure 20. Select the infotable layer.

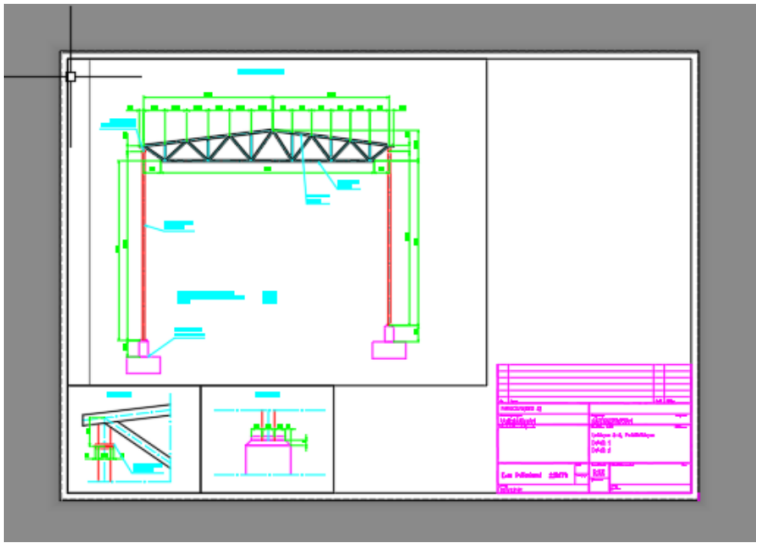


Figure 20. Snapshot of almost ready paper space

<u>Before the final printing:</u>

Select all three viewports and change their layer to "DEFPOINTS", so that the borders will not be printed on the PDF. Alternatively, you can create new layer, that will not be printed, for the viewports like in the exercise 1.

Change the pen assignments → Instructions can be found from MyCourses.

When you are ready to print your exercise:

- NOTE! The information in the upper right corner of the model drawing must be added to paper space before printing.
- When everything is ready, you can try printing: **Ctrl + p** or **PLOT**
- Make sure that correct pen assignment is selected.

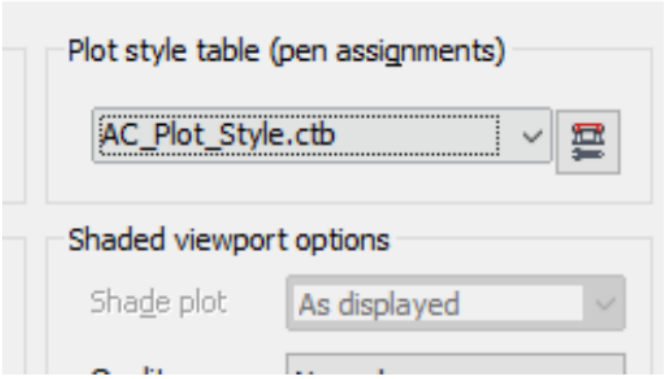


Figure 21. Pen assignment selection

- **Preview** → to see what the printout looks like
- If everything is as in the model drawing, you can print the final PDF printout of your work

Other instruction materials

- Downloadable files from MyCourses:
    a. AUTOCAD: USEFUL TOOLS IN EXERCISE 2