4. Finite Element (FE) analysis of a solid body

4.1. Case Study 1

Perform a static study of the shown in Fig. 4 - 1 solid body.

➢ Develop the CAD model of the body, regarding the instructions in Fig. 4 - 2. All dimensions are in millimeters.

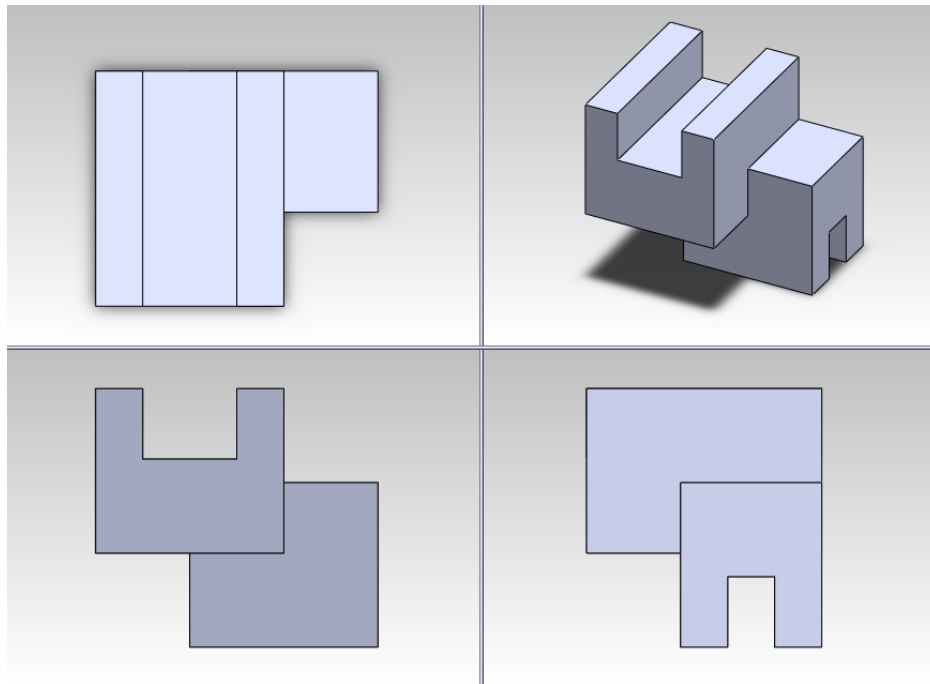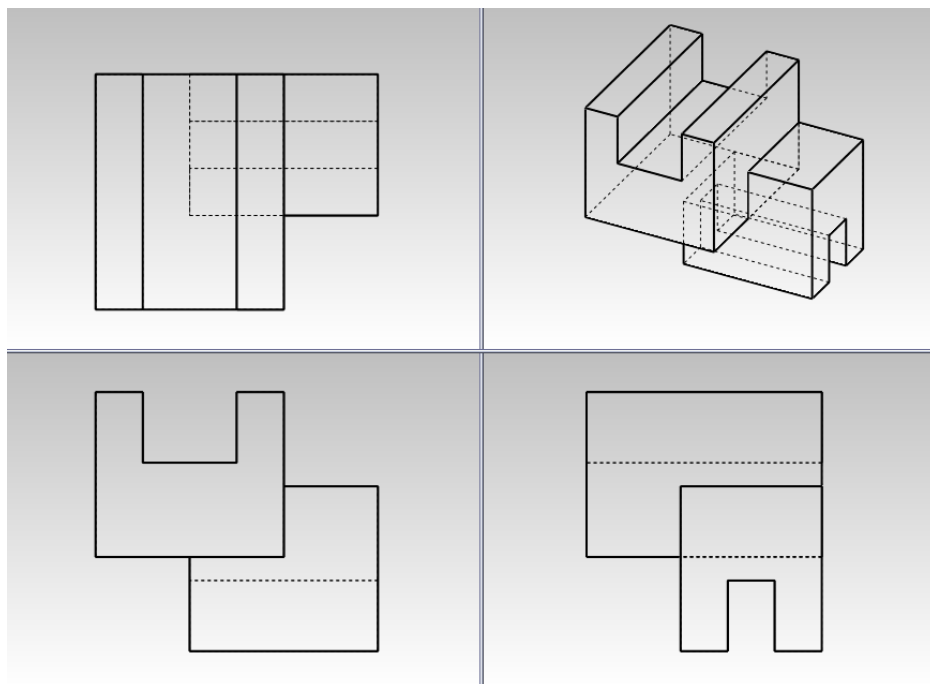➢ Apply the material to the part: ***Steel*** (***AISI 1020***, Yield Strength = 350MPa).

➢ Input **Fixed Geometry** (⬚) fixture at the bottom of the unit (Fig. 4 - 3a).

➢ Define the external loads:

- **Gravity** (⬚);

- Vertical force of ***20000N*** total at the three colored in blue faces (⬚, the cyan arrows, Fig. 4 - 3b);

- Horizontal force of ***5000N*** per item at both blue side faces of the opening (⬚, the pink arrows, Fig. 4 - 3c);

➢ **Mesh** (⬚) the part, using standard mesh with maximal FE size of ***5mm.***

➢ Plot the mesh and the aspect ratio (Fig. 4 - 3d).

➢ **Run** the model (⬚).

➢ **Plot** von Mises stresses (⬚, Fig. 4 - 3e), displacement (⬚, Fig. 4 - 4a) and FoS (⬚, Fig. 4 - 4b).
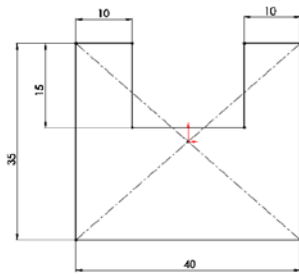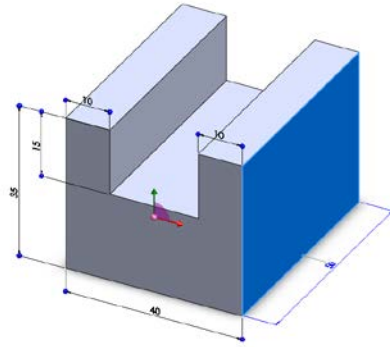
a) Different views of the solid body
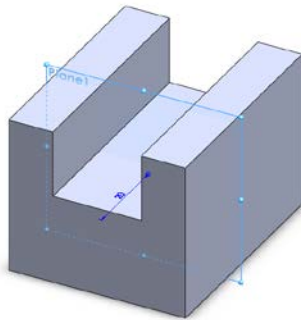

b) Transparent views of the design body

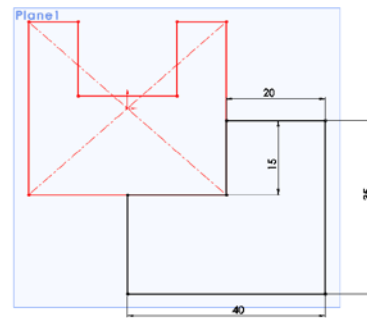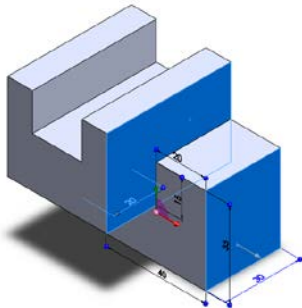Fig. 4 - 1 Views of the design solid body

a) Draw Sketch1

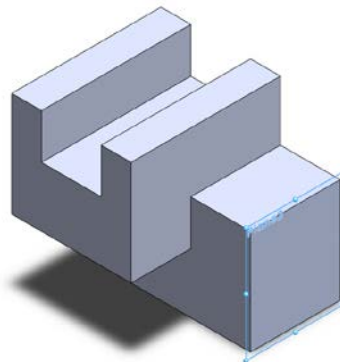b) Extrude the sketch at a distance of 50mm

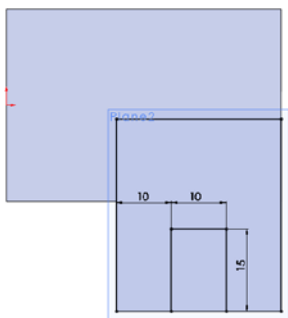c) Define a plane parallel to the Front Plane at a distance of 20mm

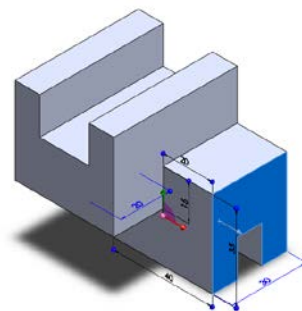d) Draw Sketch2 in the new plane. The red line outlines Sketch1.

e) Extrude Both extruded components

f) Defining a plane at the right side of the body

g) Draw the shown sketch in the newly defined plane

h) Extrude a hole in the supporting parallelepiped, according to the last sketch

Fig. 4 - 2 Stages of the development of the geometrical model of the analyzed solid body

a)   Define fixtures

b)   Vertical force of 20000N total.

c)   External force of 5000N per item.

d)   Plots of the mesh and of the aspect ratio
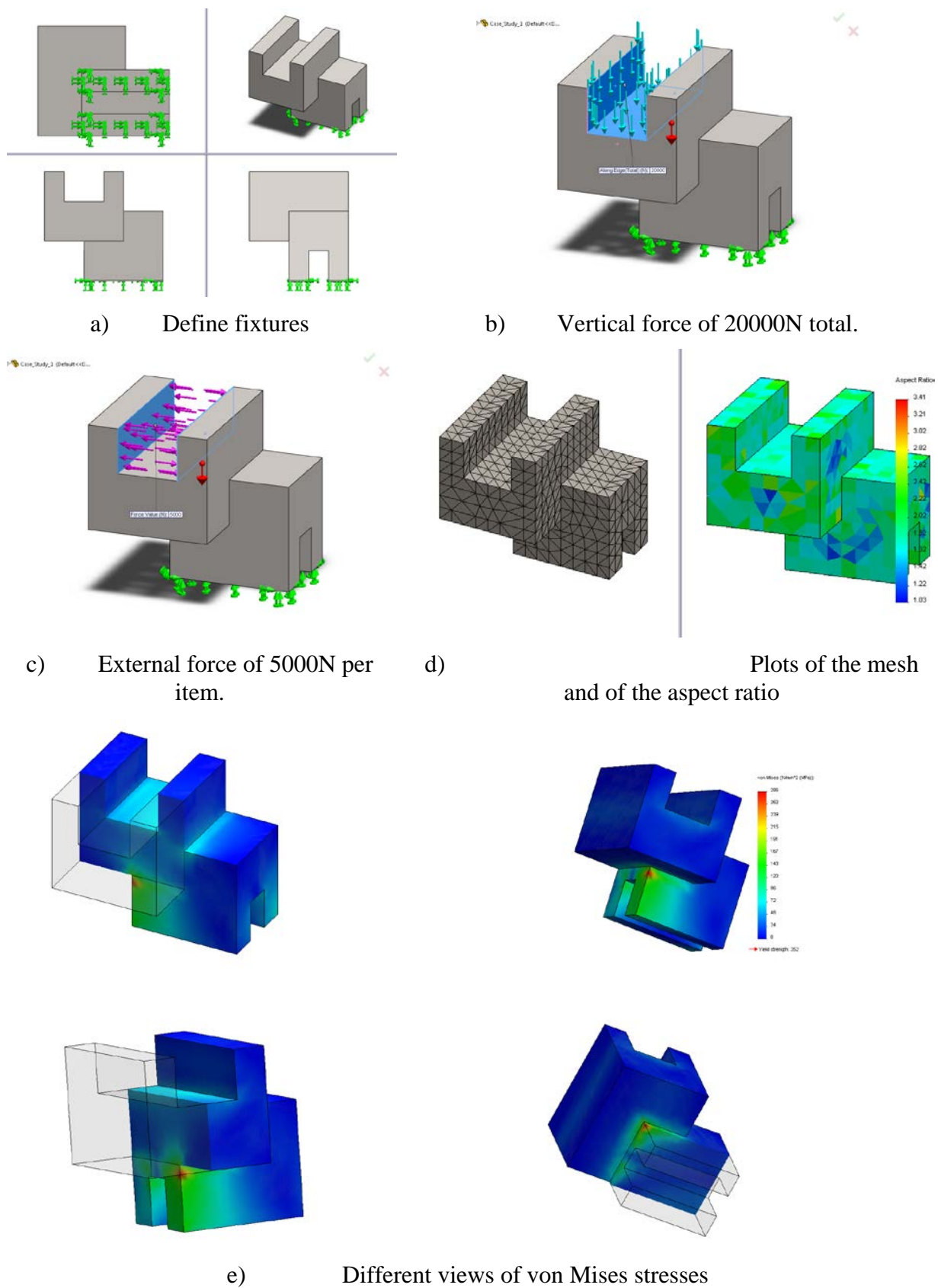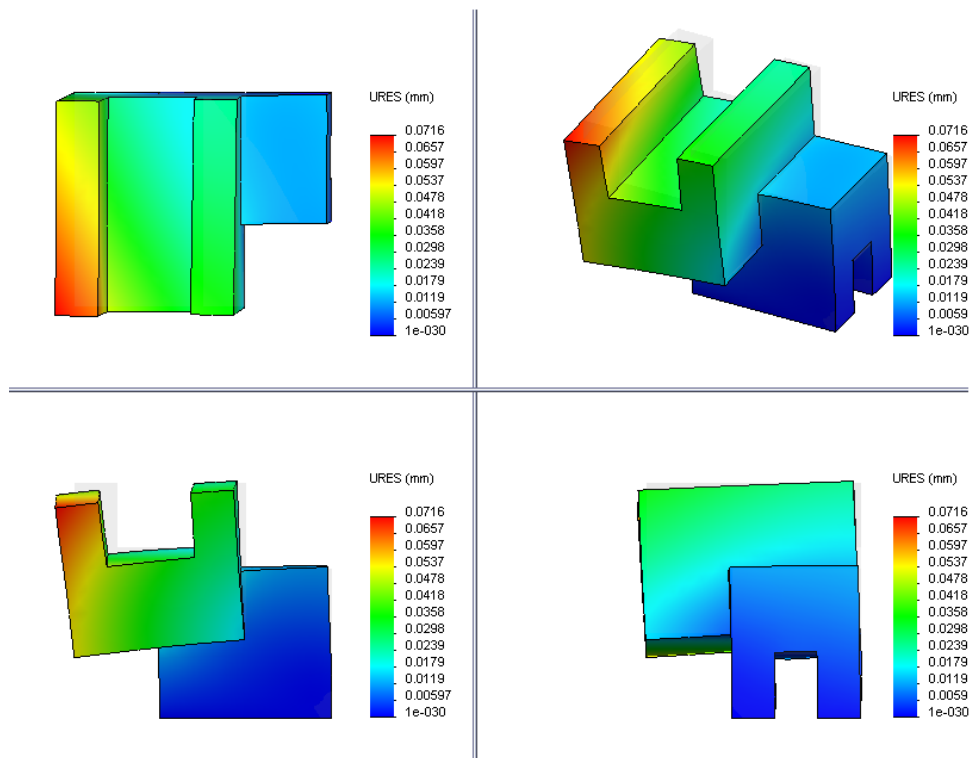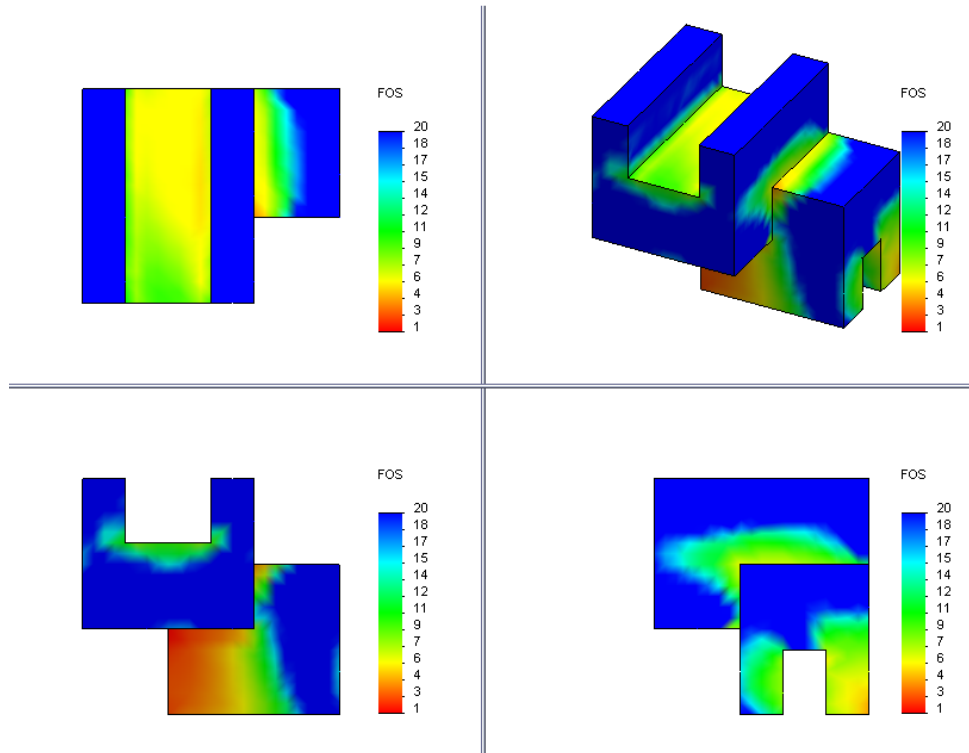

e)   Different views of von Mises stresses

Fig. 4 - 3 Development and results of the FE model of the analyzed solid body

a) Total displacement plots – top, front and left views, superimposed on the undeformed shape

b) Factor of safety plots – top, bottom and left views.

Fig. 4 - 4 Displacement and FoS plots

4.2.   Case Study 2

Perform a static study of the shown in Fig. 4 - 5 unit.

➢   Develop the CAD model of the body, regarding the instructions in Fig. 4 - 6 and Fig. 4 - 7. All dimensions are in millimeters.

➢   Apply the material to the part: ***Iron*** (***Gray Cast Iron***, Tensile Strength = 150MPa, Compressive Strength = 570MPa).

➢   Input **Fixed Geometry** (⬚) fixture at the bottom of the unit (the green arrows, Fig. 4 - 8a).

➢   Define the external loads:

-        **Gravity** (🍎, the red arrow, Fig. 4 - 8a);

-        Vertical force of ***1000N*** at the top. Split the face according to the figure (⬇, the pink arrows, Fig. 4 - 8a);

➢   Mesh the part (⬚), using standard mesh with maximal FE size of ***4mm.***

➢   Plot the mesh and the aspect ratio (Fig. 4 - 8b).

➢   Run the model (⬚).

➢   **Plot** first (P1) and third (P3) principal stresses to find the maximal tensile stress and the maximal compressive stress (⬚, Fig. 4 - 8c and d).

➢   Plot displacements UX, UY, UZ and the total displacement UREZ (⬚, Fig. 4 - 8e and f).
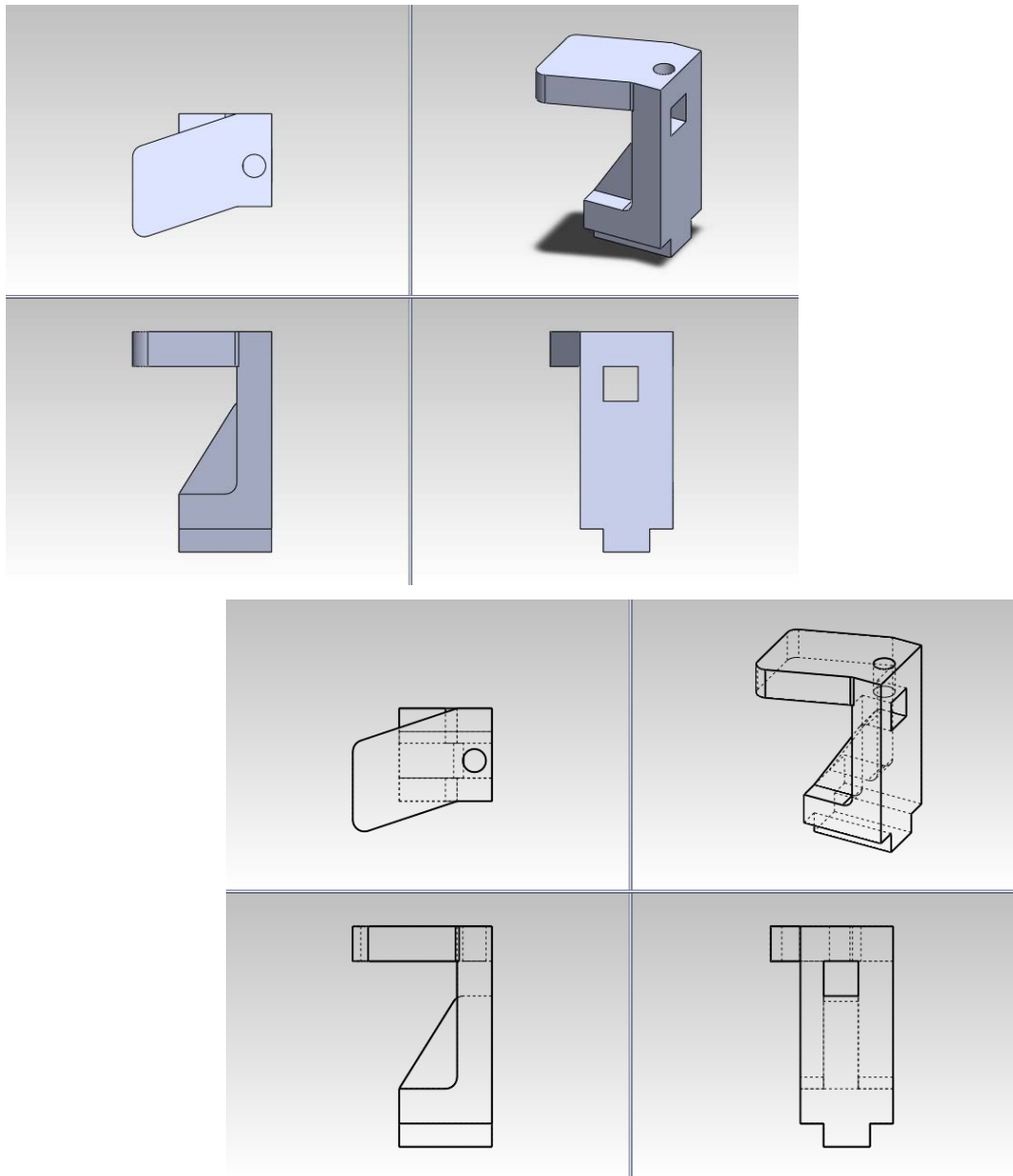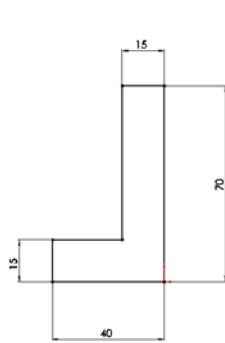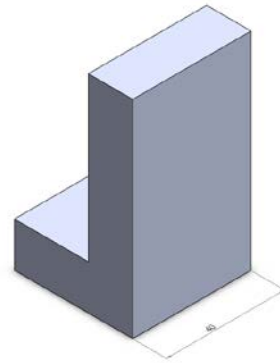
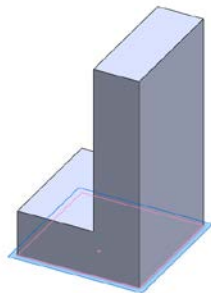Fig. 4 - 5 Study this supporting unit
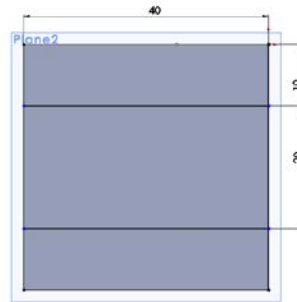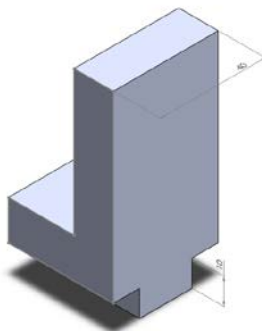
a) Draw this sketch in the Front Plane

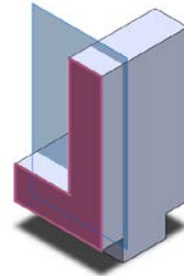b) Exrude the sketch to 40mm

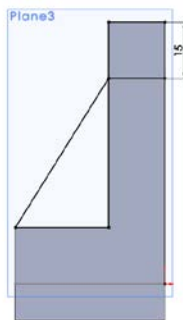c) Define a plane at the bottom of the component

d) Sketch2 at the bottom plane

e) Extrude the sketched region to 10mm

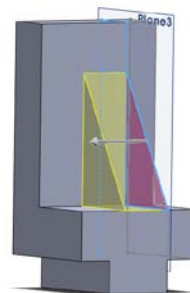f) Define a new plane parallel to the Front plane at a distance of 10mm from the front face

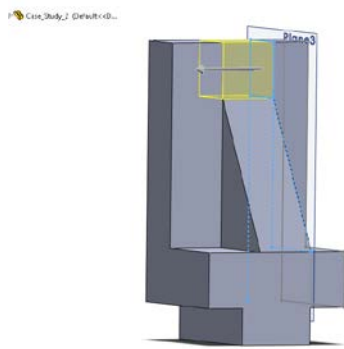g) Draw Sketch3 in the newly defined plane
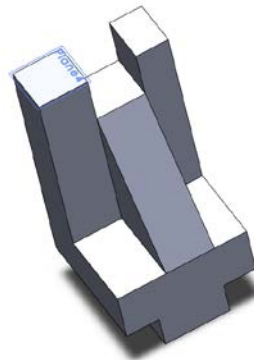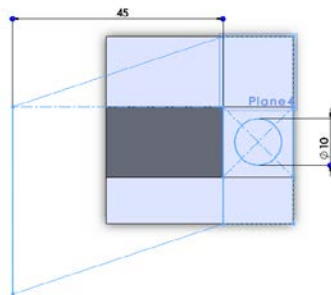
Extrude the rib

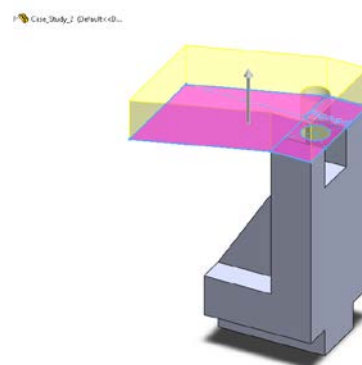Fig. 4 - 6 Developing the CAD model of the unit – part 1

a)   Cut-Extrude the opening

b)   Define a new plane at the top of the unit
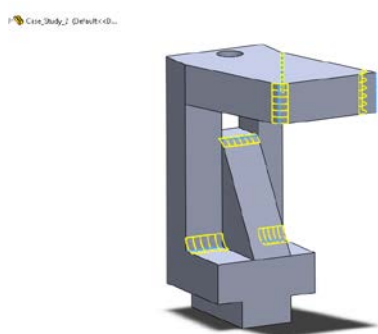

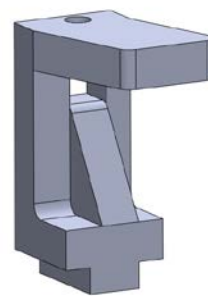c) Sketch4 at the top plane – Plane4

d) Extrude Sketch4 according to the drawing.
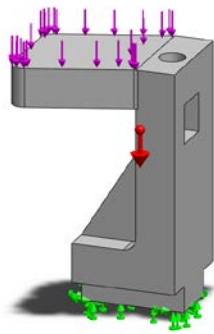
Depth of the extrusion is 15mm
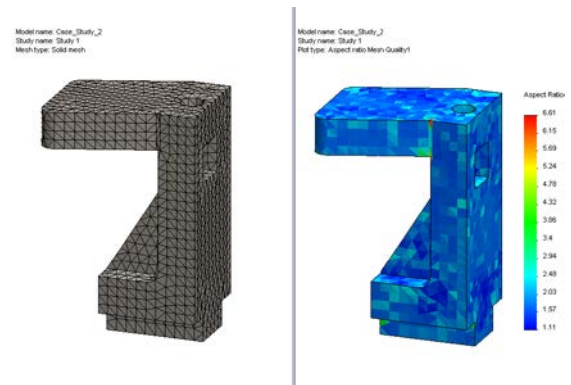

e) Fillet selected edges with a radius of 5mm

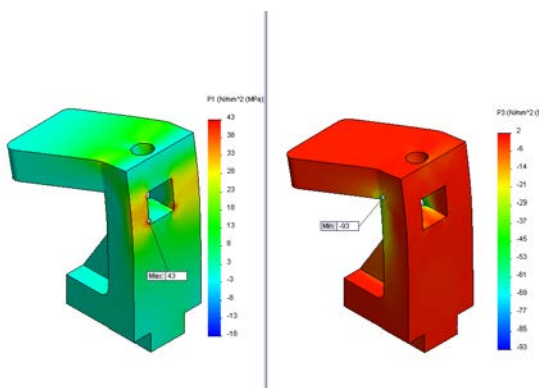f) 3D view of the designed init

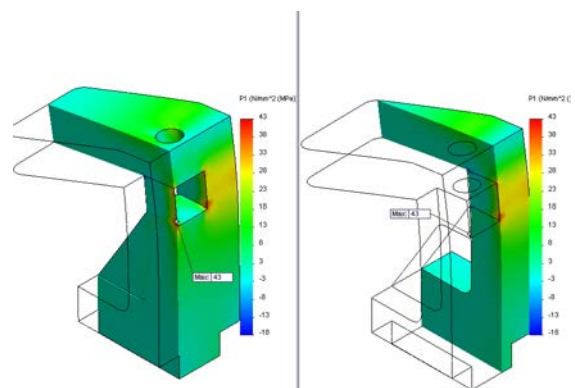Fig. 4 - 7 Developing the CAD model of the unit – part 2

a)   The model of the unit with all applied restraints

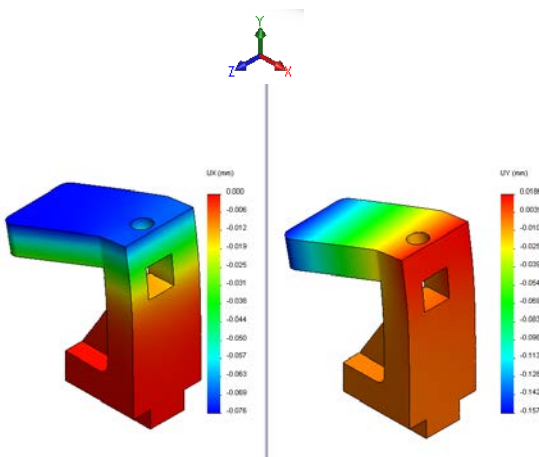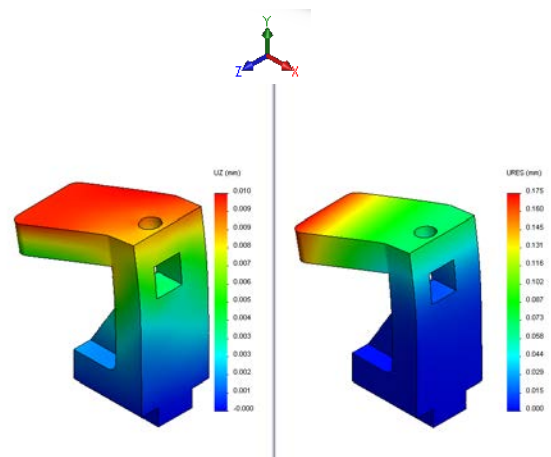b)   The mesh and the aspect ratio plots

c)   P1 and P3 plots

d)   Cut sections through the most vulnerable tesiled areas

e)   Horizontal displacements' plots

f)   Vertical and total displacements' plots

Fig. 4 - 8 CAE model and analysis results

Table of Figures of Chapter 4