

## STRESS AND DEFORMATION OF THE FILTER PRESS

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**Abstract:** *The paper presents the stress and deformation analyses of the new design of the filter press made by Envites spol. s r. o. The analyses are solved in system ANSYS and there are nonlinear - due to the modelling by the contact elements and due to the material nonlinearities.*

**Keywords:** Filter press, Envites, Finite element method, Large deformation.

### 1. Introduction

Sludge created during the treatment of surface and communal water as well as the suspensions from metallurgy, chemistry, mining, kaolin washing facilities, papermaking, textile industry, food processing, and pharmacy are characteristic with their content of very fine particles. The costs for static processing / disposal – by mere settling are disproportionally high due to the large volumes and weight, therefore weight and volume reduction via machine sludge dewatering is approached. The dewatering of sludge using filter presses, apparently according to the processing of sludge sometimes called sludge presses, guarantees unrivalled high concentration of dry matter of the filtration cake with low costs. The different variants of the filter press (made by ENVITES® spol. s r. o.) are shown in Fig. 1. The principle of filtering in filter presses consists in the flow of the suspension through the filtering fabric, so-called filter-press cloth. Solid particles are caught, the liquid, so-called filtrate, is let through. The settled particles create a filtration cake on the cloth that grows with further influent quantity under higher and higher pressure, the back pressure against the suspension's flow increases. As soon as a compact cake with the required dry matter concentration is created in the filtering board chambers, the filter press is opened and emptied. The aforementioned suggests that the filter presses work in cycles. They consist of several characteristic phases that, however, are not the subject of this description.



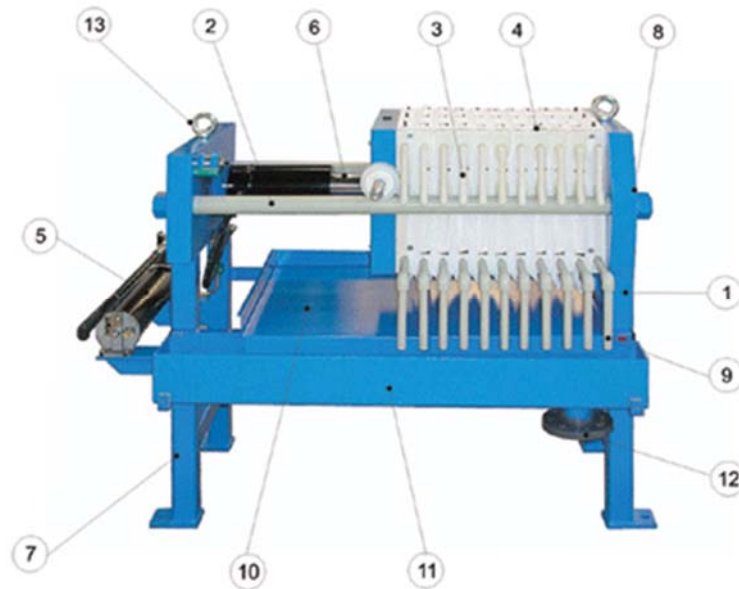
*Fig. 1: Different variants of the filter press.*

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The operation of the filter press can be secured by one to two workers and consists in the initiation of the running, supervision over the emptying of the filter press, and maintenance of cleanliness at the filtering station. However, the entire cycle can be fully automated up to completely unattended 24-hour operation.



*Fig. 2: Basic parts of the filter press: 1. Filter press frame; 2. Frame beam; 3. Filtration plate; 4. Filtration cloth; 5. Hydraulic pump; 6. Hydraulic cylinder; 7. Filter press support; 8. Inlet of suspension for dewatering; 9. Filtrate outlet; 10. Drip trays; 11. Trough collecting filtrate; 12. Flange for filtrate outlet; 13. Fixtures for handling (www.envites.cz).*

Filter presses consist of a steel frame, a set of filtering plates coated with the filtering cloths, and the hydraulic system (Fig. 2). Depending on the required automation, the filter press can be complemented with further additional equipment. Using of materials resistant to both organic and inorganic chemical load is surely. The press size is characterised by the number of filtering plates and the length of their edge that determines the press format. ENVITES® spol. s r. o. produces and supplies filter presses with board formats from 250 x 250 mm to 1500 x 2000 mm. ENVITES® spol. s r. o. produces filter presses of the SIDE BAR type with a round and/or flat bars. The first type is used for smaller filter presses – up to the filtering plate size of 800 x 800 mm, the flat side bar is used in filter presses up to the size of 1500 x 2000 mm. This design appears to be disadvantageous with the requirement for filter presses with filtering plates made of materials with high specific weight, e.g. PVDF, and/or high filtering area, i.e. filter presses with a very long pack of plates.

In order to remove the deflection of the side bar from an empty set of plates – it may be even over 25 mm in case of long filter presses, it is burnt. That is why, a change in the actual design of the profile and its seating has been designed. However, the aforementioned bears the requirement for a change of the heads forming the frame of the filter press.

Currently, the heads are burnt from thick-wall sheet metal – sheet metal thickness up to 150 mm, then welded, heat processed and machined. The goal of the new shapes of the feeding and hydraulic heads with the utilisation of thin-wall sheet metal with better price affordability and time availability - is a stable, rigid stable frame with a lower weight, see Fig. 3.

## 2. Input parameters

Modelled filter press (Fig. 3) consists of the 11 main parts and the main dimensions are the followings:

- filtering plate size is 1200 x 1200 mm,
- length of the frame beam is 13000 mm,
- filter press height is 1500 mm,
- maximal dimension of the filtration plates is 10000 mm,
- diameter of the piston is 220 mm.

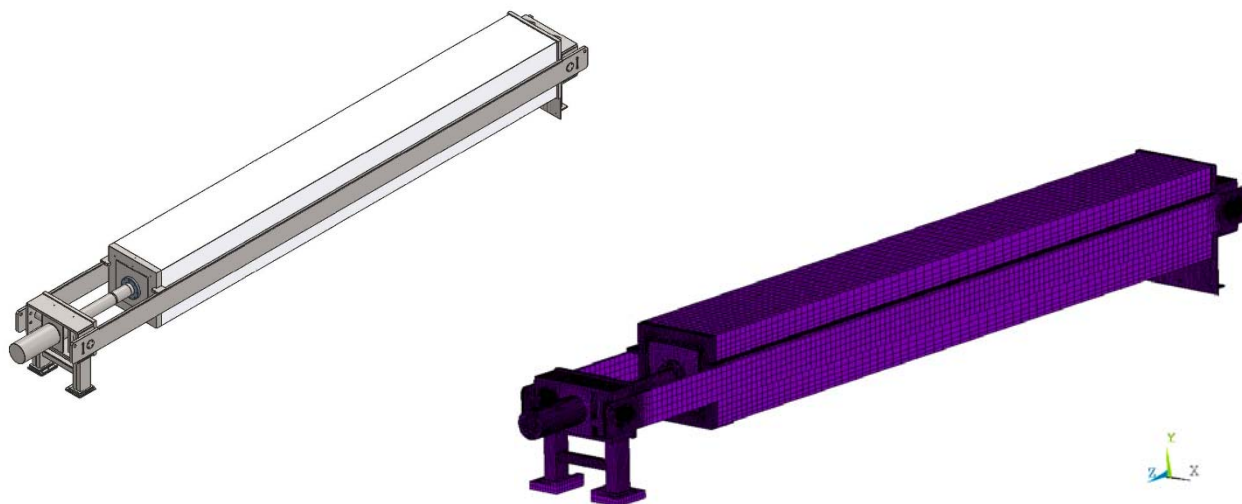


Fig. 3: Model and mesh of the new type of the filter press designed by ENVITES® spol. s r. o.

The solution of the deformation and stress in the filter press is used in system ANSYS CLASSIC (ANSYS, 2018). Filter press is modelled with two materials with the following properties: steel parts  $E = 206 \text{ GPa}$ ,  $\mu = 0.3$  and density  $\rho = 7850 \text{ kg.m}^{-3}$ , filtration plates made of plastic with  $E = 1.25 \text{ GPa}$ ,  $\mu = 0.38$  and density  $\rho = 1066 \text{ kg.m}^{-3}$ . The friction ratio is  $f = 0.15$  (94 contact pairs – contact type “bonded” is used for pins and spigots, the last contacts are realized with contact type “standard”). The steel material is modelled as bilinear with  $Re = 295 \text{ MPa}$  – see Fig. 4. The filter press is loaded with a pressure of  $39 \text{ MPa}$  in the cylinder which cause pressing force  $F = 1.4835 \text{ MN}$ . The second assumed loading is the gravitation field.

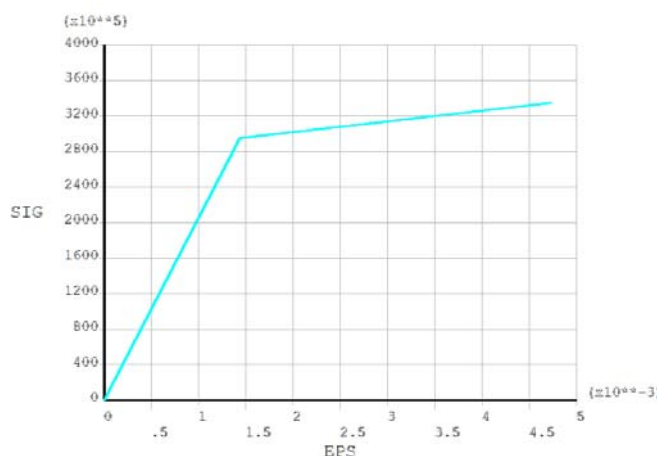


Fig. 4: Material model of the steel [Pa].

### 3. Results

The following figures show the results of the computational modelling for the second loading case. The main deformation of the press filter in the x direction (perpendicular to the piston axis) is the shape deviation of the sidewalls – see Fig. 5a. In the vertical direction is important the bending of the filtration plates and the sidewalls which cause the rotation of both consoles (filling and hydraulic) – see Fig. 5b. The pressing process of the filtration plates is shown in Fig. 5c with axial deformation. The maximal values of the compression of the filtration plates is  $14.4 \text{ mm}$  (only deformation of the filtration plates).

The whole press filter is in an elastic state, only a small area around the pins and spigots exceeds the yield point (see Fig. 6) and this area will be further optimized.

### Acknowledgement

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### References

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 ENVITES products: [https://www.envites.cz/en/products/filter\\_presses](https://www.envites.cz/en/products/filter_presses)

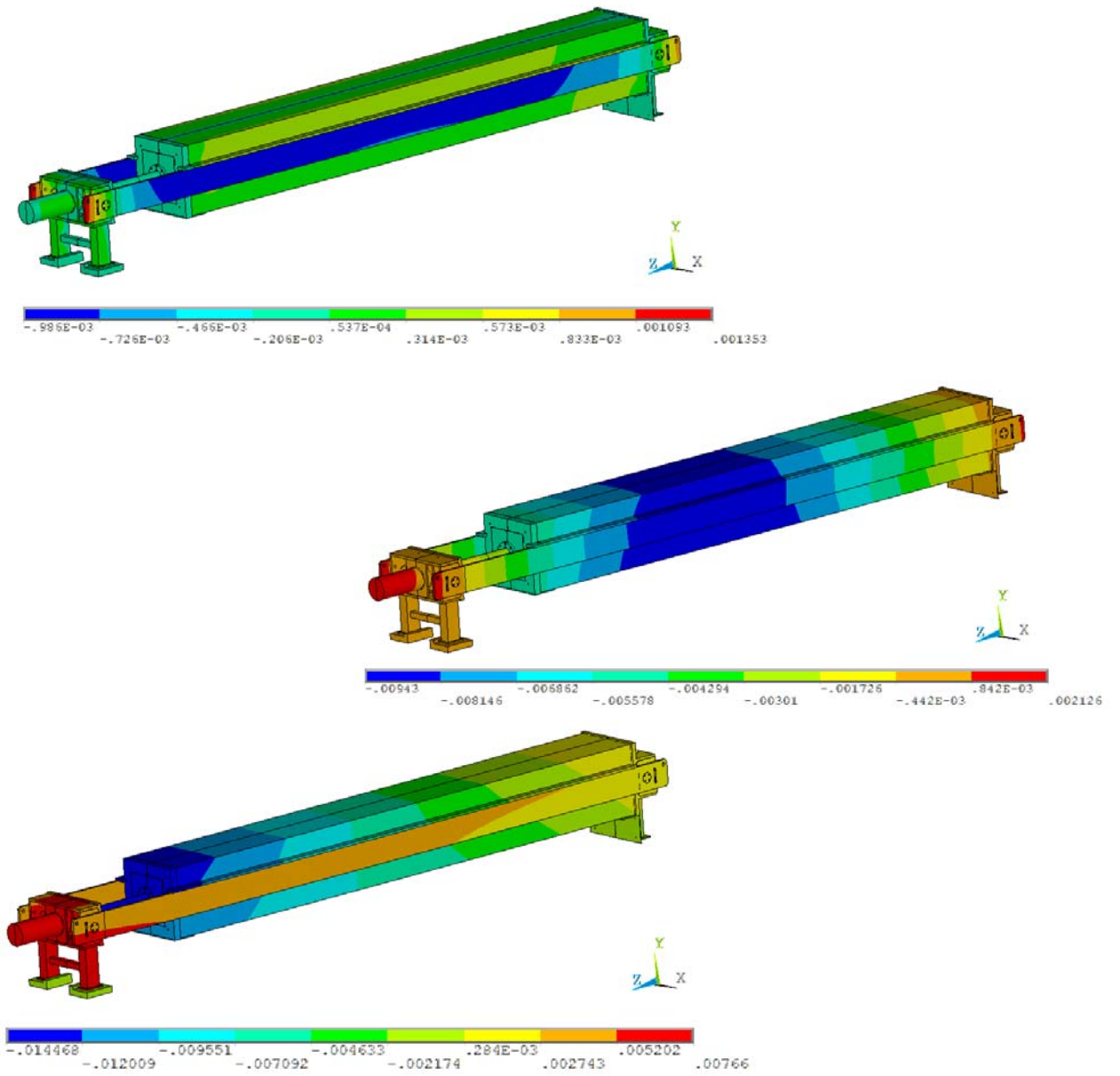


Fig. 5: Deformation of the filter press [m]: a) x-direction; b) y-direction and c) z-direction.

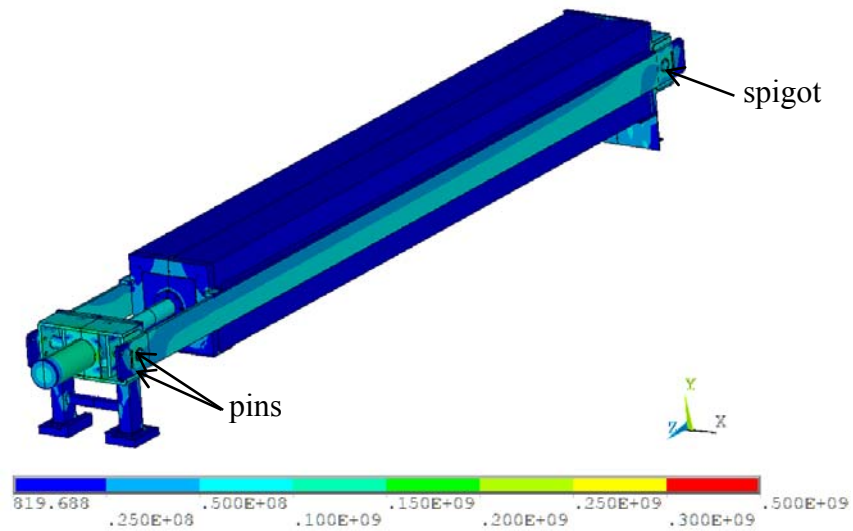


Fig. 6: Equivalent stress [Pa].