

Design of strength characteristics on the example of a mining support

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Abstract. It is a special group of particular design approaches that could be characterized as “design for X”. All areas of specific design methodology, taking into account the requirements of the life cycle are described with the acronym DfX. It means an integrated computing platform approach to design binding together both the area of design knowledge and area of computer systems. In this perspective, computer systems are responsible for the link between design requirements with the subject of the project and to filter the information being circulated throughout the operation of the project. The DfX methodologies together form an approach integrating to different functional areas of industrial organization. Among the internal elements it can distinguish the structure of the project team, the people making it, the same process design, control system design and implementation of the action tools to assist this process. Among the elements that are obtained in the framework of this approach should be distinguished: higher operating efficiency, professionalism, the ability to create innovation, incremental progress of the project and the appropriate focus of the project team. It has been done attempts to integrate identified specific areas for action in the field of design methodology. They have already taken place earlier in the design due to the Economic Design for Manufacture. This approach was characteristic for European industry. In this case, an approach was developed in methodology, which can be defined as the Design to/for Cost. The article presents the idea of an integrated design approach related with the DfX approach. The results are described on the base of a virtual 3D model of a mining support. This model was elaborated in the advanced engineering platform like Siemens PLM NX.

1. Introduction

Finite element analysis (FEA) is one of the most powerful engineering tools utilized in the area of mechanical solutions testing and optimization. The FEA approach includes some specific stages like: mesh generation, determining the load and fixing points, conducting calculation and results presentation [1-4]. It is a very good tool to conduct analysis of very complicated technical systems and for different and changing loads. This tool is particularly useful when it is applied in new, modern design methodologies. Recent years have brought the development of different DfX design methodologies that develop their specific approaches. They are connected with various aspects of the life cycle of technical means. The most important from this perspective should be included: Design for



Manufacture and Assembly, Design for Competition, Design for Dimensional Control, Design for Inspectability, Design for Storage and Distribution, Design for Reliability, Design for Compatibility, Design for Service [5-10]. Design for Recycling, Design for Quality, Design for Modularity, Design for Optimal Environmental Impact etc. In all these domains FEA could be profitably applied [11]. In the paper is presented application of FEA for the analysis of influence of different roof loads on stress distribution in a construction of a mining support.

2. Roof support as a part of a longwall system

In the paper is presented the cycle of analysis of stress distribution for the four-props support in the lowest position, in which the influence of roof load are the least favorable (figure 1).

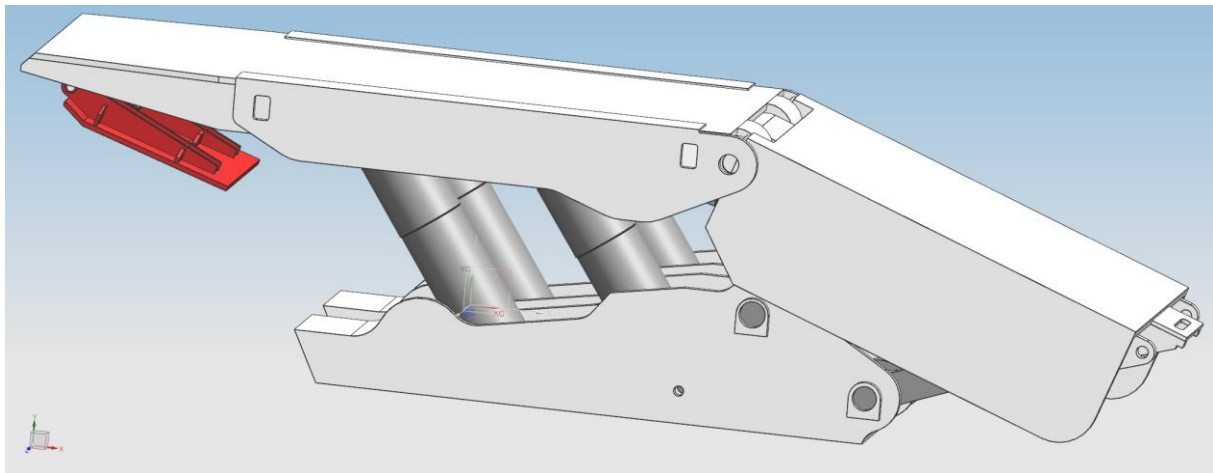


Figure 1. Virtual model of a four-props support.

The least favorable system of elements is related with the inclination of hydraulic props in the relation to the direction of roof mass load which is vertical. In the highest position, when the props are extracted, their inclination is closer to the vertical direction.

3. Comparison analysis

The conduct the comparison analysis it was assumed that the direction of the load of roof mass is strictly horizontal. It happens when the stratification of seams is strictly vertical and there is no other factors influencing it. In figure 2 is presented the system of loads and fixings of the model.

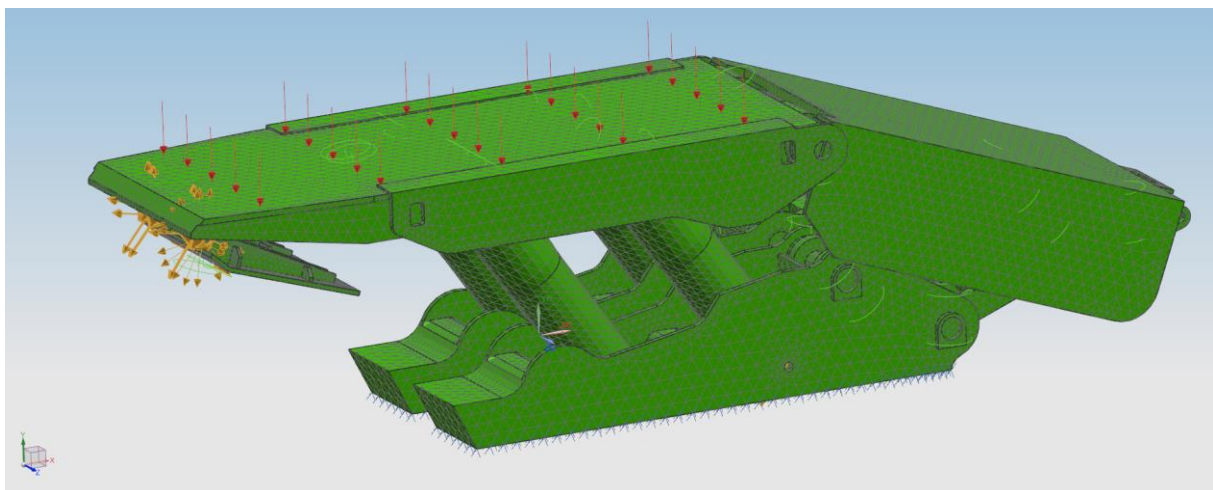


Figure 2. Visualization of the load for the vertical direction.

For such a system of loads and fixings it has been conducted the strength analysis to obtain the pattern system of stresses and displacements. In figure 3 is presented the system of displacement for the entire model of the support.

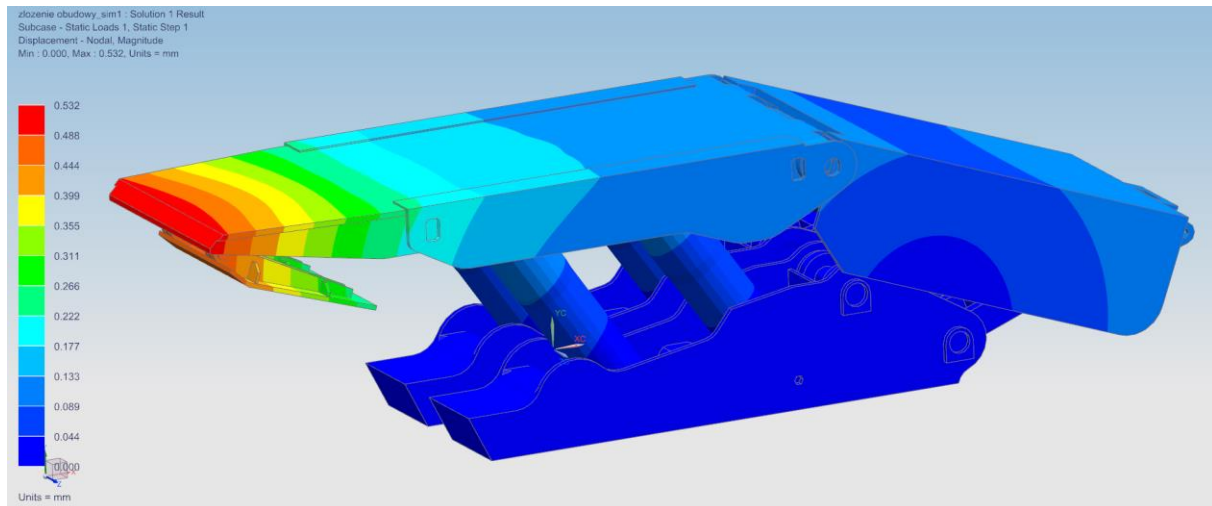


Figure 3. System of displacements for the vertical direction of load.

According to the conducted analysis it was stated that the most loaded elements of the support are lemniscate joints. In figure 4 is presented the stress distribution for this elements.

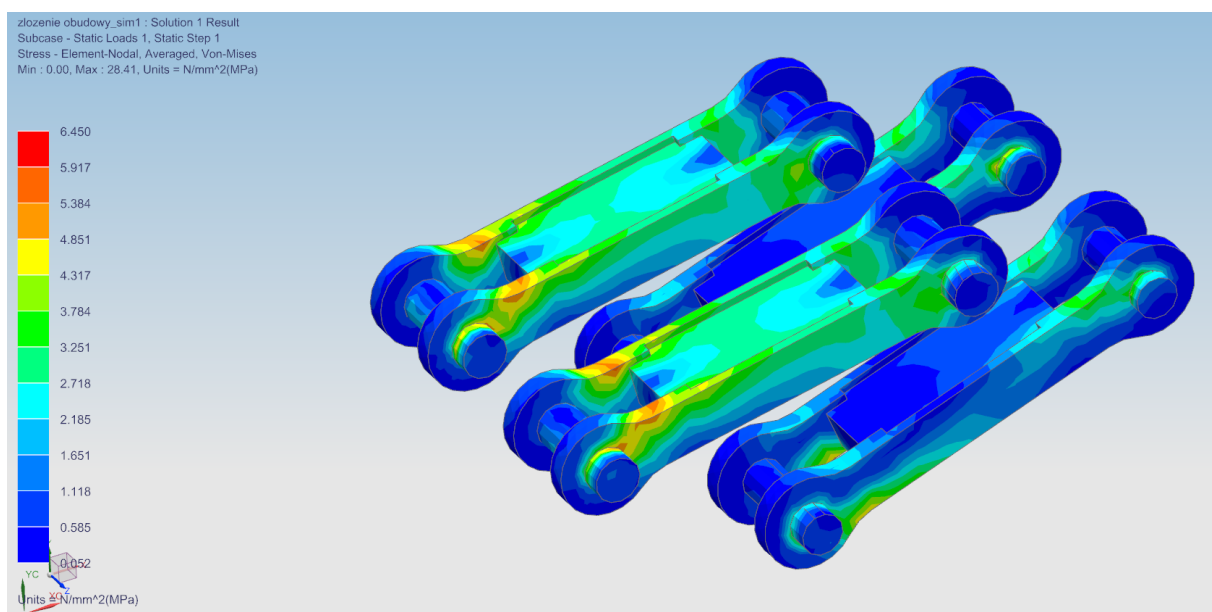


Figure 4. Visualization stresses in Lemniscate joints for the vertical direction of load.

The obtained results of stress distribution have been used to compare them with the results for other forms of loads, what is presented in the next chapter.

4. Analysis of influence of loads with other directions

It was assumed that for analysis should be considered loads actin at the angle of 45° from two different directions. The first load acts in accordance with the main axis of the support in the direction of its front (-45°) what is presented in figure 5. This type of load is less favorable then the load in the

direction of the back of the support because in the first case the direction of the load action and the direction of the propos action are less compatible. The results of the analysis, especially the stress composition for the lemniscate joints are presented in figure 6.

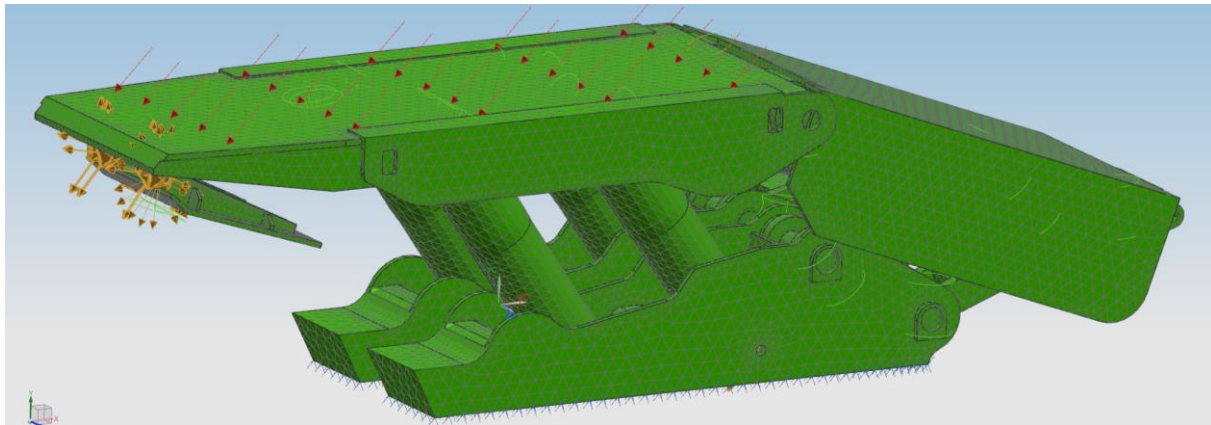


Figure 5. Visualization of the load for the angle of -45° .

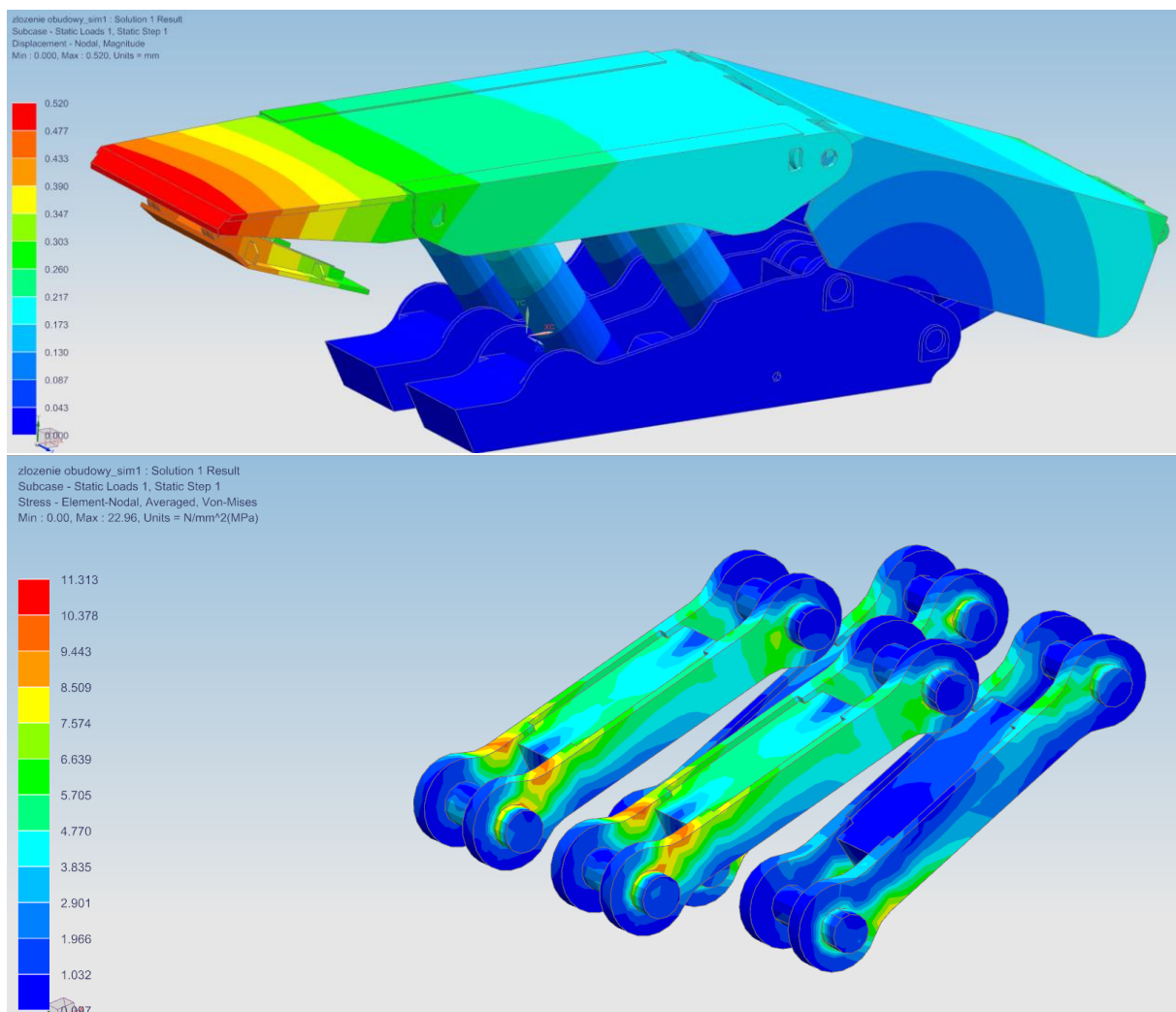


Figure 6. Visualization of displacements and stresses for the load for the angle of -45° .

The second case was analyzed for the direction of load acting perpendicular to the main axis of the support at the inclination of 45° . This angle of load action was determined as left 45° . In figure 7 is presented the load of the support model and in figure 8 are presented the obtained results.

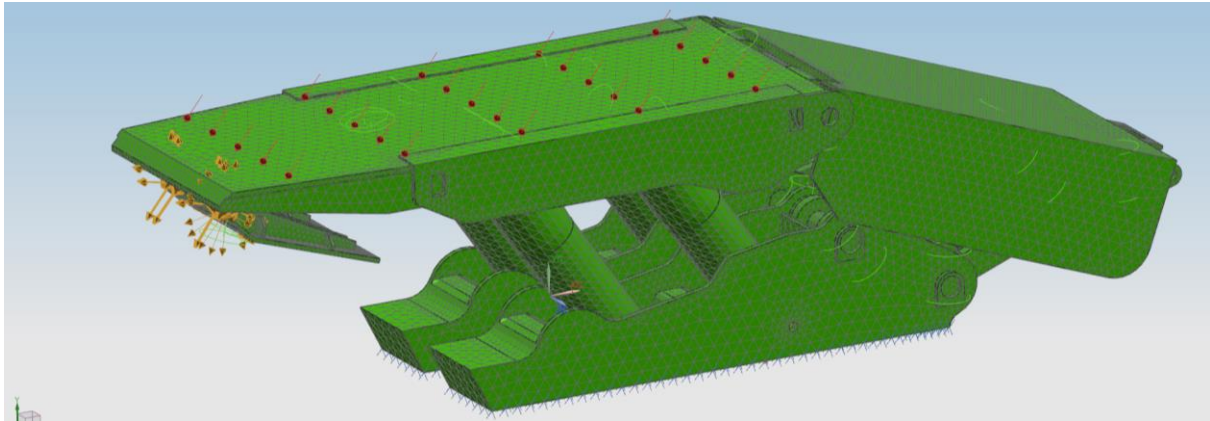


Figure 7. Visualization of the load for the angle of left_45°.

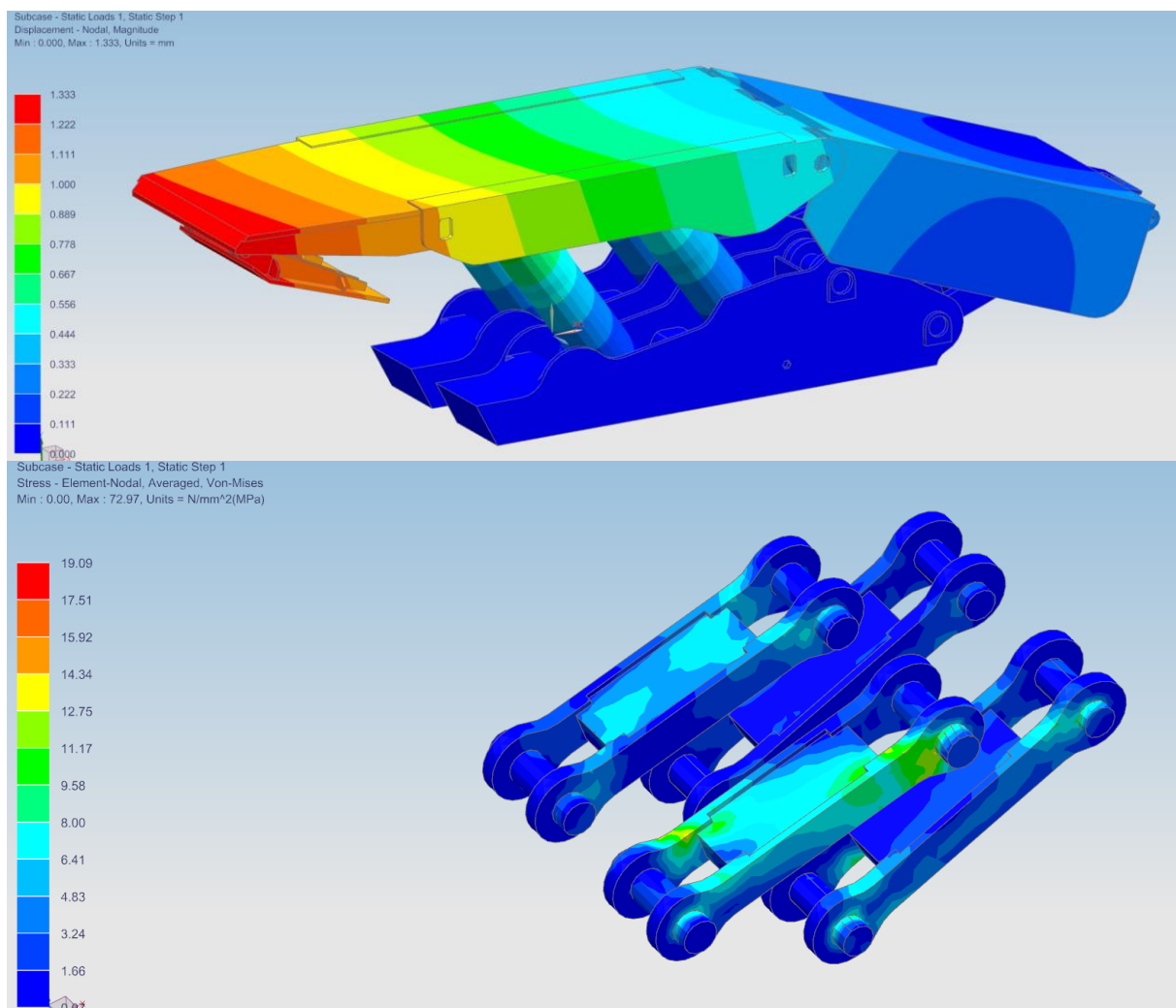


Figure 8. Visualization of displacements and stresses for the load for the angle of left_45°.

5. Conclusions

The conducted virtual tests allow determining the pattern of displacements and stresses for the analyzed four-propos roof support. Comparing them with the results obtained for the vertical load allows concluding some constructional observation. Firstly it could be observed that the highest values of stresses are found in the upper lemniscate joints. For the -45o angle of roof mass load direction stresses, found in the lemniscate joints, are two times higher than for the vertical direction of load action. The severe is also the load acting at the direction perpendicular to the main axis of the support. In this case the highest value of stresses could be found for the one upper lemniscate joint, located at the side from which the load acts. In this case the stresses are 1.5 time higher than for the vertical direction of load action. Generally it could be stated that results show that the new design actions are needed to improve the operation of the lemniscate mechanism.

The next should be realized investigations according application new solutions [12-13] and materials for such structural elements like analyzed lemniscate joints. The work should be focused on the utilization of such materials [14,15] that guarantee higher resistance to strata actions.

6. References

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