TOPOLOGY OPTIMISATION OF AN EXTERNAL CIRCULAR FIXATOR.

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Introduction

External fixation device systems are widely used to treat unstable fractures, limb lengthening, and the correction of pathological orthopaedical deformities, among other things. [1, 2].

This study aimed to perform biomechanical topography optimisation of a continuous dynamic compression system on the fracture surfaces to satisfy the demand by reducing materials and cost.

Methodology

The Ilizarov external frame, model was developed by Dassault Systems. The femur bone was attached via a four-pin connector to a cylinder in the design frame. The lower and upper part of the femur have been separated by 20m to mimic a real-life bone behaviour. In this study, the external cage, bone were 3 mm in mesh size and the pin 1mm . The experimental research has been conducted using Instron 5966 Series Dual Column Table Frames with 770N as the maximum load applied

Results

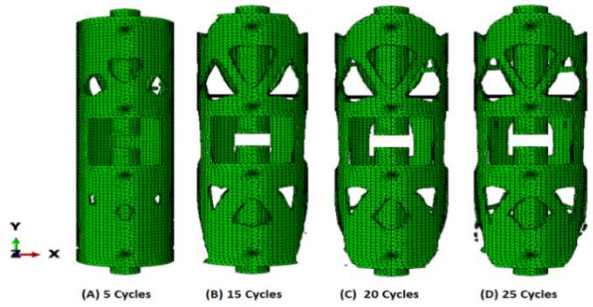

Figure 1:Topography optimisation Cycles

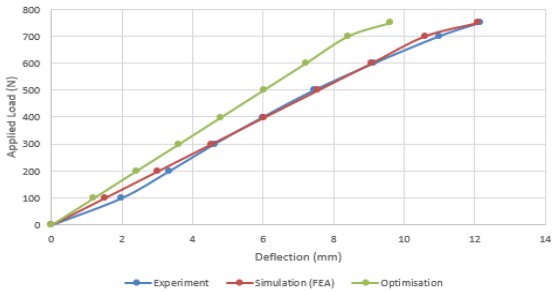

Figure 2:Comparison of von mises stress obtained before and after the optimisation process.

Figure 1 shows the topology optimisation cycles results from the finite element analysis using tosca structure.The results shows that materials has been removed . Figure 2 shows the comparison of results from the von ises stress versus displacement for experimental analysis , and the finite element analysis before and after optimisation.

Discussion

During the Optimisation phase, the job task was configured to run for 25 cycles to obtain the high quality of the design shape after optimisation by reducing the weight by 40%. The results obtained from figure 1 and 2 shows that the cost of external fixator will be lower compare to the previous design due to less materials used.

References

1. Dichio, G., et al., Engineering and manufacturing of a dynamizable fracture fixation device system. Applied Sciences, 2020. 10(19): p. 6844.
2. Mitousoudis, A., E. Magnissalis, and S. Kourkoulis. A biomechanical analysis of the Ilizarov external fixator. in EPJ web of conferences. 2010. EDP Sciences.

Acknowledgements

The research was funded by the Tshwane University of Technology and the University of South Africa (Unisa).
The experiments were conducted in biomechanics laboratory facilities at Unisa's Science Campus in Johannesburg, Florida , South Africa.