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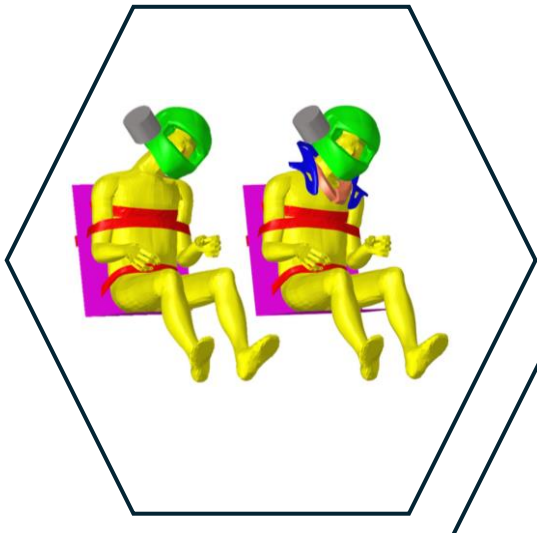

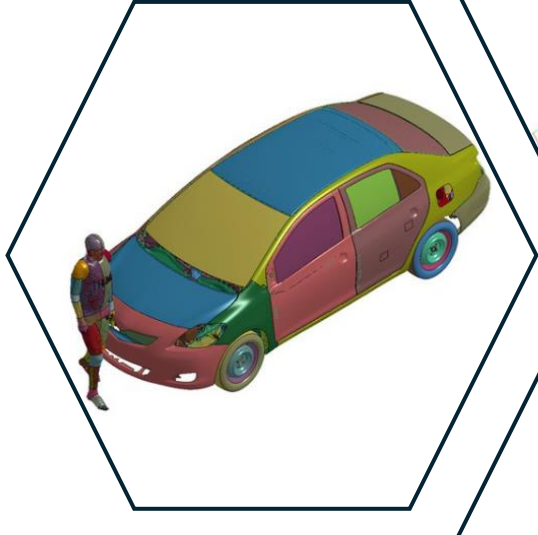

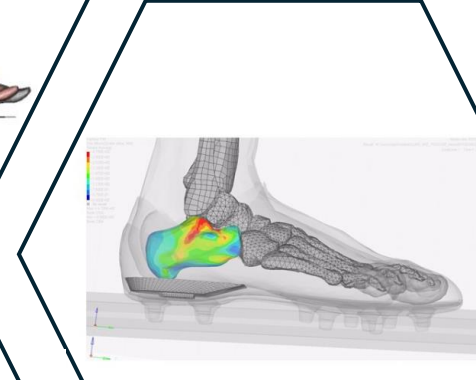

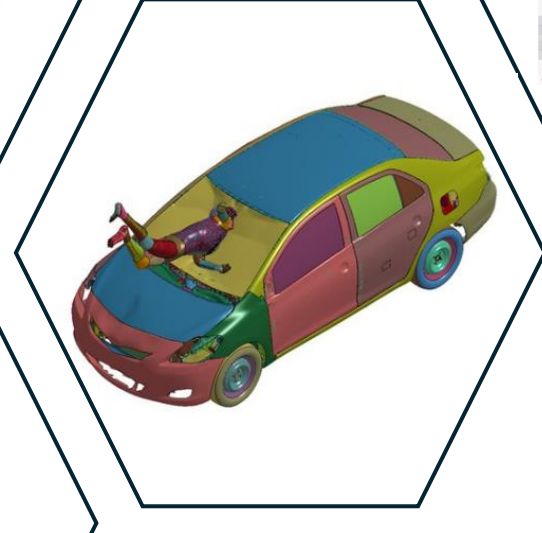

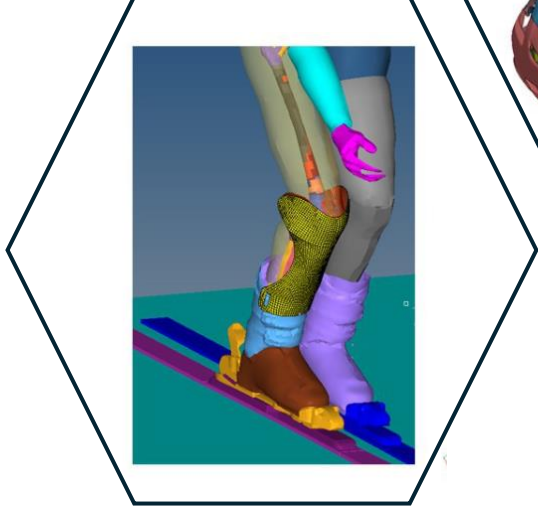

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Fracture toughness of an industrially supplied cancellous bone simulant

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Introduction

The human cancellous bone has a hierarchical structure that gives it its unique mechanical properties. The study of the mechanical integrity of bone is crucial in diagnosing and treating condition of bone loss such as osteoporosis. Fracture toughness of human cancellous bone is an important parameter when predicting bone strength, Over the last decade researchers (Cook, 2009) have applied the fracture mechanics calculations on human bone. This study provides us with fracture toughness and compressive strength of commercially available SAWBONES cancellous bone simulants. These blocks have wide range of applications in orthopaedic industry such as bone disease research and bone surgery practice. Thus, understanding their mechanical properties may enable us in development of better bone simulants.

Methods

A total of 14 Sawbones cancellous bone blocks having open cell, cellular and solid structures were acquired for this study. The densities of the blocks ranged from 0.07-0.81g/cc. The micro-CT scans were conducted using X-tech HMK160. Morphometric analysis was carried out suing VG Studio Max 2.1 software. Using ASTM standard E399-90 the blocks were cut into disk shaped compact specimen DC(T). FT and compression tests were carried out using mechanical tester Easy Test EZ-50.

Results & Discussion

The morphometric analysis of the samples showed that the BV/TV was the strongest predictor of strength which proves that with increase in bone quantity the mechanical strength increases. TbS showed an inverse relationship with bone strength. The fracture toughness results showed a significant increase with an increase in the bone density. The compressive strength of the samples also showed a positive relationship with bone density. Overall, in comparison to human cancellous bone the compressive strength of the Sawbones bone simulants was found to be lower.

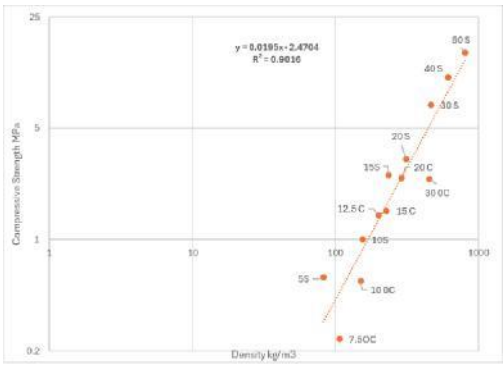

Figure 1 Compressive strength of Sawbones simulants in relation to apparent density

Conclusions

This study provides valuable insights into the fracture toughness and compressive strength of commercially available cancellous bone simulants, specifically Sawbones. By investigating their microarchitecture and correlating morphometric parameters with mechanical properties, it was found that material strength is closely tied to factors such as bone volume fraction (BV/TV) and apparent density, while trabecular separation (TbSp) is associated with weaker properties. These differences, driven largely by variations in microarchitecture and manufacturing techniques, highlight the importance of further refining bone simulants. This research has the potential to guide the development of advanced bone mimetics, which could play a crucial role in orthopaedic training and research, particularly given the challenges of sourcing large samples of biological bone. Ultimately, this work could contribute to enhancing the realism and applicability of bone simulants in both clinical and research settings.

References

Cook, R.B. and Zioupos, P., 2009. The fracture toughness of cancellous bone. Journal of biomechanics, 42(13), pp.2054-2060.

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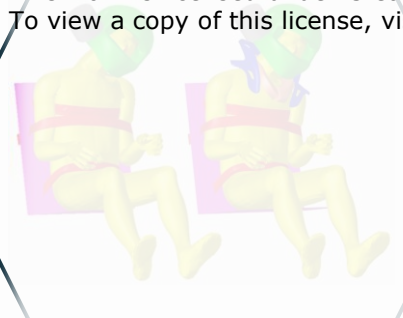

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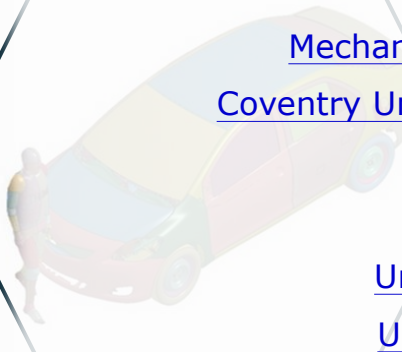

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