



IMPACT ANALYSIS OF SKULL WITH AND WITHOUT HELMET

Analysis of the role that a helmet plays during a bicycle crash with finite element models.

Challenge

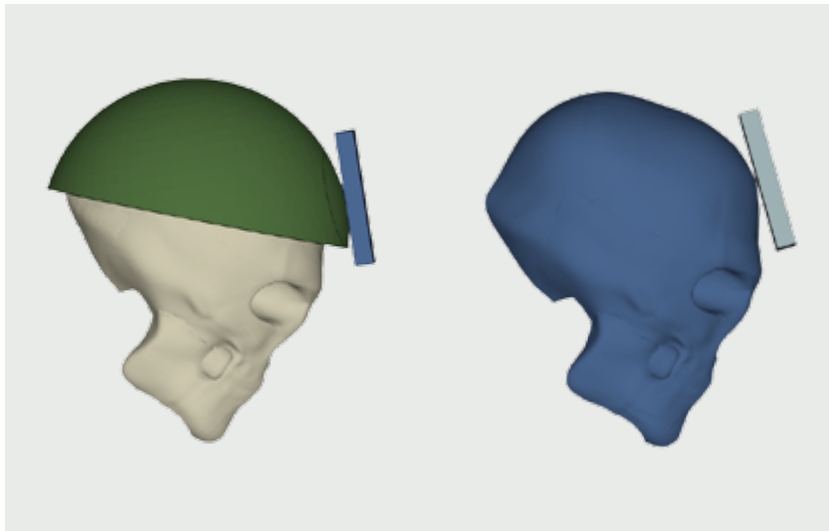
The objective of a helmet is to protect the rider from a head injury during an impact event. **In this project, the impact of a human skull with and without a helmet was simulated with a nonlinear dynamic analysis.**

Outcome

Analysis of the **von Mises stress, nonlinear strain, and acceleration** in the skull at the maximum impact point, which shows the importance of wearing a helmet in the case of a bicycle crash.

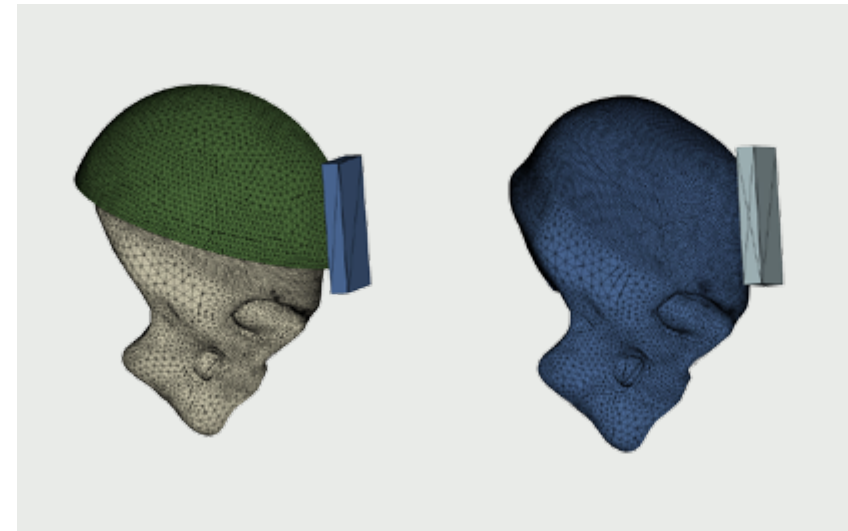


GEOMETRIES



The **3D geometry** of the skull was edited and cleaned before being uploaded to the SimScale platform. Due to symmetry, only one half of the skull was considered for the analysis.

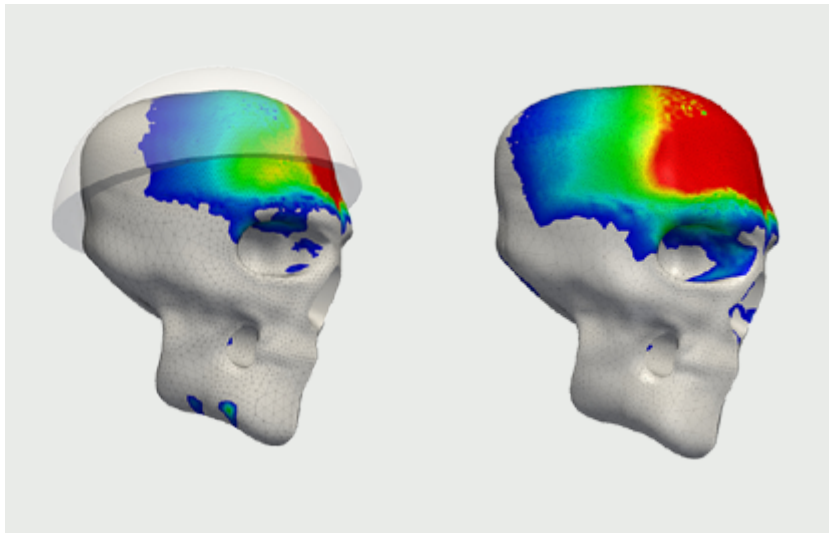
MESHES



Both geometries were **meshed on SimScale** using the **tet-dominant meshing algorithm**. Mesh refinements were added to the wall and inner and outer surfaces of the skull.



SIMULATION



A **nonlinear dynamic analysis** was performed to simulate the skull impact during a crash event.

SKULL INITIAL VELOCITY
6.944 m/s
(25 km/h)

WALL*
was considered to be rigid

SKULL & HELMET
symmetry boundary condition

HELMET STRAP
bonded to the helmet outer shell and skull**

WALL/SKULL/HELMET
augmented Lagrange contacts

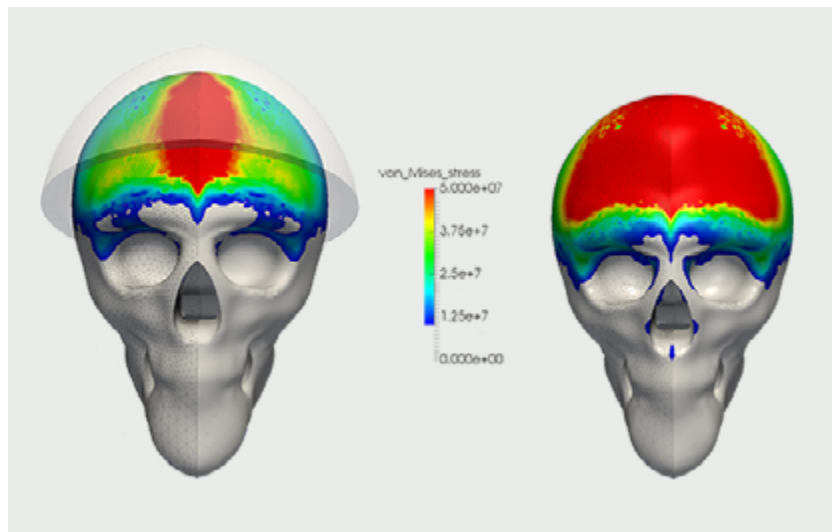
SIMULATION
long time span

*i.e. the object that the skull/helmet comes into contact with

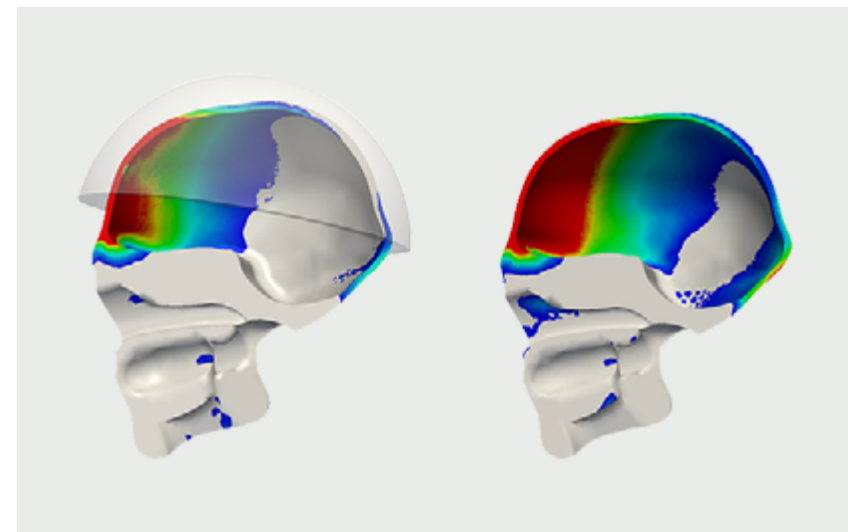
**using remote force boundary condition



RESULTS



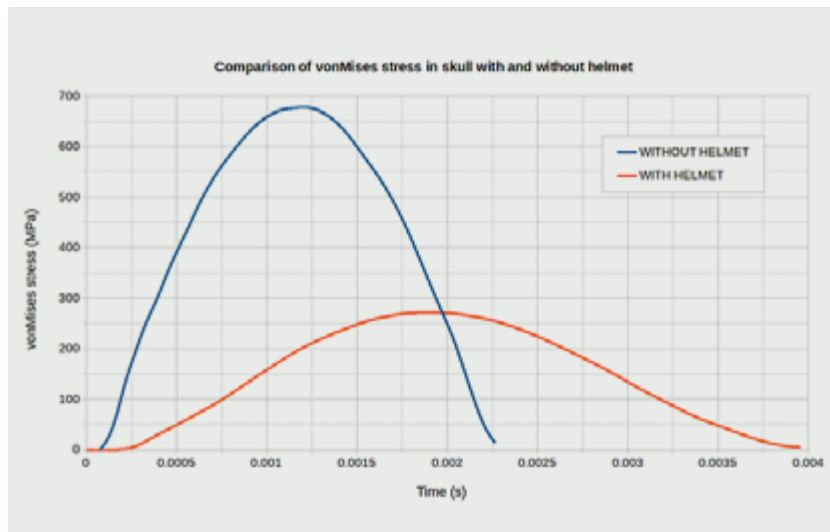
The figures show the **von Mises stress** in the skull at the highest impact point for both cases. It can be seen that there are higher stresses in the skull without the helmet.



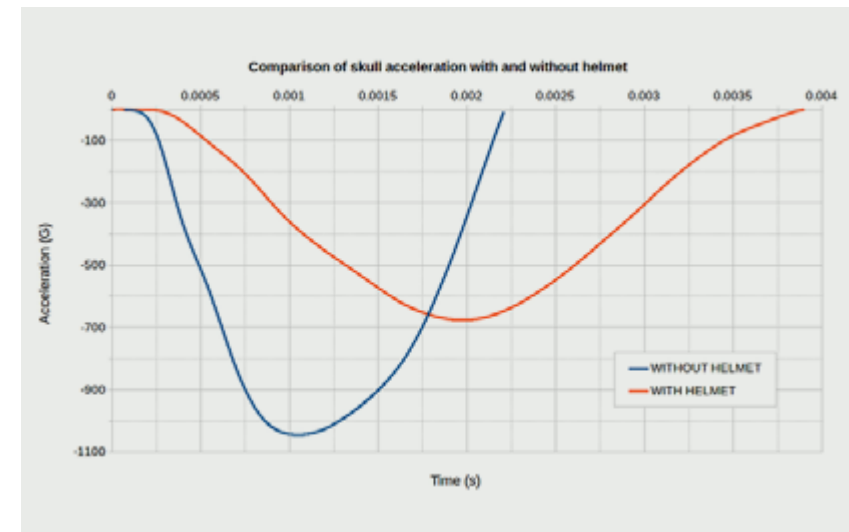
Comparing the **von Mises stress (MPa)**, the stresses in the skull are much higher during an impact when a helmet is not worn. The skull section clearly shows that the damage to the brain would be more in case of no helmet.



RESULTS



Comparison of von Mises stress in skull with and without helmet.



The graph shows the **acceleration (G)** in the skull with and without the helmet. A decrease of nearly 35% of acceleration can be observed in the case where a helmet was used.

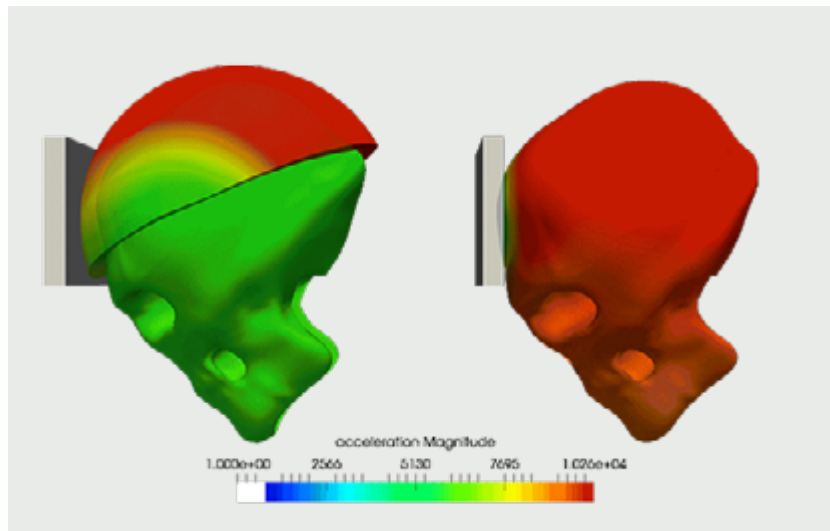


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CONCLUSION



Find this project and use it as a template [here](#).

Based on the finite element analysis,
**a decrease of nearly 35%
of acceleration and 60% of stress**
in the skull was achieved by
the introduction of the helmet,
which absorbs part of the impact.

“While riding a bicycle
it is essential to wear a helmet
to decrease the chances of severe head
injury in the case of a crash.”

The SimScale Team