
Mechanics of the Golf Swing

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Project Overview

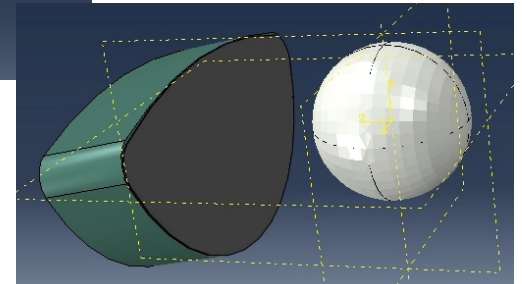
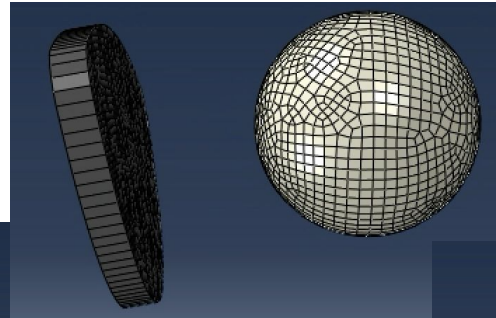
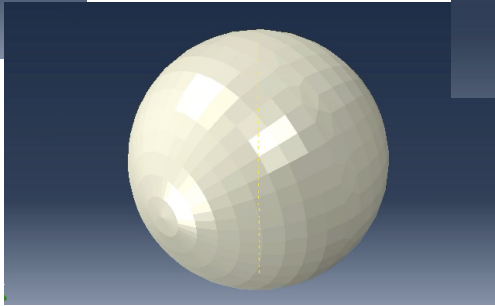
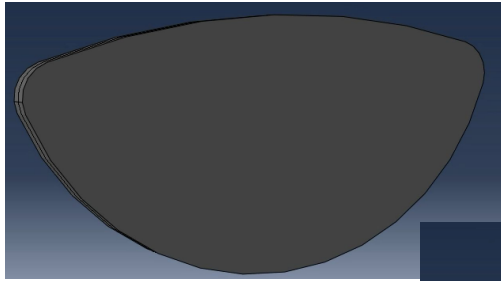
- The primary purpose of this project is to observe an idealized collision between a golf ball and a golf club.
- Three models were created for varying swing speeds to demonstrate differing golfer skill levels: high handicap, low handicap, and professional.
- The goal of this study was to understand the stress experienced by the golf ball during a golf swing as well as how great of an impact swing speed had on these results.

Objects Tested

- Golf Ball Cover (Surface)
 - Spherical Shell w/ Diameter of 1.68 in
 - Young's Modulus = 56.56 ksi Poisson's Ratios: .43 Density: .04088 lb/in³
- Golf Ball Core (Solid)
 - Solid Sphere w/ Diameter of 1.68in
 - Same values as cover but more dense
- Golf Club Face (Driver)
 - Titanium Shell face at 9 degree of loft
 - Young's Modulus = 6240 ksi Poisson's Ratios: .34 Density: .163 lb/in³

The Abaqus Models

- Below are the Abaqus Parts and Assemblies
 - From Left to Right: Driver Face, Golf Ball(core & surface), face & ball, entire golf club & ball

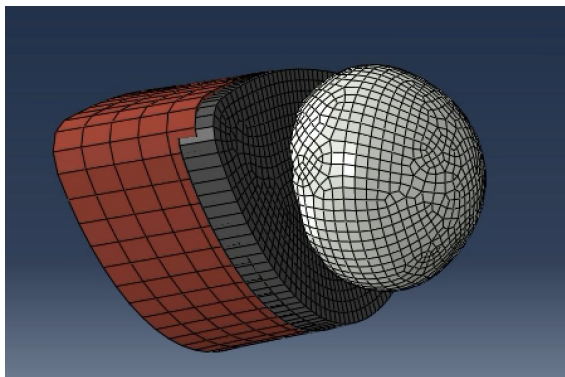


Assumptions and Conditions

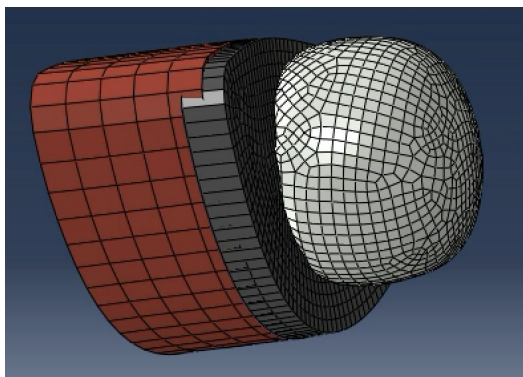
- The simulations are simplified version of a true golf swing with far fewer factors than actually exist.
- Many of the material properties were assumed from idealized testing.
- The body of the golf club's head was incorrect shape but made to be the same weight as the correct shape to ensure collision was as close to realistic.
- No boundary conditions were applied but tie constraints were used between the golf club's body and face as well as the golf ball's surface and core.
- The ball speeds were simulated by imputing initial velocities in predefined fields.

Results pt1

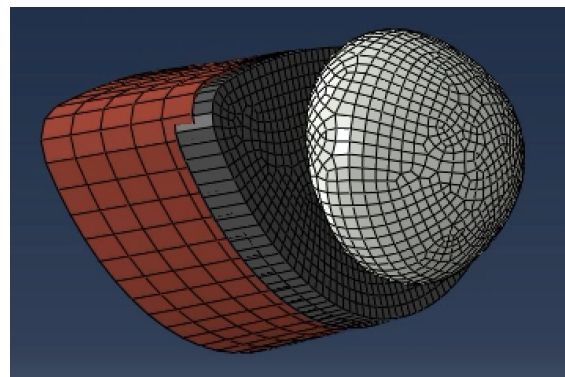
- Below are the deformation of each of the three swing speeds
 - The deformation are at the frame with the greatest compression of the ball prior to movement of the ball



Club Head Speed
of 80 mph



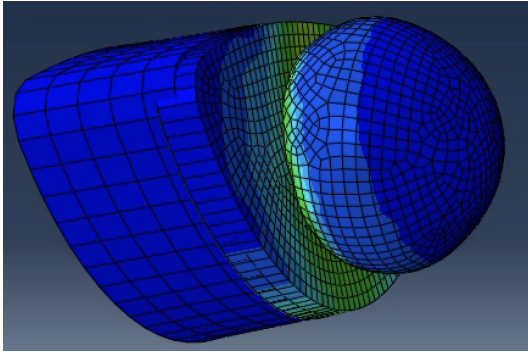
Club Head Speed
of 100 mph



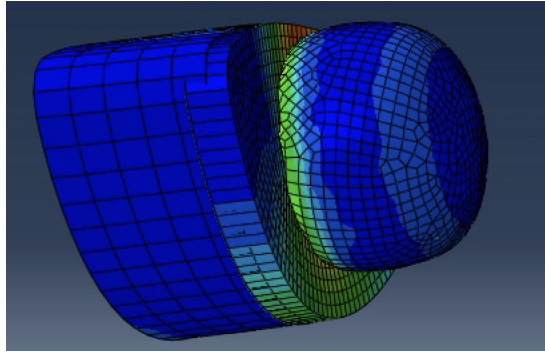
Club Head Speed
of 120 mph

Results pt2

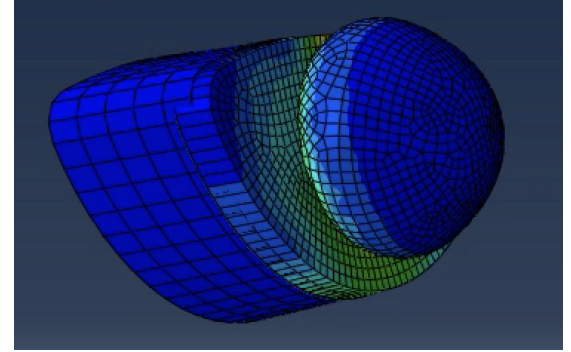
- Below are the deformations with equivalent stress of each of the three swing speeds and maximum stresses
 - These deformations coincide with the previous slide because the maximum stress were observed when max compression occurred



Club Head Speed
of 80 mph



Club Head Speed
of 100 mph



Club Head Speed
of 120 mph

Results pt3

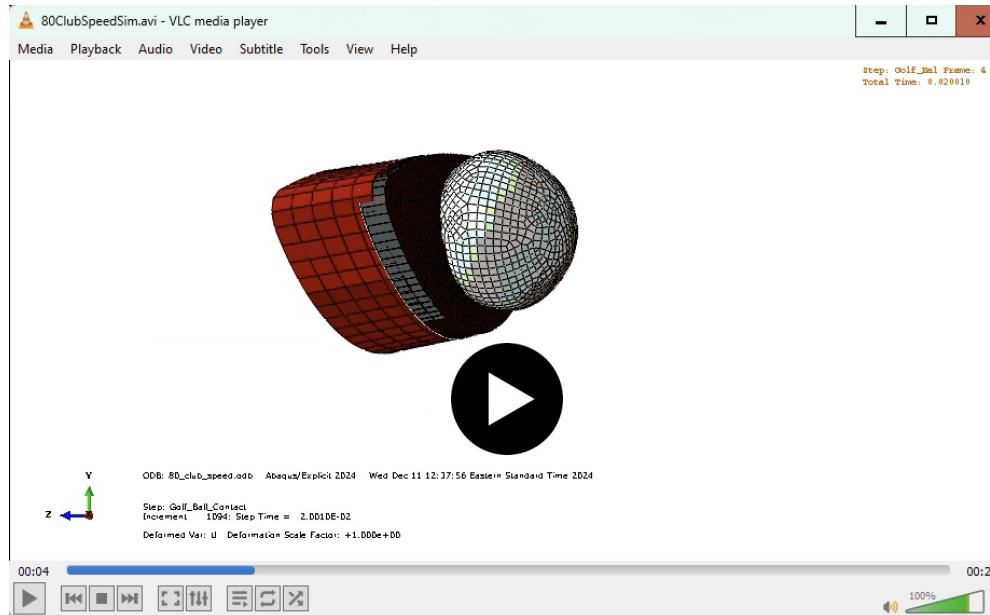
- The maximum observed stress of each club head speed are shown in the table to the right.
- The trend show a nearly linear increase in stress with increase of velocity but it could also be logarithmic on a larger scale.
- The wide gap in these values makes sense given that professional golfers often hit the ball 50% further than nearly all amateur golfers
- It is also worth noting that this means that near 4000 pounds of force are applied to a golf ball with a club head speed of 120 mph

Maximum Observed Stresses(psi)

Club Head Speed(mph)	Stress(psi)
80	1.806e3
100	2.939e3
120	3.779e3

Animation of the Simulation

- Below is a video of the 80 mph club speed simulation



*attached in submission
cause PowerPoint is a PDF

References

- [1] <https://golf.com/instruction/how-fast-swing-driver-based-handicap/>
- [2] https://me.calpoly.edu/wp-content/uploads/2021/07/Mace-Tom_sem04ballpaper.pdf