



Penn State's
Center for Sports Surface Research

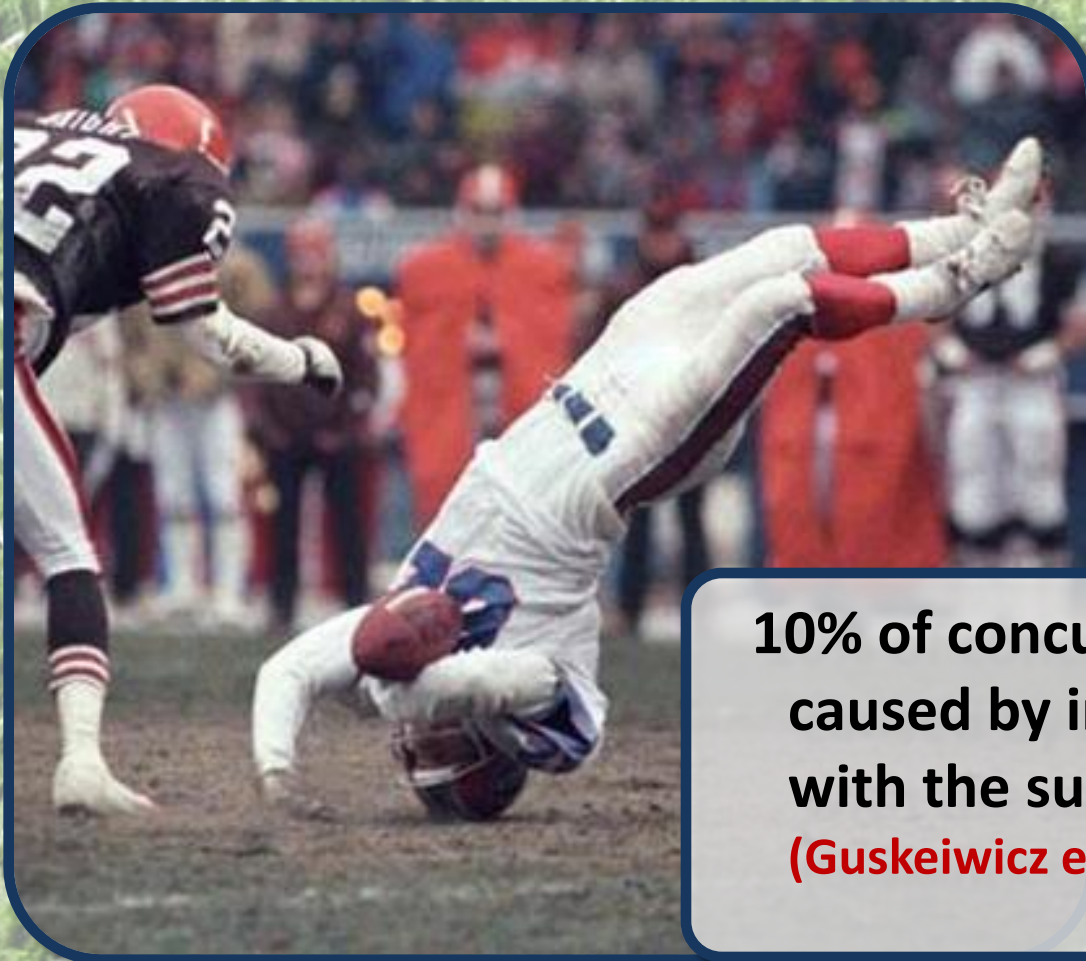
THE **SPORTSTURF**
SCOOP

Understanding Gmax

Penn State's Center for Sports Surface Research



Gmax



How much force does the surface absorb?

10% of concussions caused by impact with the surface
(Guskeiwicz et al, 2000)



Gmax - Definition

- **1 G = acceleration due to gravity**
- **Measure magnitude of impact – peak deceleration**
- **Gmax = maximum negative acceleration on impact**



Gmax

- How many *G*'s can the surface absorb?
- How much returned to athlete?
 - High *G*max = less absorption of force by surface



How is Gmax tested?

- **American Society for Testing and Materials (ASTM)**
 - **Synthetic Turf**
 - F355
 - F1936
 - **Natural Grass**
 - F1702



ASTM F355 – Test Method

- **F355 Device**
 - Drop weighted missile from standard height
 - Accelerometer in missile measures impact



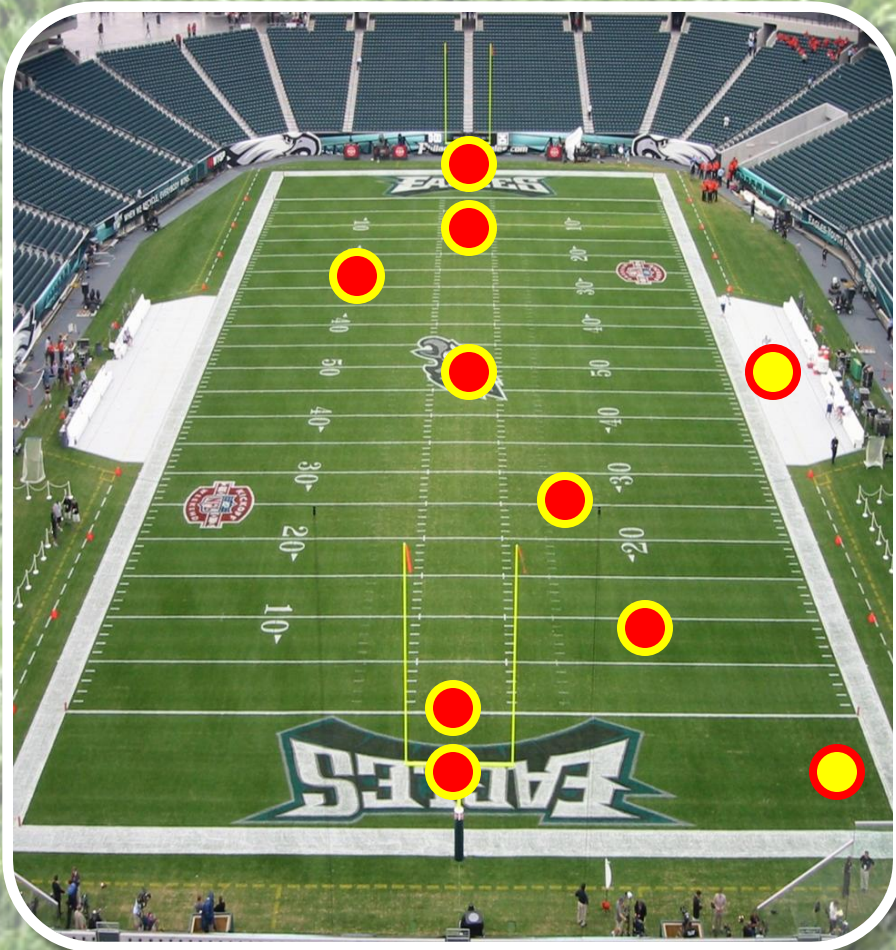
ASTM F355 – Test Method



- **Missile – 20 lbs (human head, neck), flat faced**
- **Drop height – 2 ft.**
 - 1960's crash tests **(Gadd, 1966, 1971)**
 - Impact energy during football game **(Reid et al., 1971)**



ASTM F1936 – Test Procedure



- 3 successive drops on each test point (10 total)
- G_{max} – average of 2nd and 3rd drop



Maximum Gmax

- **200 G**
- **>200 G = life threatening head injuries may be expected to occur**
- **200 G – accepted by U.S. Consumer Products Safety Commission**



Minimum Gmax?



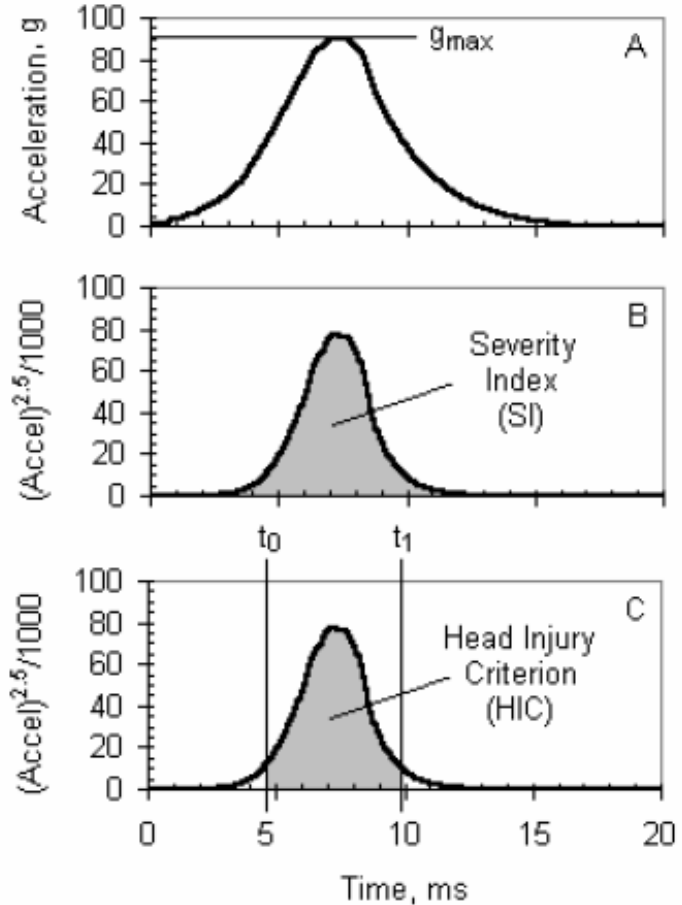
- No minimum standard
- Too soft =
 - Decrease in performance?
(Pinnington and Dawson , 2001)
 - Increased injury risk?



Head Injury Tests

- **Gmax**
 - Peak of curve
- **Severity Index (SI)**
 - Total area under curve, total time
- **Head Injury Criterion (HIC)**
 - Area and time

From Shorten and Himmelsbach, 2003



HIC

- **HIC score = 1000**
 - “Safe” limit
 - Above – risk of fatal head injury is non-zero
- **Used for automobile safety, sports equipment**



Other *G*max tests

- **Clegg Impact Tester**
- **ASTM F1702 – Natural Turfgrass**
- **5 lb missile, drop height: 18 inches**
- ***G*max values are lower than F355 (200 = 135)**



Clegg Impact Tester

- **Mathematical Relationship (2nd and 3rd drop)** (<http://ssrc.psu.edu/infill/infill5.cfm>)

$$F355 = (\text{Clegg} + 27.1) / 0.81$$

R² value: 0.81

*Penn State surface hardness data (2001-2009)
available at <http://ssrc.psu.edu/infill/infill5.cfm>



Gmax

ADVANTAGES

- 200 Gmax level based on safety studies (F355)
- Proactive approach to safety
- Protects field owners from lawsuits

DISADVANTAGES

- Testing small percentage of field
- Routine testing (yearly)
 - Cost
- Flat missile – human head?



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Website: <http://ssrc.psu.edu>



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