Measurement of Shielding Stiffness in Ice Hockey

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Introduction

Biomechanical principles and clinical evidence suggest that the accelerations and strains experienced by the brain, and the corresponding risk for traumatic brain injury during head impacts, depend on the velocity, stiffness, and mass of the colliding objects. Previous analysis of injuries in World Championship ice hockey games showed that light flexible acrylic shielding above the dasher boards reduced the risk of injury by 29% when compared to heavy tempered glass. However, no study (to our knowledge) has measured how the stiffness of the shielding varies around the rink. We conducted measures with a portable test device to test the hypothesis that the stiffness of the shielding would vary depending on the proximity to the caprail or aluminum posts that support the shielding.

Methods

Data were collected at the Bill Copeland ice hockey rink, which is equipped with 16 mm tempered glass shielding with vertical aluminum support posts. The portable test setup consisted of a ratchet tie-down strap, a pulley, and a suction cup firmly attached to the shielding (Figure 1). Force was measured with a load cell installed in line with the strap, and displacement was measured with a linear variable inductance transducer installed on a tripod and aligned to the middle of the suction cup. We incrementally tightened the ratchet strap one click at a time, and measured force and displacement over a range of 0-1000 N.

Measures were acquired along the side, corner and end of the rink at heights from the caprail of 20.3, 44.2, and 62.8 cm (low, middle, high). These heights correspond to the 10th, 50th, and 90th percentiles of all head-to-shielding impacts observed among SFU hockey players. Additionally, measures were acquired at two horizontal locations: the middle of the panel and the edge, as close as possible (10.15 cm) to the post connecting adjacent shielding panels. For each location, we performed three repeated trials.

Results

The measured stiffness of the shielding varied between 60.0 and 282.4 kN/m (Table 1). Stiffness at a height of 20.3 cm above the caprail was 171% greater than the stiffness at a height of 62.8 cm, but there were no differences in stiffness between the middle and post region of the shielding panels. The lowest shielding stiffness (60.0 ± 0.8 kN/m) was observed at the side boards at a height of 62.8 cm, and the highest stiffness (282.4 ± 12.5 kN/m) was observed at the end boards at a height of 20.3 cm.

Conclusion

Using a portable test setup, we found the stiffness of the tempered glass shielding in an ice hockey rink varied between 60 and 281 kN/m. The shielding at a height 20.3 cm above the caprail was 171% stiffer than the at a height of 62.8 cm. However, there was no difference in stiffness at middle and post region of the shielding panels.

Table 1:. Shielding stiffness at different locations along the periphery of the rink.

Location	Height above caprail	Horizontal position	Stiffness (N/m)	SD (N/m)
Corner	High	Post	73800	2900
Corner	High	Middle	73300	3200
Corner	Low	Post	175500	22700
Corner	Low	Middle	165500	7600
Corner	Middle	Post	112700	3800
Corner	Middle	Middle	108300	4900
End	High	Post	91100	2000
End	High	Middle	94100	3300
End	Low	Post	282400	12500
End	Low	Middle	236800	7500
End	Middle	Post	146300	3400
End	Middle	Middle	148800	2200
Side	High	Post	60000	800
Side	High	Middle	73800	5800
Side	Low	Post	183000	2000
Side	Low	Middle	221200	28500
Side	Middle	Post	92000	400
Side	Middle	Middle	119700	2800

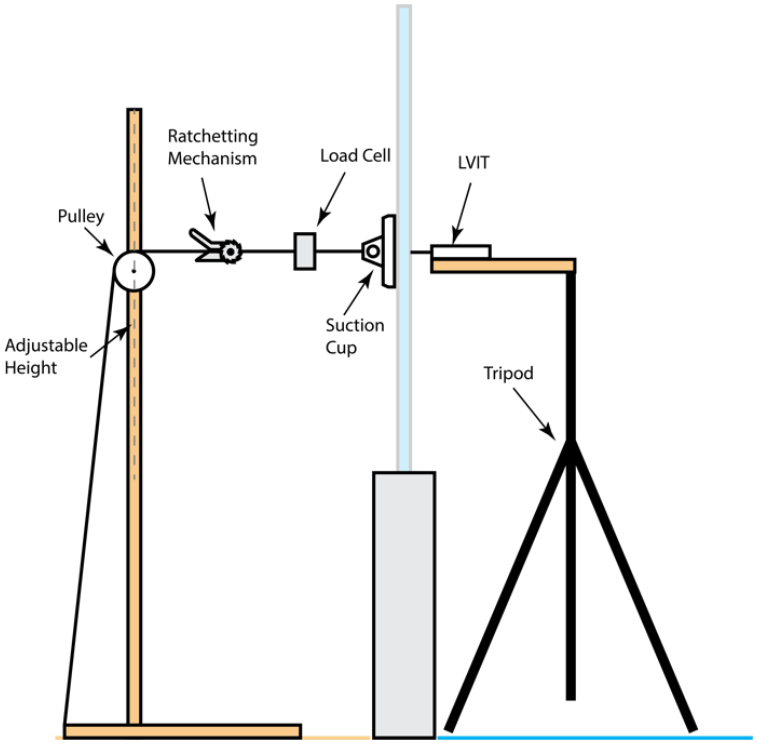

Figure 1. On ice test setup used for measuring the effective stiffness of the shielding.