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Effects of including a penetration test in motorcyclist helmet standards: influence on helmet stiffness and impact performance

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Abstract-

**Regulation ECE-22.05/06 does not require a helmet penetration test. Penetration testing is controversial since it has been shown that it may cause the helmet to behave in a non-desirable stiff way in real-world crashes. This study aimed to assess the effect of the penetration test in the impact performance of helmets. Twenty full-face motorcycle helmets were penetration tested at multiple locations of the helmet shell. Then, 10 helmets were selected and split into two groups (hard shell and soft shell) depending on the results of the penetration tests. These 10 helmets were then drop tested at front, lateral, and top areas at two different impact speeds (5 m/s and 8.2 m/s) to assess their impact performance against head injuries. The statistical analyses did not show any significant difference between the two groups (hard/soft shell) at 5 m/s. Similar results were observed at 8.2 m/s, except for the top area of the helmet in which the peak linear acceleration was significantly higher for the soft shell group than for the hard shell group (230 ± 12 g vs. 211 ± 11 g; p-value = 0.038). The results of this study suggest that a stiffer shell does not necessarily cause helmets to behave in a stiffer way when striking rigid flat surfaces. These experiments also showed that hard shell helmets can provide better protection at higher impact speeds without damaging helmet performance at lower impact speeds. **

Index Terms- motorcyclist helmet; penetration test; impact test; shell stiffness

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