Evaluation of the fall protection of Type I industrial helmets

** Dataset **

Introductory Information

Type I industrial helmets have been widely used at construction sites and by manufacturers as ``general purpose'' safety helmets. The performance of Type I industrial helmets for fall protection is not required to be tested in standardized tests. Chin straps and suspension system adjustment mechanisms are two important components of a typical industrial helmet, but the effects of proper use of them on the protective performance of Type I helmets have not been evaluated. The current study was designed to analyze the fall protection performance of Type I industrial helmets and to evaluate if the use of a chin strap and the suspension system tightness have any effect on protection performance. Head impact tests were performed by letting an instrumented manikin free fall backwards, from a standing posture, so that the manikin would make head-first contact with a solid surface of two different materials (concrete and plywood-covered). The results showed that all four tested helmet models demonstrated excellent performances for fall protection compared to the control group without wearing helmets. The fall protection performance of the advanced helmet models was substantially better than the basic helmet models. However, the effects of the use of chin straps and suspension system tightness on the helmets' fall protection performance were statistically not significant. The findings of our study provide information to help construction companies and manufacturers better manage the use of Type I helmets for fall protection, thereby reducing work-related traumatic brain injury risks.

Methods Collection

- Experimental setup
  - Head impact tests were performed using an instrumented manikin.
  - The test manikin was customer-built using the body of an off-the-shelf manikin, a 50th percentile crash test dummy headform, and a 50th percentile Hybrid III neck with a reinforced spine. The height and body mass of the test manikin with all customarily revised elements were close to a standard 50th percentile male.
  - The manikin was fitted with a fall protection harness to facilitate lifting.
  - The accelerations of the head during the impacts were measured using a triaxial, piezoelectric accelerometer.
- Experimental procedure
  - At the start of the test, the manikin was hoisted, by a lifter, to a height of 5 feet.
  - The hanging manikin was released by an electromagnetic release mechanism, such that the instrumented manikin experienced free fall and impacted a flat surface with the manikin's head back being struck first.
  - The impact surface had one of two different covering materials (concrete or plywood-covered).
  - Four representative helmet models were selected in the study; two of them were basic helmet models and two of them were advanced helmet models.
  - All four selected helmet models were equipped with a suspension tightening ratchet and were provided with a removable chin strap attachment.

- Two independent factors regarding the proper helmet wearing were considered: (1) chin strap usage (with or without), and (2) tightness of the suspension system (tight, comfortable, and loose).
- Under each of the test conditions, impact tests were replicated four times.
- A set of impact tests without a helmet under all other applicable test conditions were applied as the control or reference group.
- There were a total of 192 trials for the impact tests with helmets and 8 trials for the control group.

- Data processing
  - Peak accelerations (Acc) and Head Injury Criterion (HIC) values were calculated using the time-history data of the head accelerations collected in the experiments.
  - The average values for each of the parameters were calculated by the arithmetic mean of four repetitions for each of the test conditions.
  - The helmet use/type [i.e., no helmet (bare head), and four different helmet types] or helmet type (four different helmet types), the chin strap use (with or without chins strap), the suspension tightness (tight, comfortable, or loose), and the impact surface condition (concrete or plywood-covered) were considered as independent variables, whereas the peak acceleration (Acc) and HIC were considered as dependent variables.

Citations

1. Wu, J. Z., C. S. Pan, C. Cobb, A. Moorehead, T-Y Kau, and B. M. Wimer. Evaluation of the fall protection of Type I industrial helmets. Evaluation of the Fall Protection of Type I Industrial Helmets. Ann Biomed Eng. 2022 Feb 5. doi: 10.1007/s10439-022-02922-3.

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