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Composition, Velocity, and Mass of Projectiles Generated from a Chain Shot Event

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Abstract : A hazard associated with the use of timber harvesters is chain shot. Harvester saw chain is subjected to large dynamic mechanical stresses which can cause it to fracture. The resulting open loop of saw chain can fracture a second time and create a projectile consisting of several saw-chain links referred to as a chain shot. Its high kinetic energy enables it to penetrate operator enclosures and be a significant hazard. Accurate data on projectile composition, mass, and speed are needed for the design of both operator enclosures resistant to projectile penetration and for saw chain resistant to fracture. The work presented here contributes to providing this data through the use of a test machine designed and built at Oregon State University. The machine's enclosure is a standard shipping container. To safely contain any anticipated chain shot, the container was lined with both 9.5 mm AR500 steel plates and 50 mm high-density polyethylene (HDPE). During normal operation, projectiles are captured virtually undamaged in the HDPE enabling subsequent analysis. Standard harvester components are used for bar mounting and chain tensioning. Standard guide bars and saw chains are used. An electric motor with flywheel drives the system. Testing procedures follow ISO Standard 11837. Chain speed at break was approximately 45.5 m/s. Data was collected using both a 75 cm solid bar (Oregon 752HSFB149) and 90 cm solid bar (Oregon 902HSFB149). Saw chains used were 89 Drive Link .404"-18HX loops made from factory spools. Standard 16-tooth sprockets were used. Projectile speed was measured using both a high-speed camera and a chronograph. Both rotational and translational kinetic energy are calculated. For this study 50 chain shot events were executed. Results showed that projectiles consisted of a variety combinations of drive links, tie straps, and cutter links. Most common (occurring in 60% of the events) was a drive-link / tie-strap / drive-link combination having a mass of approximately 10.33 g. Projectile mass varied from a minimum of 2.99 g corresponding to a drive link only to a maximum of 18.91 g corresponding to a drive-link / tie-strap / drive-link / cutter-link / drive-link combination. Projectile translational speed was measured to be approximately 270 m/s and rotational speed of approximately 14000 r/s. The calculated translational and rotational kinetic energy magnitudes each average over 600 J. This study provides useful information for both timber harvester manufacturers and saw chain manufacturers to design products that reduce the hazards associated with timber harvesting.

Keywords : chain shot, timber harvesters, safety, testing
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