World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:05, 2018

Creation of a Test Machine for the Scientific Investigation of Chain Shot

Authors : Mark McGuire, Eric Shannon, John Parmigiani

Abstract : Timber harvesting increasingly involves mechanized equipment. This has increased the efficiency of harvesting, but has also introduced worker-safety concerns. One such concern arises from the use of harvesters. During operation, harvesters subject saw chain to large dynamic mechanical stresses. These stresses can, under certain conditions, cause the saw chain to fracture. The high speed of harvester saw chain can cause the resulting open chain loop to fracture a second time due to the dynamic loads placed upon it as it travels through space. If a second fracture occurs, it can result in a projectile consisting of one-to-several chain links. This projectile is referred to as a chain shot. It has speeds similar to a bullet but typically has greater mass and is a significant safety concern. Numerous examples exist of chain shots penetrating bullet-proof barriers and causing severe injury and death. Improved harvester-cab barriers can help prevent injury however a comprehensive scientific understanding of chain shot is required to consistently reduce or prevent it. Obtaining this understanding requires a test machine with the capability to cause chain shot to occur under carefully controlled conditions and accurately measure the response. Worldwide few such test machine exist. Those that do focus on validating the ability of barriers to withstand a chain shot impact rather than obtaining a scientific understanding of the chain shot event itself. The purpose of this paper is to describe the design, fabrication, and use of a test machine capable of a comprehensive scientific investigation of chain shot. The capabilities of this machine are to test all commercially-available saw chains and bars at chain tensions and speeds meeting and exceeding those typically encountered in harvester use and accurately measure the corresponding key technical parameters. The test machine was constructed inside of a standard shipping container. This provides space for both an operator station and a test chamber. In order to contain the chain shot under any possible test conditions, the test chamber was lined with a base layer of AR500 steel followed by an overlay of HDPE. To accommodate varying bar orientations and fracture-initiation sites, the entire saw chain drive unit and bar mounting system is modular and capable of being located anywhere in the test chamber. The drive unit consists of a high-speed electric motor with a flywheel. Standard Ponsse harvester head components are used to bar mounting and chain tensioning. Chain lubrication is provided by a separate peristaltic pump. Chain fracture is initiated through ISO standard 11837. Measure parameters include shaft speed, motor vibration, bearing temperatures, motor temperature, motor current draw, hydraulic fluid pressure, chain force at fracture, and high-speed camera images. Results show that the machine is capable of consistently causing chain shot. Measurement output shows fracture location and the force associated with fracture as a function of saw chain speed and tension. Use of this machine will result in a scientific understanding of chain shot and consequently improved products and greater harvester operator safety.

Keywords : chain shot, safety, testing, timber harvesters
Conference Title : ICFEN 2018 : International Conference on Forest Engineering and Nature
Conference Location : Rome, Italy
Conference Dates : May 03-04, 2018