Canadian AgriSafety Applied Science Program

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Challenges of DIY ROPS

Producing a Simple-to-Build and Safe ROPS Design

Tractor roll-over events are a leading cause of work-related farm fatalities in Canada. It has been determined that having a roll-over protective structure (ROPS) and a seatbelt installed on a tractor is an extremely effective way to eliminate injury and death from tractor roll-over events. However, the cost to purchase and install commercial ROPS has been found to be the main deterrent preventing farmers from installing ROPS on tractors that have been manufactured without them (i.e., older-model tractors). The overall goal of the *Low Cost ROPS Program Rollout* project is to develop a low-cost ROPS system that would allow farmers to build their own ROPS on farm. However, one of the main challenges of this endeavour is to design a ROPS that is structurally sound even when built by a farmer who is not necessarily an expert fabricator or welder.

Design Techniques

The goal was therefore to create a simple weldable design that doesn't require journeyperson skills while remaining structurally sound. A special focus was placed on locating the welds away from high stress locations and using design techniques to keep the stresses low at the welds:

1. As shown on the pictures in Figure 1, a proposed design uses two angle braces to the top corners, which adds more welded area to reduce the stress per inch of weld. The braces also create a triangle at each corner that greatly reduce the torsional stresses on the corner welds.
2. Typically, the post bottom and the mounting plates would be welded together, but the research team came up with a novel idea involving a large piece of angle iron. The corner of the heavy angle iron, which has no welding, is located at a point of high stress. The post is then welded to the side of the vertical angle iron, so the location of that weld is away from the high-stress corner which also provides a greater welding length that reduces the stress per weld area.

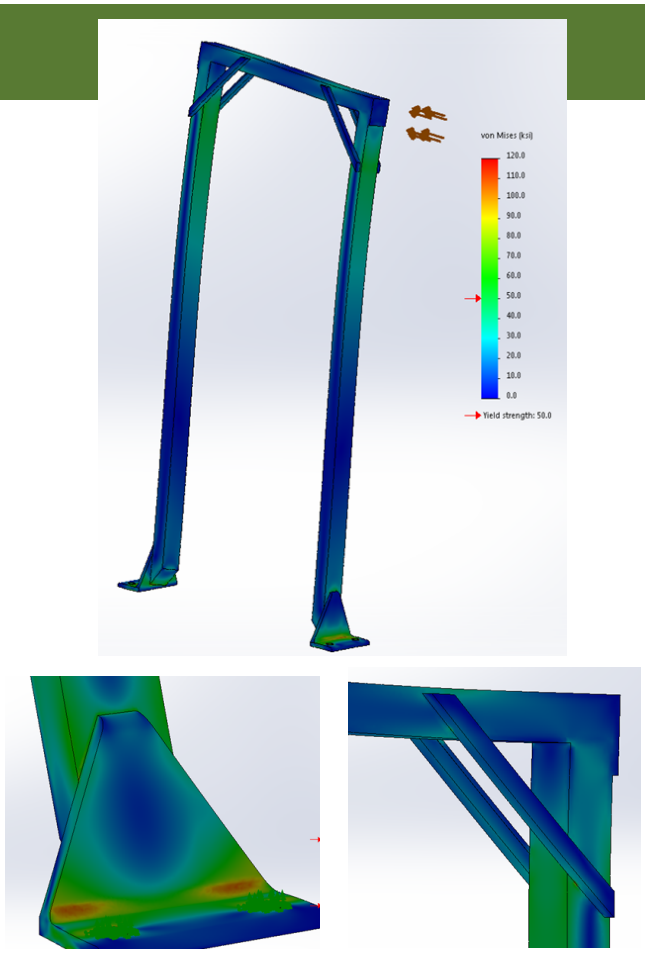

Figure 1: FEA Analysis of ROPS Stresses

A simulation using finite element analysis (FEA) was developed that shows a colour representation of the stresses (Figure 1). All welded corners would typically be red on a conventional design indicating high stress at those locations. On the proposed design, only the bottom corners have red areas and those are on the heavy angle iron, which is designed to flex as there is no weld at that location.

"Poor Weld" Experiment

In order to determine the impact of the weld quality on the performance of the proposed design, the research team produced 3 ROPS with common welding flaws: cold weld, undercut and porosity (Figure 2).

Figure 2: Flawed Welds

These ROPS were then put through their paces and all 3 passed the standardized tests! Therefore, even a poorly welded but properly designed ROPS will provide the necessary protection in case of tractor roll-over events.

What's Next

Now that the research team has developed an innovative and simple ROPS design that will still function properly even with poor welds, the next steps in the project are to:

1. Test the feasibility of the proposed design by having ROPS built by actual farmers and then assessed by the research team to determine their structural integrity.
2. Test the engineer-supervised remote inspection process that was drafted as an alternative to an on-site physical inspection on every farm by a qualified engineer, which is cost prohibitive.

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