

EVALUATION OF FOLDABLE TRACTOR ROLL-OVER PROTECTIVE STRUCTURES (ROPS) CLEARANCE

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Abstract

Tractor rollovers are a leading cause of death in the agricultural industry. While rollovers continue to happen, Roll-Over Protective Structures (ROPS) have shown great ability to prevent or reduce the casualties and injuries associated with rollover events. Foldable ROPS provide a practical solution to various issues faced by tractor operators. However, a ROPS is not meant to be used in the folded down position, as they are commonly used.

This study determined the operator protection provided by ROPS in the extended and the folded positions relative to the applicable engineering standards. To accomplish this, six different sized tractors with different ROPS were analyzed to determine the measurements required to calculate the protection that the tractor and ROPS combination provides in both positions, folded and extended. These calculations yielded results that show consistent trends among all tractors measured.

Procedure

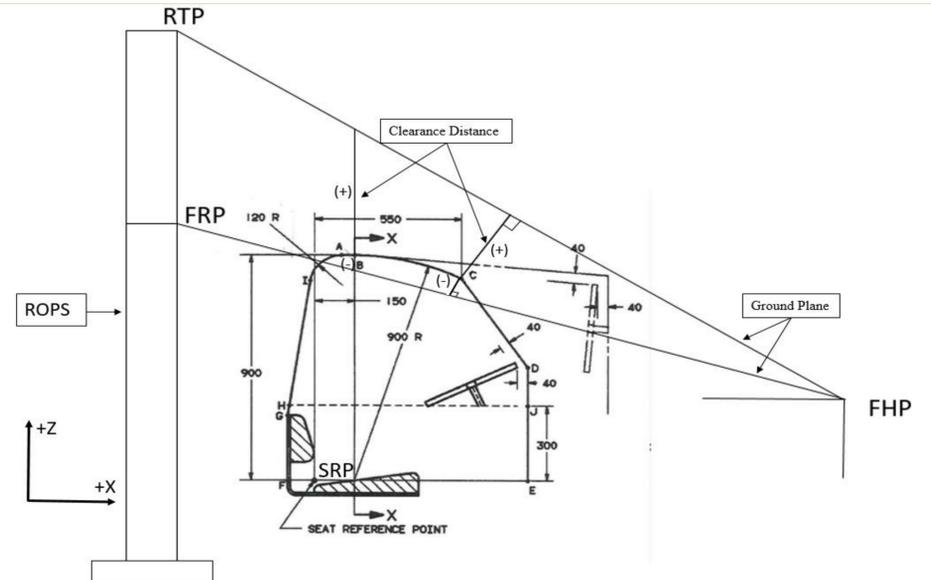
The applicable engineering standards that were used are SAE J2194 (SAE, 2009) and ASABE S478 (ASABE, 2012). The clearance zone is defined in SAE J2194 and provides the dimensions of the operator protection. The main value determined in this study is clearance distance. The two main differences in the clearance zones provided by ASABE S478 and SAE J2194 are the radii (SAE J2194 using a 900 mm radius and ASABE S478 using a 760 mm radius) and the point on the seat from which the radius originate. For this study, two clearance zones were used: the SAE J2194 zone with the 900 mm radius from the defined seat reference point (SRP) and that same zone, but a radius of 760 mm applied at the same point. The use of multiple clearance zones allowed for the clearance distances for a wider range of tractor sizes to be accurately represented. Using measured dimensions from the sample set of tractors, the clearance distance can be determined at points B and C (shown on diagram), and the operator protection offered by each ROPS and tractor combination can be quantified.

Data on the Tractors Analyzed

Tractor	A	B	C	D	E	F
Standard Applicable	ASABE S478	ASABE S478	ASABE S478/SAE J2194	ASABE S478/SAE J2194	SAE J2194	SAE J2194
Weight (kg)	655	752	987	1315	2497	3200
SRPX	-95	-120	-60	-80	100	120
SRPZ	1020	1080	1040	1120	1280	1400
FHPX	1880	1880	1930	2290	2670	3000
FHPZ	990	1020	1140	1180	1430	1500
RTPX	-440	-110	-200	-200	-100	-120
RTPZ	2180	2260	2300	2330	2480	2570
FRPX	-260	-250	-160	-100	0	-100
FRPZ	1640	1640	1680	1740	1880	1960

Left: Measurements being taken on a sample tractor.

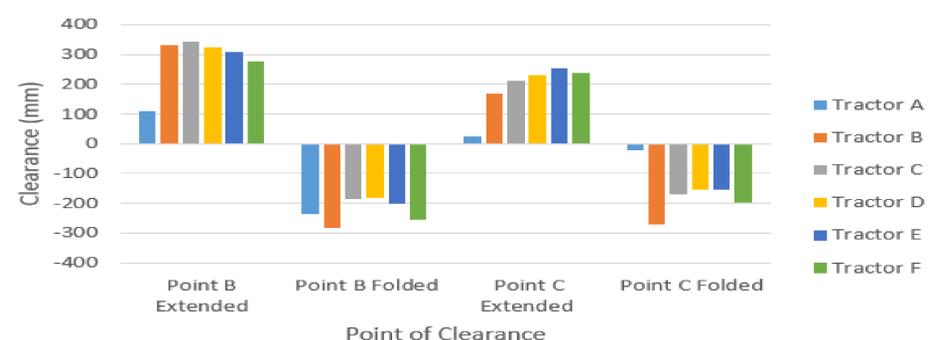
Clearance Zone with ROPS Superimposed



Results and Conclusions

The clearance distance calculations produced fairly consistent results. The clearance distances for the six tractors measured can be seen in the graphs below, with positive values representing clearance distances that extend outside the clearance zone and negative values representing instances in which the ground plane intrudes into the clearance zone. At any point and using either radius, no ROPS provides enough clearance when folded to satisfy the standards. These results affirm the hypothesis that a ROPS in the folded position does not provide enough clearance to meet the standards; however, these results quantify the lack of protection provided by a folded ROPS, and provide an optimistic view for possible adjustment to ROPS themselves and to regulations regarding foldable ROPS.

Clearance (760 mm radius)



Clearance Distance (900 mm radius)

