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To:	Mr Uwe CORSEPIUS, Secretary-General of the Council of the European Union
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Subject:	ANNEXES to the Commission Delegated Regulation of XXX supplementing and amending Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to vehicle construction and general requirements for the approval of agricultural and forestry vehicles

Delegations will find attached document C(2014) 6494 final - Annexes 7 to 8.

Encl.: C(2014) 6494 final - Annexes 7 to 8

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ANNEXES 7 to 8

ANNEXES

to the

Commission Delegated Regulation

of XXX
supplementing and amending Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to vehicle construction and general requirements for the approval of agricultural and forestry vehicles

ANNEX VII

Requirements applying to roll-over protection structures (track-laying tractors)

A. **General provision**

1. The Union requirements applying to roll-over protection structures (track-laying tractors) are set out in point B.

B. **Requirements applying to roll-over protection structures (track-laying tractors)[(1)]**

1. **DEFINITIONS**

1.1 [Not applicable]

1.2. Over Protective Structure (ROPS)

Roll-over protective structure (protective cab or frame), hereinafter called "protective structure", means the structure on a tractor the essential purpose of which is to avoid or limit risks to the driver resulting from roll-over of the tractor during normal use.

The roll-over protective structure is characterized by the provision of space for a clearance zone large enough to protect the driver when seated either inside the envelope of the structure or within a space bounded by a series of straight lines from the outer edges of the structure to any part of the tractor that might come into contact with flat ground and that is capable of supporting the tractor in that position if the tractor overturns.

1.3. **Track**

1.3.1. Preliminary definition: median plane of the track

The median plane of the track is equidistant from the two planes containing its periphery at their outer edges.

1.3.2. Definition of track width

Track width is the distance between the median planes of the tracks

1.3.3. Additional definition: median plane of the tractor

The vertical plane at right angles to the axle at its centre point is the median plane of the tractor.

1.4. ***Protective structure***

System of structural members arranged on a tractor in such a way as to accomplish its primary purpose of reducing the likelihood of an operator being crushed should his tractor roll-over. Structural members include any sub-frame, bracket, mounting, socket, bolt, pin, suspension or flexible shock absorber used to secure the system to the tractor frame but exclude mounting provisions which are integral with the tractor frame.

1.5. ***Tractor frame***

The main chassis or main load-bearing member(s) of the tractor which extend(s) over a major part of the tractor and upon which the protective structure is directly mounted.

1.6. **Protective structure-tractor frame assembly**

System consisting of the protective structure attached to the tractor frame.

1.7. ***Bedplate***

A substantially rigid part of the test structure to which the tractor frame is attached for the purpose of the test.

1.8. **Seat index point (SIP)**

1.8.1. The seat index point (**SIP**) is located in the central longitudinal plane of the apparatus for determination when installed in the operator seat. The **SIP** is fixed with respect to the tractor and does not move with the seat through its range of adjustment and/or oscillation.

1.8.2. When determining the **SIP**, the seat shall be adjusted with all fore, aft, vertical and angular seat adjustments placed in their centre position. The suspension systems shall be set so that the seat is at the mid-point of its oscillation range with the weighted apparatus for determination of **SIP** in place.

1.8.3. The **SIP** must be established by means of the apparatus illustrated in Figure 8.1.The apparatus is placed on the seat. A 20 kg mass is added 40 mm in front of the **SIP** mark on the horizontal section of the apparatus. A horizontal force of about 100 N shall then be applied to the apparatus at the **SIP** (see $\mathbf{F_o}$ in Figure 8.1). Finally, a further 39 kg mass shall be placed 40 mm in front of the **SIP** mark on the horizontal section of the apparatus.

1.9. ***Deflection-limiting volume (DLV)***

That volume, related to the operator, which serves to set limits and deflections permissible when performing laboratory evaluations of the protective structure (Figure 8.2). It is an orthogonal approximation of the dimensions of a large, seated operator.

1.10. ***Vertical reference plane***

A vertical plane, generally longitudinal to the tractor and passing through the seat index point and the centre of the steering wheel or of the control hand levers. Normally, the vertical reference plane coincides with the median plane of the tractor.

1.11. ***Lateral simulated ground plane***

Surface on which a tractor, after rolling over, is assumed to come to a standstill with the tractor lying on its side. The simulated ground plane is determined as follows (see 3.5.1.2):

a upper member to which the force is applied;

b outermost point in end view of member as defined in **(a)** above;

c vertical line through point defined in **(b)** above;

d vertical plane parallel to vehicle's longitudinal centreline through the line defined in **(c)** above;

e rotate plane described in **d** above, 15° away from the **DLV** about an axis which is perpendicular to the vertical line given in **c** above and also passes through the point described in **b** above; this establishes the simulated ground plane;

The simulated ground plane shall be established on an unloaded protective structure and shall move with the member to which the load is applied.

1.12. ***Vertical simulated ground plane***

For a machine coming to rest in an upside-down position, the plane is defined by the top cross-member of the protective structure and that front (rear) part of the tractor likely to come in contact with flat ground at the same time as the protective structure and capable of supporting the upside-down tractor. The vertical simulated ground plane moves with the deformed protective structure**.**

Note: The vertical simulated ground plane applies only to two-post protective structures.

1.13. ***Unballasted mass***

The mass of the tractor without ballasting devices. The tractor shall be in running order with tanks, circuits and radiator full, protective structure with cladding and any track equipment or additional front wheel drive components required for normal use. The operator is not included.

1.14. ***Permissible measurement tolerances***

Time:	± 0.1 s
Distance:	± 0.5 mm
Force:	± 0.1 % (of the sensor full scale)

Angle		± 0.1 °
Mass:		± 0.2 % (of the sensor full scale)

1.15. **Symbols**

D	(mm)	Deflection of the structure;
F	(N)	Force;
M	(kg)	Maximum tractor mass recommended by the tractor manufacturer. It shall be equal or superior to the unballasted mass as defined in paragraph 1.13;
U	(J)	Energy absorbed by the structure related to the tractor mass.

2. **FIELD OF APPLICATION**

This Annex is applicable to tractors, propelled and steered by endless tracks, having at least two axles with track attachments, and with following features:

2.1. an unballasted tractor mass not less than 600 kg;

2.2. the ground clearance not more than 600 mm beneath the lowest point of the front and rear axles.

3. **RULES AND DIRECTIONS**

3.1. General regulations

3.1.1. The protective structure may be manufactured either by the tractor manufacturer or by an independent firm. In either case a test is only valid for the model of tractor on which it is carried out. The protective structure must be retested for each model of tractor to which it is to be fitted. However, testing stations may certify that the strength tests are also valid for tractor models derived from the original model by modifications to the engine, transmission and steering and front suspension *(see below 3.6: Extension to other tractor models).* On the other hand, more than one protective structure may be tested for any one model of tractor.

3.1.2. The protective structure submitted for test must be supplied attached in the normal manner to the tractor or tractor chassis on which it is used. The tractor chassis shall be complete including attaching brackets and other parts of the tractor that may be affected by loads imposed on the protective structure.

3.1.3. A protective structure may be designed solely to protect the driver in the event of the tractor overturning. Onto this structure it may be possible to fit weather protective for the driver, of a more or less temporary nature. This will usually be removed by the driver in warm weather. There are protective structures however, in which the cladding is permanent and warm weather ventilation provided by windows or flaps. As the cladding may add to the strength of the structure and if removable may well be absent when an accident occurs, all parts that can be so taken away by the driver will be

removed for the purpose of the test. Doors, roof hatch and windows which can be opened shall be either removed or fixed in the open position for the test, so that they do not add to the strength of the protective structure. It shall be noted whether, in this position, they would create a hazard for the driver in the event of overturning.

Throughout the remainder of these rules, reference will only be made to testing the protective structure. It must be understood that this includes cladding not of a temporary nature.

A description of any temporary cladding supplied is to be included in the specifications. All glass or similar brittle material shall be removed prior to the test**.** Tractor and protective structure components which might sustain needless damage during the test and which do not affect the strength of the protective structure or its dimensions may be removed prior to the test if the manufacturer wishes. No repairs or adjustment may be carried out during the test.

3.1.4. Any component of the tractor contributing to the strength of the protective structure such as mud-guards, which has been reinforced by the manufacturer, should be described and its measurements given in the test report.

3.2. Apparatus

3.2.1. Deflection-limiting volume

The **DLV** and its location shall be in accordance with ISO 3164:1995 (see Figure 8.3). The **DLV** shall be fixed firmly to the same part of the machine to which the operator's seat is secured, and shall remain there during the entire formal test period.

For track-laying tractors with an unballasted mass of less than 5 000 kg, fitted with a two-post front mounted protective structure, the **DLV** corresponds to Figures 8.4 and 8.5.

3.2.2. Zone of clearance and safeguard plane

The zone of clearance, as defined in Annex VIII (Definitions Chapter, Section 1.6), must remain covered by the safeguard plane, **S**, as shown in Figures 8.2 and 8.4. The safeguard plane is defined as an oblique plane, perpendicular to the vertical longitudinal plane of the tractor, forming a tangent at the front with the protective structure and at the back with whichever of the following hard fixtures of the tractor prevents the aforementioned plane **S** from entering the zone of clearance, via:

a housing or rigid part of the rear of the tractor;
the tracks;
an additional hard structure firmly mounted on the rear of the tractor.

3.2.3. Rear hard fixture test

If the tractor is fitted with a rigid section, a housing or other hard fixture placed behind the driver’s seat, this fixture shall be regarded as a protective point, in the event of sideways or rear overturning. This hard fixture placed behind the driver’s seat shall be capable of withstanding, without breaking or

entering the zone of clearance, a downward force $\mathbf{F_i}$ where:

$$\mathbf{F_i} = \boldsymbol{15\ M}$$

applied perpendicularly to the top of the frame in the central plane of the tractor. The initial angle of application of force shall be 40° calculated from a parallel to the ground as shown in Figure 8.4. The minimum width of this rigid section shall be 500 mm (see Figure 8.5).

In addition, it shall be sufficiently rigid and firmly attached to the rear of the tractor.

3.2.4. Lashings

Facilities for securing the protective structure-tractor frame assembly to the bedplate, as described above, and for applying the horizontal and vertical loads shall be provided (see Figures 8.6 to 8.9).

3.2.5. Measuring instruments

The test apparatus shall be equipped with instruments for measuring the force applied to the protective structure and the deflection (deformation) of the structure.

The percentages below are nominal ratings of the accuracy of the instrumentation and shall not be taken to indicate that compensating tests are required.

Measure	Accuracy
Deflection of the protective structure	± 5 % of maximum deflection measured
Force applied to the protective structure	± 5 % of maximum force measured

3.2.6. Arrangements for load application

Loading arrangements for load application are shown in Figures 8.7, 8.10 to 8.13 (side loading), in Figures 8.8 and 8.9 (vertical loading) and Figure 8.14 (longitudinal loading).

3.3. Test conditions

3.3.1. The protective structure shall comply with production specifications and shall be fitted to the appropriate tractor model chassis in accordance with the manufacturer's declared method of attachment.

3.3.2. The protective structure - tractor frame assembly shall be secured to the bedplate so that the members connecting the assembly and the bedplate experience minimal deflection when the protective structure is side loaded. During side loading, the protective structure - tractor frame assembly shall not receive any support from the

bedplate, other than that due to the initial attachment.

3.3.3. The protective structure shall be instrumented with the necessary equipment to obtain the required force-deflection data.

3.3.4. All tests shall be performed on the same protective structure. No repair or straightening of any protective structure - tractor member shall be carried out during or between the side and vertical loadings.

3.3.5. For side and longitudinal loading, connection to the bedplate shall be through the main housing or track frames (see Figures 8.6 to 8.8).

3.3.6. For vertical loading, there is no limitation on securing or supporting the protective structure-tractor frame assembly.

3.3.7. On completion of all the tests, permanent deflections of the protective structure shall be measured and recorded.

3.4. Test procedure

3.4.1. General

The test procedures shall consist of the operations described in 3.4.2, 3.4.3 and 3.4.4 in the order listed.

3.4.2. Side loading

3.4.2.1. The force-deflection characteristics shall be determined by side loading the top major longitudinal members of the protective structure.

For a protective structure having more than two posts, the side loading shall be applied through a load-distribution device having a length not greater than 80 per cent of the top member straight length **L** between the front and rear posts of the protective structure (see Figures 8.13 to 8.16). The initial loading shall be within the zone that is established by the vertical projection of two planes parallel to the front and rear planes of the **DLV** and located 80 mm outside of them.

3.4.2.2. For a protective structure with an overhead shield, having a two-post system, the initial loading shall be dictated by the total longitudinal distance between major, upper protective structure members **L** and the vertical projection of the front and rear planes of the **DLV**. The force (load) point shall not be within **L/3** distance from the posts.
Should the **L/3** point be between the vertical projection of the **DLV** and the posts, the force (load) point shall be moved away from the post until it enters the vertical projection of the **DLV** (see Figures 8.13 to 8.16). Any load distribution plate used shall not impede or restrict the rotation of the protective structure around a vertical axis during the loading and shall not distribute the load over a distance greater than 80 per cent of **L**.

The force shall be applied to the major, upper and longitudinal members except when a post structure is used without the cantilevered overhead shield. For this type of structure, the force shall be applied in line with the upper cross-member.

3.4.2.3. The initial direction of the force shall be horizontal and perpendicular to a vertical plane through the tractor's longitudinal centre-line

3.4.2.4. As loading continues, the deformations of the protective structure - tractor frame assembly may cause the direction of the force to change; this is permissible.

3.4.2.5. Should the operator's seat be off the tractor's longitudinal centre-line, the loading shall be against the outermost side nearest the seat.

3.4.2.6. For on-centre-line seats, if mounting of the protective structure is such that different force-deflection relations are obtained from loading from left or right sides, the side loaded shall be that which will place the most severe requirements on the protective structure - tractor frame assembly.

3.4.2.7. The rate of deflection (application of load) shall be such that it can be considered static, i.e. less than or equal to 5 mm/s.

3.4.2.8. At deflection increments no greater than 25 mm at the point of application of the resultant load, the force and deflection shall be recorded and plotted (Figure 8.17).

3.4.2.9. The loading shall be continued until the protective structure has achieved both the force and energy requirements. The area under the resulting force-deflection curve (Figure 8.17) equals the energy.

3.4.2.10. The deflection used in calculating energy shall be that of the protective structure along the line of action of the force. The deflection should be measured at the mid-point of the loading.

3.4.2.11. Any deflection of members used to support load-application devices shall not be included in deflection measurements used for calculation of energy absorption.

3.4.3. Vertical loading

3.4.3.1. After removal of the side load, a vertical load shall be applied to the top of the protective structure.

3.4.3.2. The load shall be applied using a stiff beam with a width of 250 mm.

3.4.3.3. For structures having more than two posts, the vertical load shall be applied at both the front and the rear

3.4.3.3.1. Vertical loading at the rear (Figures 8.10, 8.11.a and 8.11.b)

3.4.3.3.1.1. The crushing beam shall be positioned across the rear uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane. The crushing force shall be applied and maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.4.3.3.1.2. Where the rear part of the protective structure roof will not sustain the full crushing force, the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the protective structure with that part of the rear of the tractor capable of supporting the tractor when overturned. The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force shall then be applied.

3.4.3.3.2. Vertical loading at the front (Figures 8.10 to 8.12)

3.4.3.3.2.1. The crushing beam shall be positioned across the front uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane. The crushing force F shall be applied and maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.4.3.3.2.2. Where the front part of the roof of the protective structure will not sustain the full crushing force (Figures 8.12.a and 8.12.b), the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the protective structure with that part of the front of the tractor capable of supporting the tractor when overturned. The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force shall then be applied.

3.4.3.4. For a protective structure having a two-post system, the vertical loading shall be dictated by the total longitudinal distance between major upper protective structure members L and the vertical projection of the front and rear planes of the DLV. The force (load) point shall be at a distance not less than L/3 distance from the posts (see Figure 8.9).

Should the L/3 point be between the vertical projection of the DLV and the posts, the force (load) point shall be moved away from the post until it enters the vertical projection of the DLV.

For front-mounted protective structures having a two-post system without an overhead shield, the vertical loading shall be applied in line with the transverse member connecting the upper members.

3.4.4. Longitudinal loading

3.4.4.1. After removal of the vertical load, a longitudinal load shall be applied to the protection structure.

3.4.4.2. The longitudinal load shall be applied at the deformed location of the originally established point, since the lateral (and vertical) loading of the protection structure is likely to result in permanent deformation of the structure. The originally established point is determined by the location of the load distributor and socket prior to any test being performed on the structure.

The load distribution device may span the width in cases where no rear (front) cross-member exists. In all other cases, the device may not distribute the load over a length greater than 80 % of the width, W, of the protection structure (see Figure 8.18).

3.4.4.3. The longitudinal load shall be applied to the upper structural members of the protection structure along the longitudinal centreline of the protection structure.

3.4.4.4. The direction of loading shall be selected to place the most severe requirements on the protection structure/tractor frame assembly. The initial direction of loading shall be horizontal and parallel to the original longitudinal centreline of the tractor. Some additional factors to consider in deciding on the direction to apply the longitudinal load are:

location of protection structure relative to DLV and the effect that longitudinal

deflection of the protection structure would have on providing crush protection for the operator;

tractor characteristics, e.g. other structural members of the tractor which may resist longitudinal deflection of the protection structure, that can limit direction of the longitudinal component of loading on the protection structure;

experience which may indicate the possibility of longitudinal tipping or the tendency of a particular classification tractor to skew as it rotates about a longitudinal axis during an actual roll-over.

3.4.4.5. The rate of deflection shall be such that the loading may be considered static (see 3.4.2.7). This loading is to continue until the protection structure has achieved the force requirement(s)

3.5. Conditions for acceptance

3.5.1. General

3.5.1.1. During each test, no part of the protective structure shall enter the deflection-limiting volume. Also, the deformation of the protective structure shall not allow the simulated ground plane (defined in paragraphs 1.11 and 1.12) to enter the DLV.

3.5.1.2. The protective structure deflection during each test shall not cause the load side planes of the **DLV** to extend beyond or intersect the simulated ground plane (see Figures 8.19 and 8.20).

The protective structure shall not break away from the tractor frame due to failure of the tractor frame.

3.5.2. Requirements for the side loading force-energy, the vertical loading force and the longitudinal loading force

3.5.2.1. These requirements shall be met within the deflection(s) permitted in 3.5.1.1.

3.5.2.2. The side-load force and the minimum energy absorbed shall attain at least those given in Table 8.1, where:

F is the minimum force attained during side loading;

M (kg) is the tractor manufacturer's maximum recommended mass;

U is the minimum energy absorbed during side loading.

If the required force is attained before the energy requirement is met, the force may decrease but shall again attain the required level when the minimum energy is obtained or exceeded.

3.5.2.3. After removal of the side load, the protective structure-tractor frame assembly shall support a vertical force:

$$F = 20\ M$$

for a period of 5 min or until any deformation has ceased, whichever is shorter.

3.5.2.4. The longitudinal-load force shall attain at least that given in Table 8.1, where **F** and **M** are defined at point 3.5.2.2.

3.6. Extension to other tractor models

3.6.1. [Not applicable]

3.6.2. Technical extension

When technical modifications occur on the tractor, the protective structure or the method of attachment of the protective structure to the tractor, the testing station that has carried out the original test can issue a "technical extension report" in the following cases:

3.6.2.1. Extension of the structural test results to other models of tractors.

The impact and crushing tests need not be carried out on each model of tractor, provided that the protective structure and tractor comply with the conditions referred to hereunder 3.6.2.1.1 to 3.6.2.1.5.

3.6.2.1.1. The structure shall be identical to the one tested;

3.6.2.1.2. The required energy shall not exceed the energy calculated for the original test by more than 5 per cent;

3.6.2.1.3. The method of attachment and the tractor components to which the attachment is made shall be identical;

3.6.2.1.4. Any components such as mud-guards and bonnet that may provide support for the protective structure shall be identical;

3.6.2.1.5. The position and critical dimensions of the seat in the protective structure and the relative position of the protective structure on the tractor shall be such that the DLV would have remained within the protection of the deflected structure throughout all tests.

3.6.2.2. Extension of the structural test results to modified models of the protective structure

This procedure has to be followed when the provisions of paragraph 3.6.2.1 are not fulfilled, it may not be used when the method of attachment of the protective structure to the tractor does not remain of the same principle (e.g. rubber supports replaced by a suspension device):

3.6.2.2.1. Modifications having no impact on the results of the initial test (e.g. weld attachment of the mounting plate of an accessory in a non-critical location on the structure), addition of seats with different SIP location in the protective structure (subject to checking that the new DLV(s) remain(s) within the protection of the deflected structure throughout all tests);

3.6.2.2.2. Modifications having a possible impact on the results of the original test without calling into question the acceptability of the protective structure (e.g. modification of a structural component, modification of the method of

attachment of the protective structure to the tractor). A validation test can be carried out and the test results will be drafted in the extension report.

The following limits for this type extension are fixed:

3.6.2.2.2.1. no more than 5 extensions may be accepted without a validation test;

3.6.2.2.2.2. the results of the validation test will be accepted for extension if all the acceptance conditions of this Annex are fulfilled and if the force measured when the required energy level has been reached in the various horizontal load tests does not deviate from the force measured when the required energy has been reached in the original test by more than ± 7% and the deflection measured[(2)] when the required energy level has been reached in the various horizontal load tests does not deviate from the deflection measured when the required energy has been reached in the original test report by more than ± 7%.

3.6.2.2.2.3. more than one protective structure modifications may be included in a single extension report if they represent different options of the same protective structure, but only one validation test can be accepted in a single extension report. The options not tested shall be described in a specific section of the extension report

3.6.2.2.3. Increase of the reference mass declared by the manufacturer for a protective structure already tested. If the manufacturer wants to keep the same approval number it is possible to issue an extension report after having carried out a validation test (the limits of ± 7% specified in 3.6.2.2.2.2 are not applicable in such a case).

3.7. [Not applicable]

3.8. **Cold weather performance of protective structures**

3.8.1. If the protective structure is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details which shall be included in the report.

3.8.2. The following requirements and procedures are intended to provide strength and resistance to brittle fracture at reduced temperatures. It is suggested that the following minimum material requirements shall be met in judging the protective structure's suitability at reduced operating temperatures in those countries requiring this additional operating protective.

3.8.2.1. Bolts and nuts used to attach the protective structure to the tractor and used to connect structural parts of the protective structure shall exhibit suitable controlled reduced temperature toughness properties.

3.8.2.2. All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the protective structure material as given in 3.8.2.3 below

3.8.2.3. Steel materials for structural members of the protective structure shall be of controlled toughness material exhibiting minimum Charpy V-Notch impact energy requirements as shown in Table 8.2. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003.

Steel with an as-rolled thickness less than 2.5 mm and with a carbon content less than 0.2 per cent is considered to meet this requirement.

Structural members of the protective structure made from materials other than steel shall have equivalent low temperature impact resistance.

3.8.2.4. When testing the Charpy V-Notch impact energy requirements, the specimen size shall be no less than the largest of the sizes stated in Table 8.2 that the material will permit

3.8.2.5. The Charpy V-Notch tests shall be made in accordance with the procedure in ASTM A 370-1979, except for specimen sizes which shall be in accordance with the dimensions given in table 8.2.

3.8.2.6. Alternatives to this procedure are the use of killed or semi-killed steel for which an adequate specification shall be provided. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003

3.8.2.7. Specimens are to be longitudinal and taken from flat stock, tubular or structural sections before forming or welding for use in the protective structure. Specimens from tubular or structural sections are to be taken from the middle of the side of greatest dimension and shall not include welds

Machine mass, M	**Lateral load force, F**	**Lateral load energy, U**	**Vertical load force, F**	**Longitudinal load force, F**
kg	N	J	N	N
800<M≤4630	6M	$13000(M/10000)^{1.25}$	20M	4.8M
4630<M≤59500	$70000(M/10000)^{1.2}$	$13000(M/10000)^{1.25}$	20M	$56000(M/10000)^{1.2}$
M>59500	10M	2.03M	20M	8M

Table 8.1

1.1.1. Force and energy equations

Specimen size	Energy at	Energy at
	- 30 °C	**- 20 °C**
mm	**J**	**J[b)]**
10 x 10[a)]	11	27.5
10 x 9	10	25
10 x 8	9.5	24
10 x 7,5[a)]	9.5	24
10 x 7	9	22.5
10 x 6.7	8.5	21
10 x 6	8	20
10 x 5[a)]	7.5	19
10 x 4	7	17.5
10 x 3.5	6	15
10 x 3	6	15
10 x 2.5[a)]	5.5	14

Table 8.2

Minimum Charpy V-notch impact energies

a) Indicates preferred size. Specimen size shall be no less than largest preferred size that the material permits.

b) The energy requirement at – 20 °C is 2.5 times the value specified for – 30 °C. Other factors affect impact energy strength, i.e. direction of rolling, yield strength, grain orientation and welding. These factors shall be considered when selecting and using steel.

Figure 8.1

Apparatus for determination of seat index point (SIP)

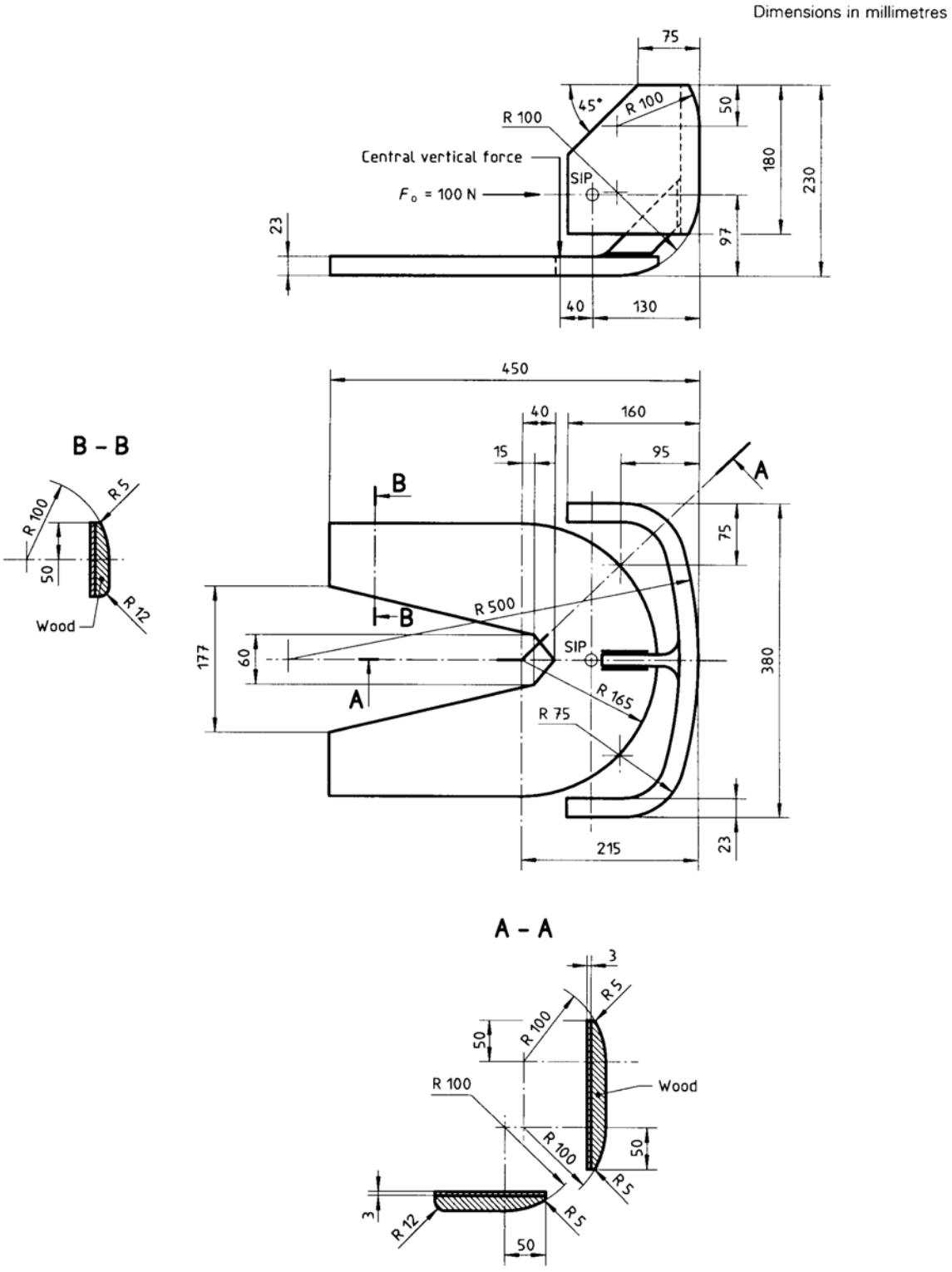


Figure 8.2

Intrusion of vertical simulated ground plane into DLV

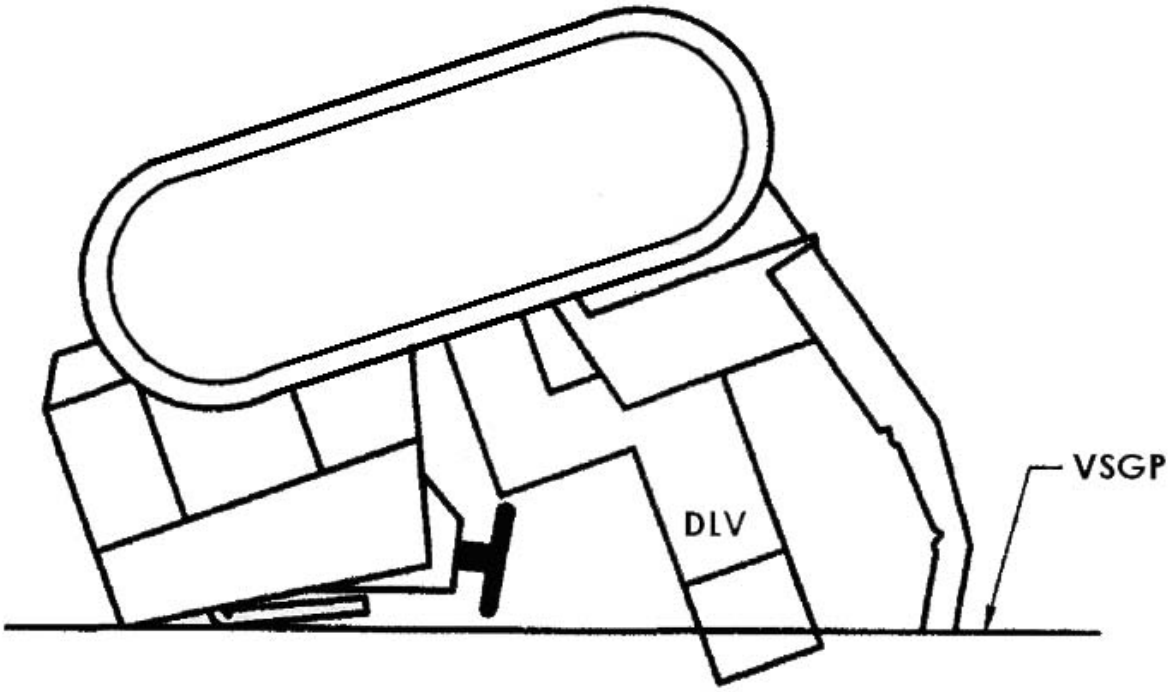


Figure 8.3

Deflection-limiting volume (DLV)

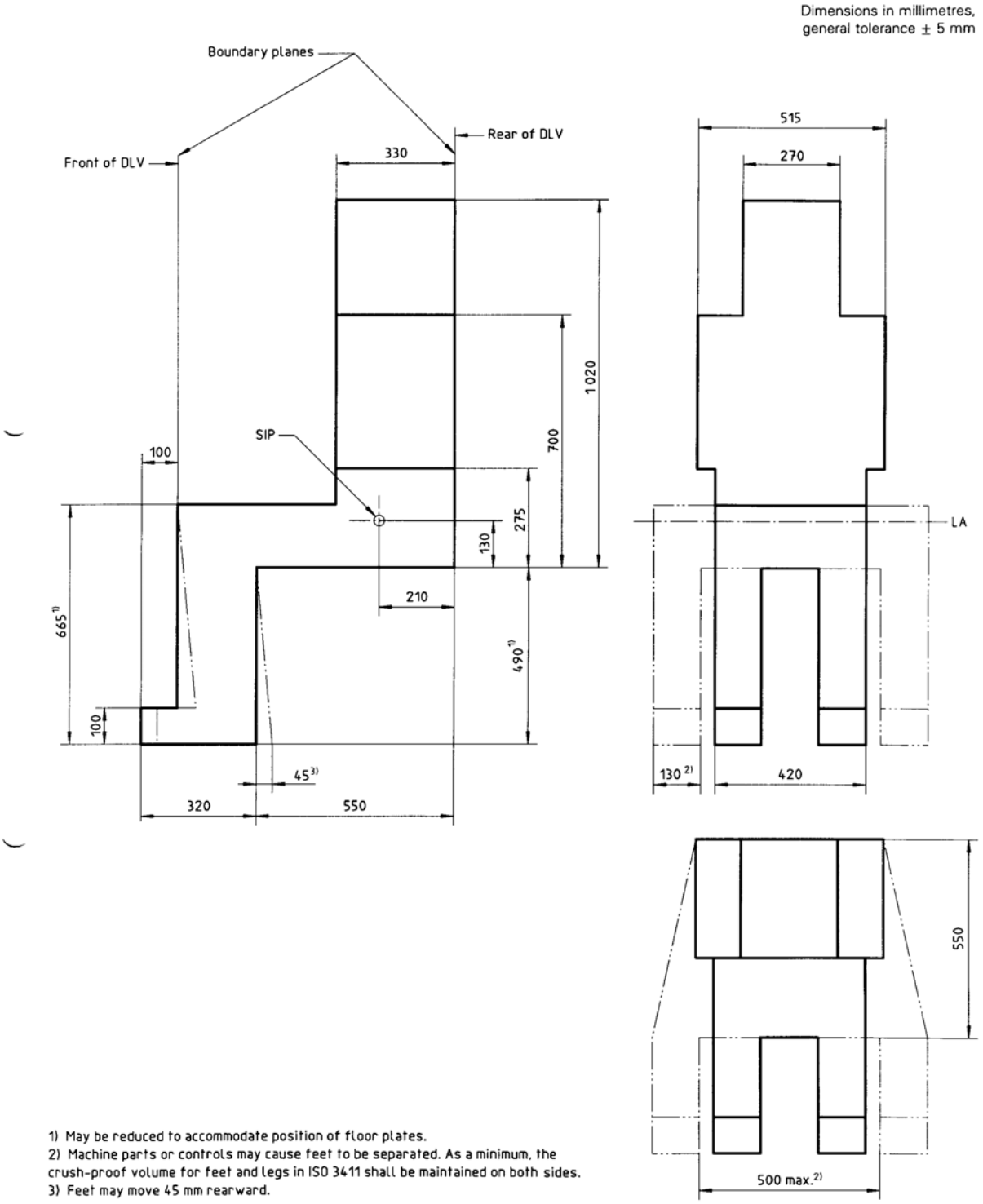


Figure 8.4

Two-post front-mounted protective structure, side view

Deflection-limiting volume (DLV)

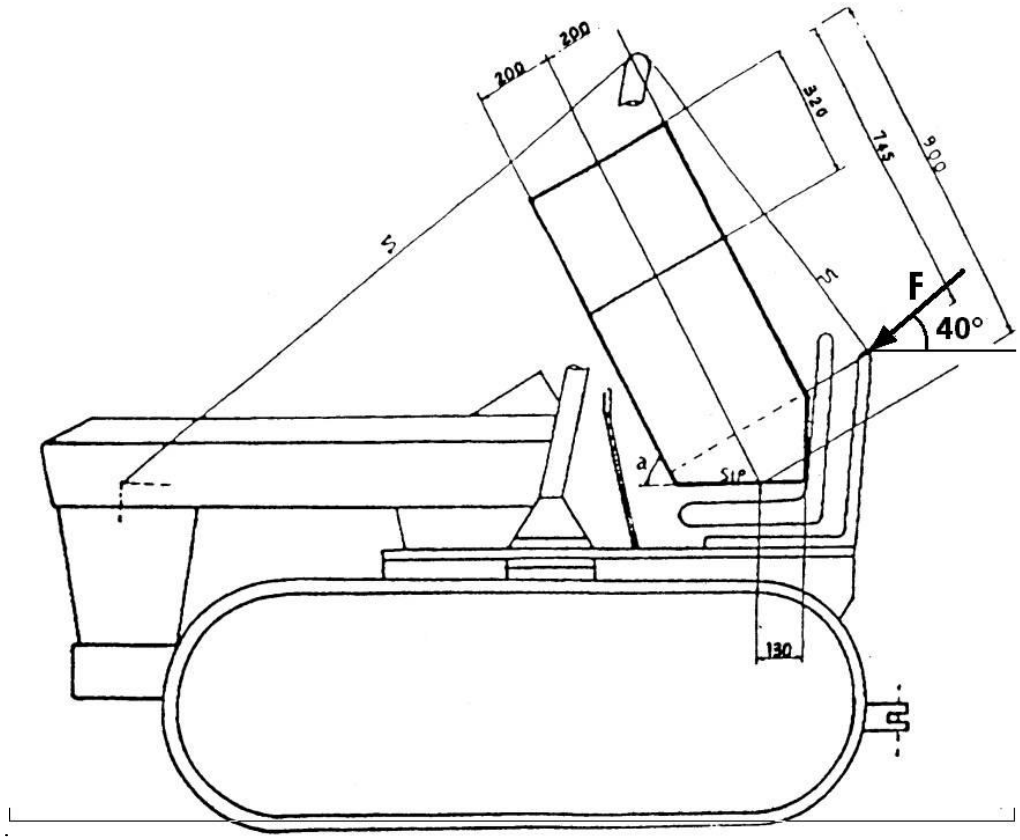


Figure 8.5

Two-post front-mounted protective structure, rear view

Deflection-limiting volume (DLV)

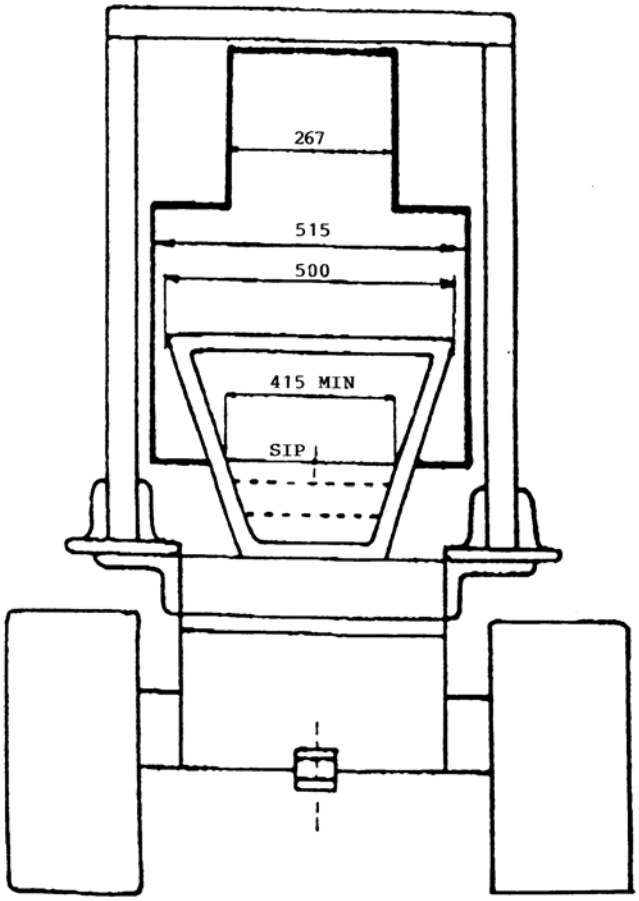


Figure 8.6

Typical arrangement for fastening the protective structure to the tractor frame

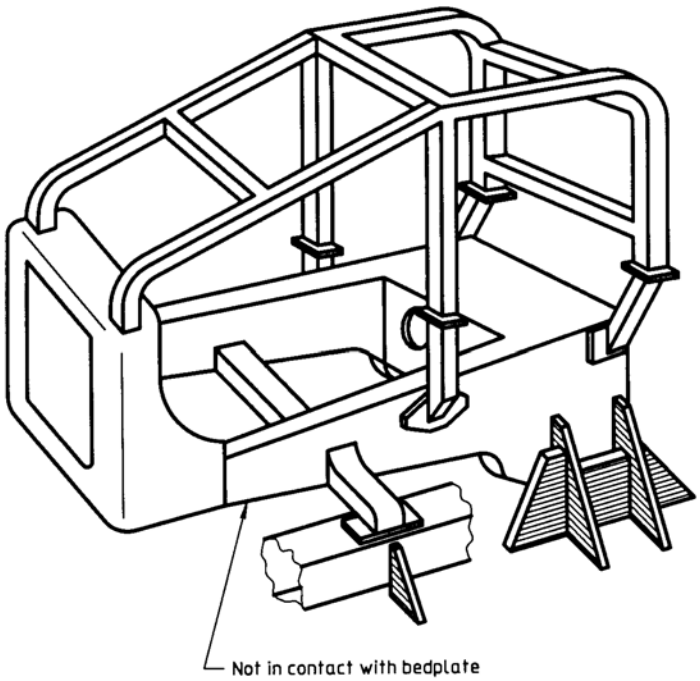


Figure 8.7

Typical arrangement for protective structure side loading

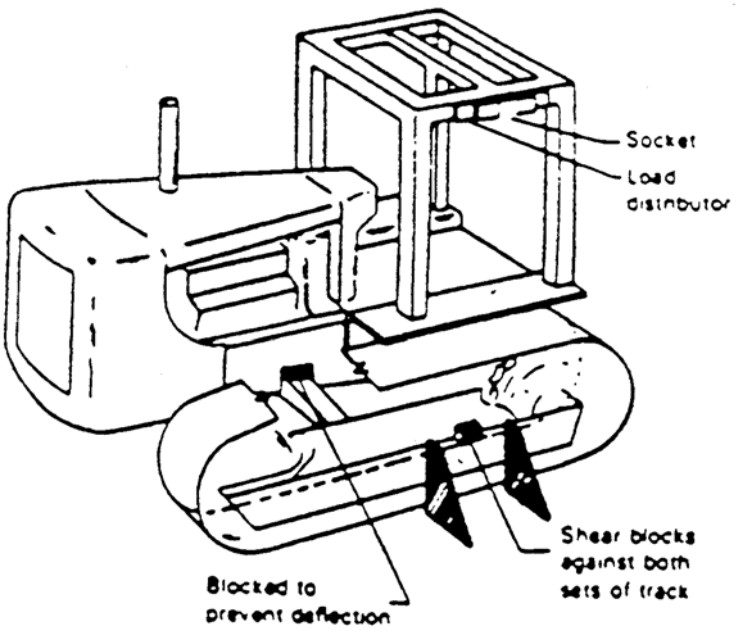


Figure 8.8

Typical arrangement for fixing the tractor frame and applying vertical load

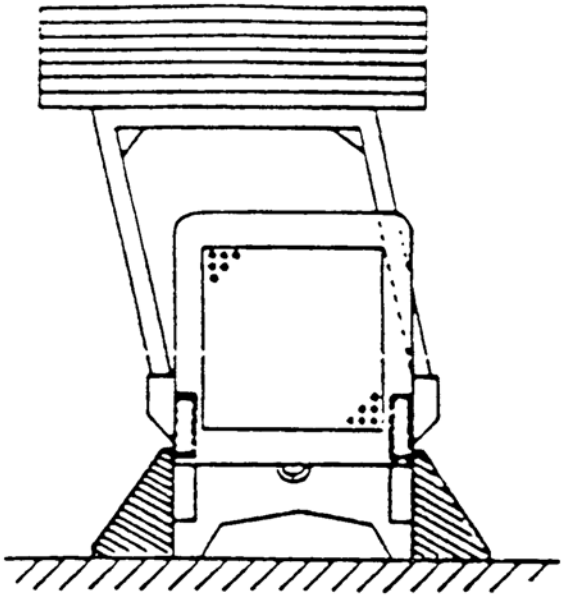


Figure 8.9

Typical arrangement for applying vertical load to the protective structure

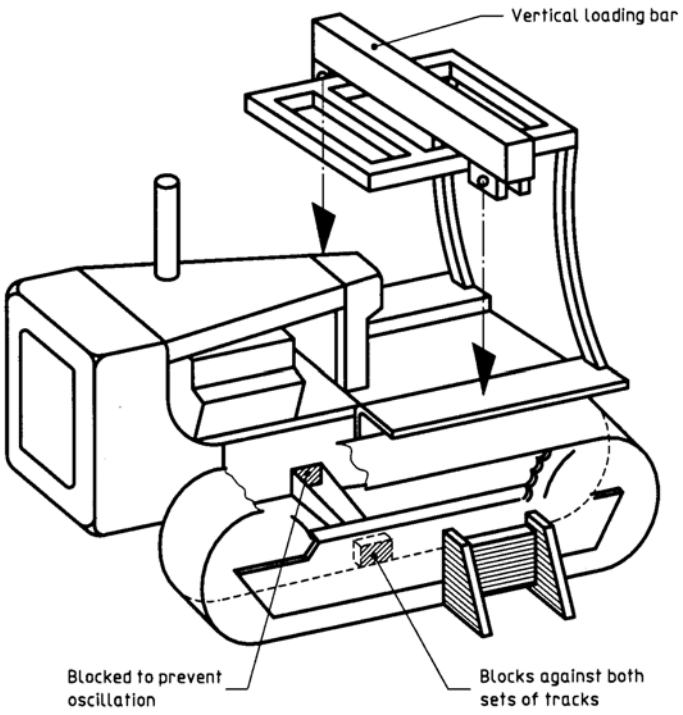
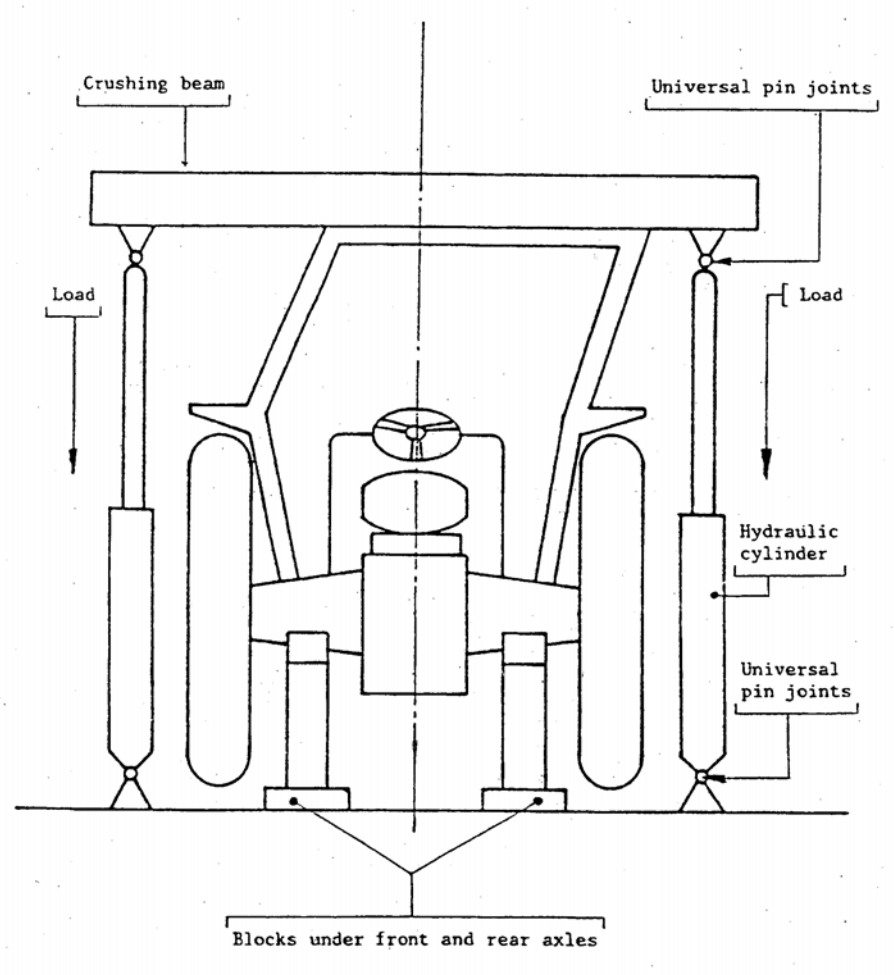


Figure 8.10

Example of an arrangement for crushing test



Figures 8.11

Position of beam for front and rear crushing tests,

protective cab and rear roll bar frame

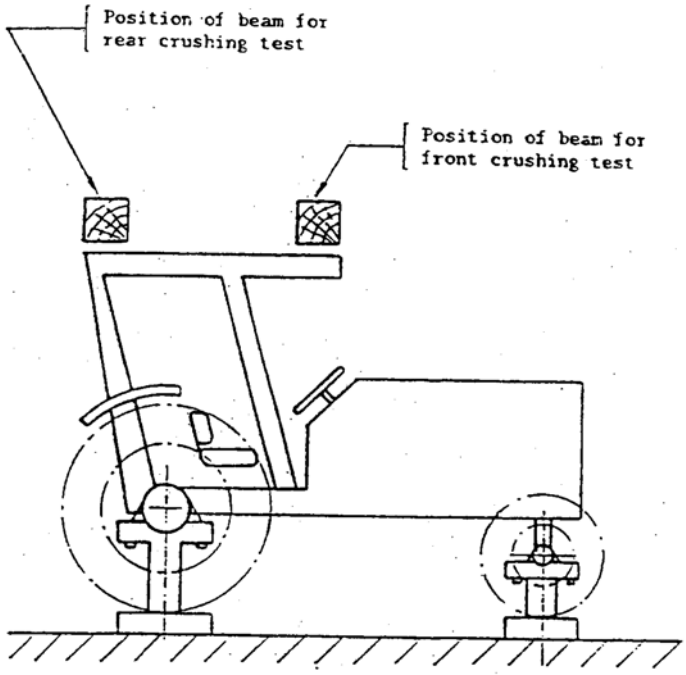


Figure 8.11.a **Protective cab**

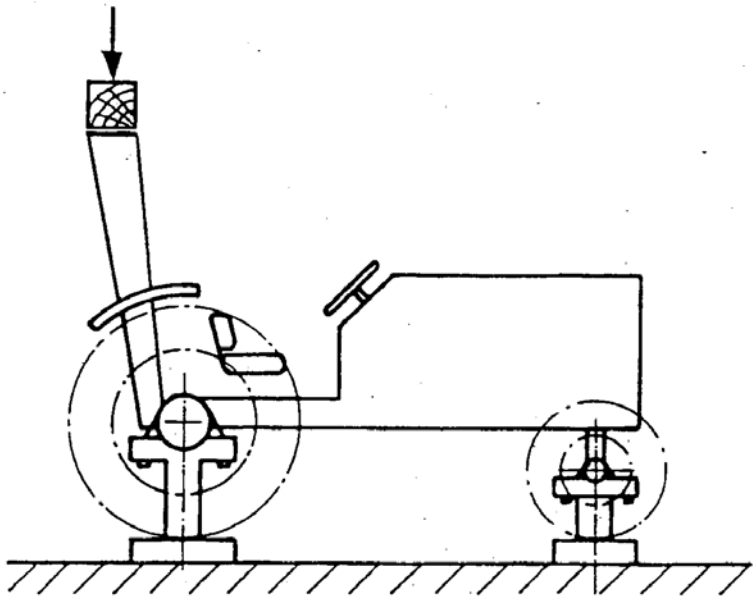


Figure 8.11.b **Rear roll bar frame**

Figures 8.12

Position of beam for front crushing test

when full crushing force not sustained in front

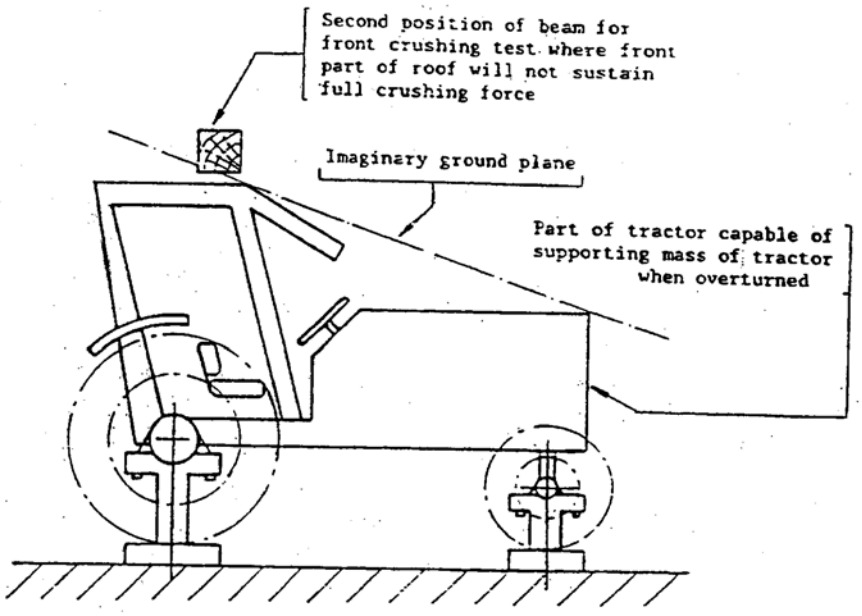


Figure 8.12.a **Protective cab**

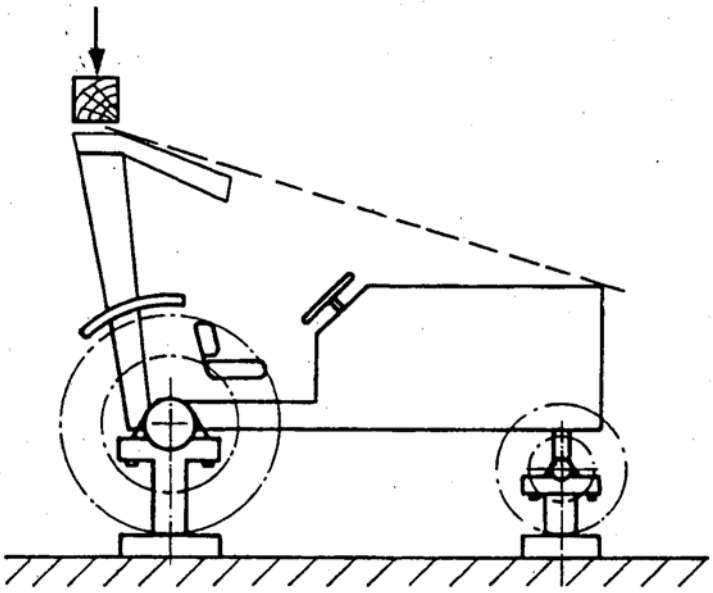
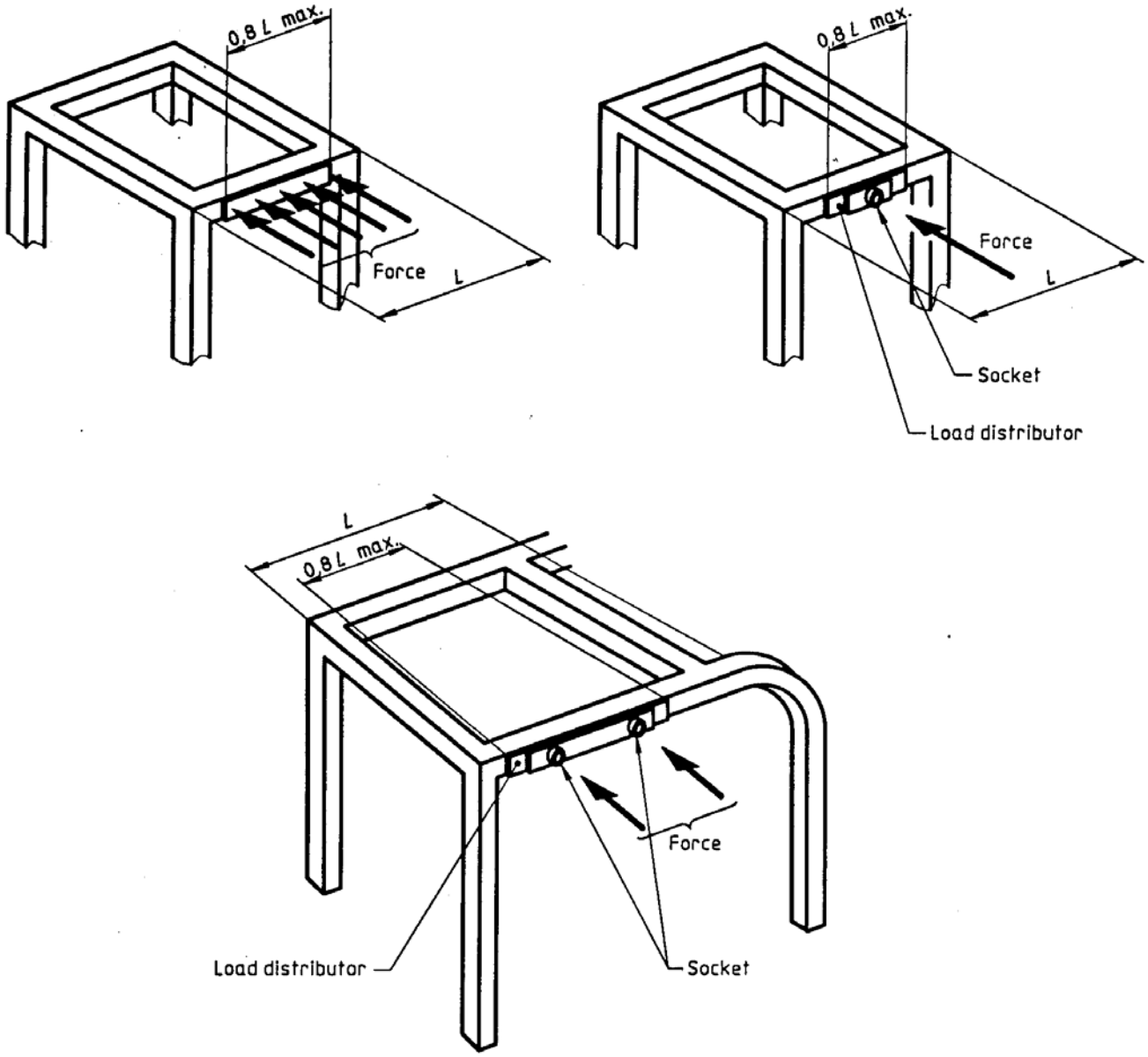


Figure 8.12.b **Rear roll bar frame**

Figures 8.13 and 8.14
Structure with four-post system
Load-distribution devices, side loading

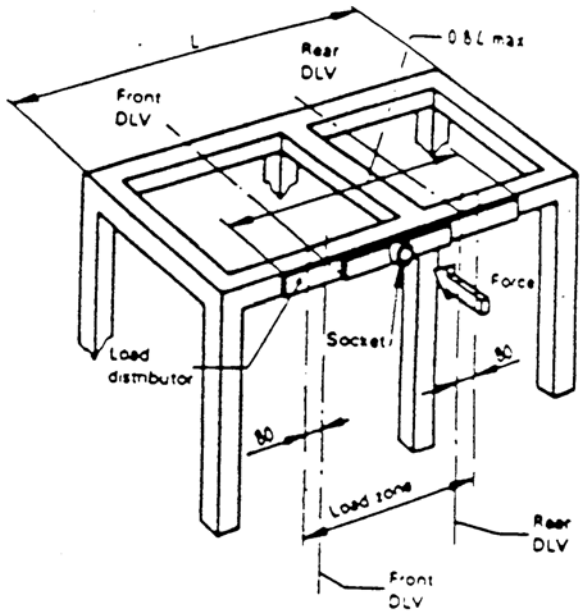


Load distributor and sockets are to prevent local penetration and to hold end load-generating device

Figure 8.15

Structure with more than a four-post system

Load-distribution device, side loading

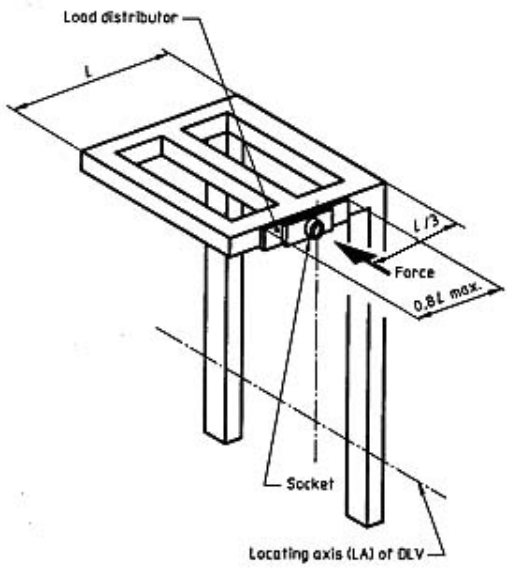


Load distributor and socket are to prevent penetration and to hold end load generating device

Figure 8.16

Structure with two-post system

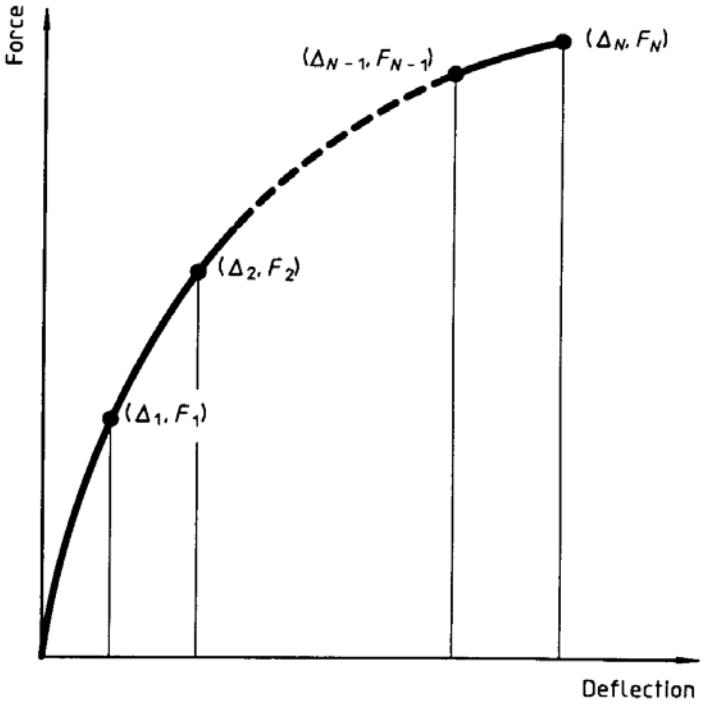
Load-distribution device, side loading



Load distributor and socket are to prevent penetration and to hold end load generating device

Figure 8.17

Force-deflection curve for loading tests



Energy

$$U = \frac{\Delta_1 F_1}{2} + (\Delta_2 - \Delta_1)\frac{F_1 + F_2}{2} + \ldots$$

$$+ (\Delta_N - \Delta_{N-1})\frac{F_{N-1} + F_N}{2}$$

To obtain the energy in joules, divide the area beneath the force-deflection curve by 1000.

Figure 8.18

Longitudinal load application point

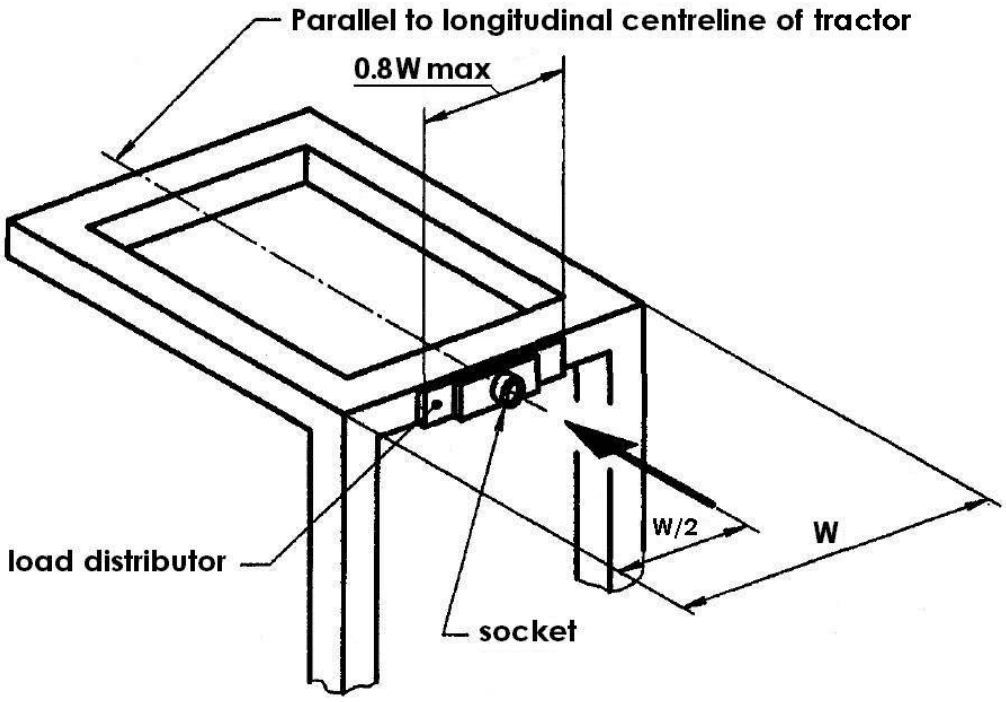
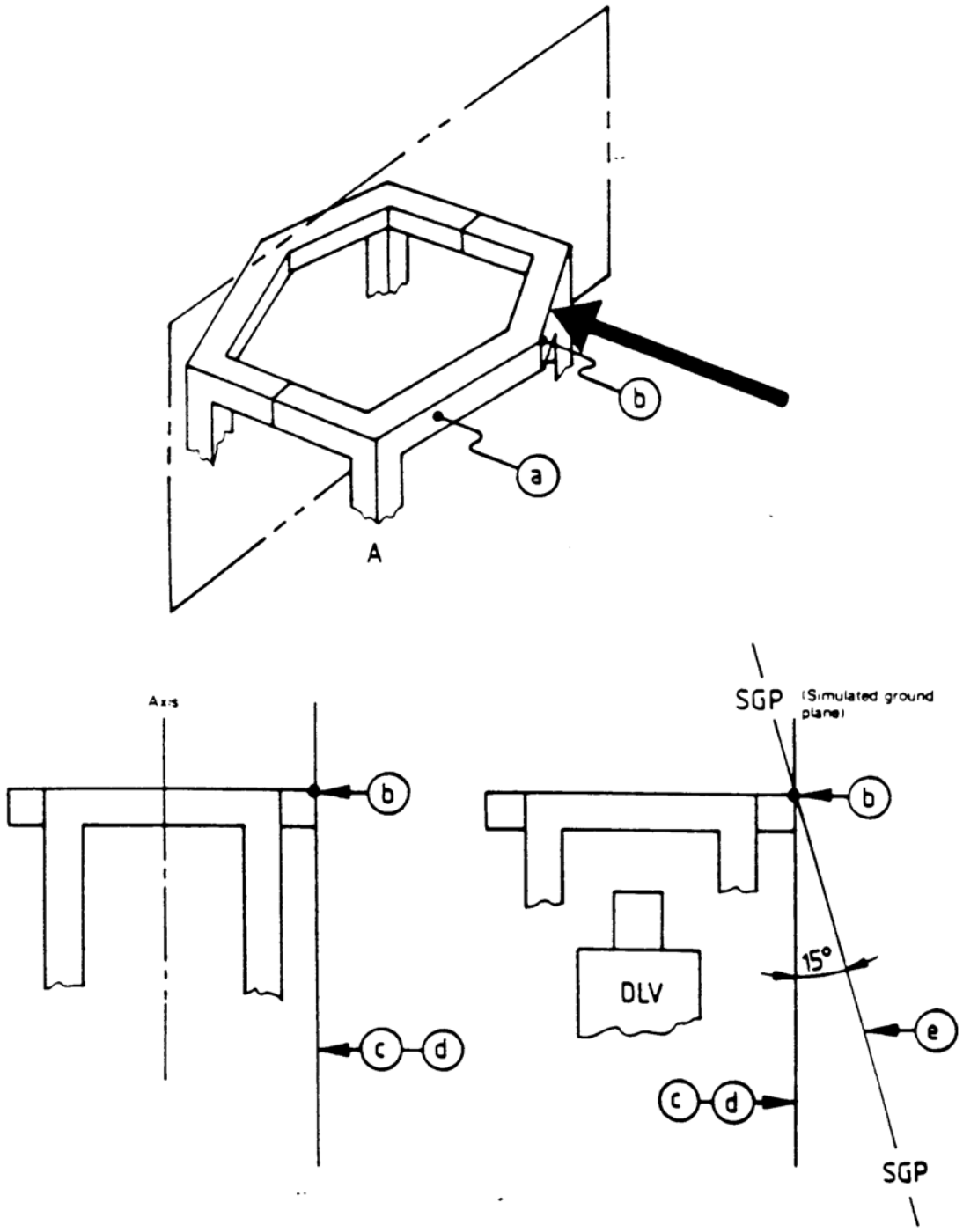


Figure 8.19

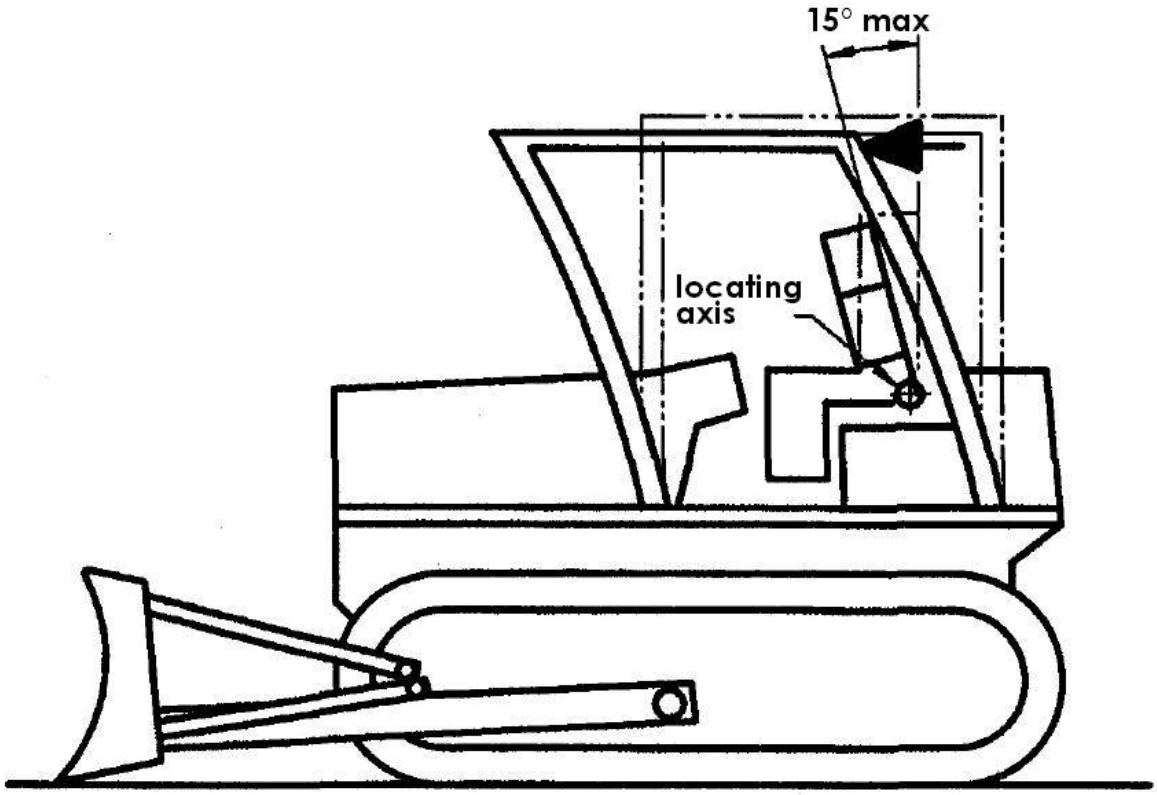
Deflection-limiting volume (DLV) application - determination of the lateral simulated ground plane (SGP)



Note: See paragraph 1.11 for the meaning of **a** to **e**.

Figure 8.20

Allowable rotation of upper DLV about locating axis (LA)



Explanatory notes to Annex VII

(1) Unless otherwise stated, the text of the requirements and the numbering set out in point B are identical with the text and numbering of the OECD standard code for the official testing of protective structures on agricultural and forestry track-laying tractors, OECD Code 8, Edition 2015 of July 2014.

(2) Permanent + elastic deflection measured at the point when the required energy level is obtained.

ANNEX VIII

Requirements applying to roll- over protection structures (static testing)

A. **General provision**

1. The Union requirements applying to roll-over protection structures (static testing) are set out in point B.

B. **Requirements applying to roll-over protection structures (static testing)[(1)]**

1. **DEFINITIONS**

1.1. [Not applicable]

1.2. ***Roll-Over Protective Structure (ROPS)***

Roll-over protective structure (protective cab or frame), hereinafter called "protective structure", means the structure on a tractor the essential purpose of which is to avoid or limit risks to the driver resulting from roll-over of the tractor during normal use.

The roll-over protective structure is characterized by the provision of space for a clearance zone large enough to protect the driver when seated either inside the envelope of the structure or within a space bounded by a series of straight lines from the outer edges of the structure to any part of the tractor that might come into contact with flat ground and that is capable of supporting the tractor in that position if the tractor overturns.

1.3. ***Track***

1.3.1. Preliminary definition: median plane of the wheel or track

The median plane of the wheel or track is equidistant from the two planes containing the periphery of the rims or tracks at their outer edges.

1.3.2. Definition of track

The vertical plane through the wheel axis intersects its median plane along a straight line which meets the supporting surface at one point. If **A** and **B** are the two points thus defined for the wheels on the same axle of the tractor, then the track width is the distance between points **A** and **B**. The track may be thus defined for both front and rear wheels. Where there are twin wheels, the track is the distance between two planes each being the median plane of the pairs of wheels.

For track-laying tractors, the track is the distance between the median planes of the tracks.

1.3.3. Additional definition: median plane of the tractor

Take the extreme positions of points **A** and **B** for the tractor rear axle, which gives the maximum possible value for the track. The vertical plane at right angles to the line **AB** at its centre point is the median plane of the tractor.

1.4. ***Wheelbase***

The distance between the vertical planes passing through the two lines **AB** as defined above, one for the front wheels and one for the rear-wheels.

1.5. Determination of seat index point; Seat location and adjustment for test

1.5.1. Seat index point (SIP)[(2)]

The seat index point shall be determined in accordance with ISO 5353:1995

1.5.2. Seat location and adjustment for test

1.5.2.1. where the seat position is adjustable, the seat must be adjusted to its rear uppermost position;

1.5.2.2. where the inclination of the backrest is adjustable, it must be adjusted to the mid position;

1.5.2.3. where the seat is equipped with suspension, the latter must be blocked at mid-travel, unless this is contrary to the instructions clearly laid down by the seat manufacturer;

1.5.2.4. where the position of the seat is adjustable only lengthwise and vertically, the longitudinal axis passing through the Seat Index Point shall be parallel with the vertical longitudinal plane of the tractor passing through the centre of the steering wheel and not more than 100 mm from that plane.

1.6. ***Clearance zone***

1.6.1. Reference plane for seat and steering wheel

The clearance zone is illustrated in figures 4.11 to 4.13 and Table 4.2. The zone is defined in relation to the reference plane and the Seat Index Point. The reference plane is defined at the beginning of the series of loadings; it is a vertical plane, generally longitudinal to the tractor and passing through the Seat Index Point and the centre of the steering wheel. Normally the reference plane coincides with the longitudinal median plane of the tractor. This reference plane shall be assumed to move horizontally with the seat and steering wheel during loading but to remain perpendicular to the tractor or the floor of the roll-over protective structure. The clearance zone shall be defined on the basis of Sections 1.6.2 and 1.6.3 below.

1.6.2. Determination of the clearance zone for tractors with a non-reversible seat

The clearance zone for tractors with a non-reversible seat is defined in 1.6.2.1 to 1.6.2.10 below and is bounded by the following planes, the tractor being on a horizontal surface, the seat adjusted and located as specified in Sections 1.5.2.1 to 1.5.2.4[(2)], and the steering wheel, where adjustable, adjusted to the mid position for seated driving:

1.6.2.1. a horizontal plane **A_1 B_1 B_2 A_2**, (810 + a_v) mm above the Seat Index Point with line B_1B_2 located (a_h - 10) mm behind the SIP;

1.6.2.2. an inclined plane **G_1 G_2 I_2 I_1**, perpendicular to the reference plane, including both a point 150 mm behind line B_1B_2 and the rearmost point of the seat backrest;

1.6.2.3. a cylindrical surface **A_1 A_2 I_2 I_1** perpendicular to the reference plane, having a radius of 120 mm, tangential to the planes defined in 1.6.2.1 and 1.6.2.2 above;

1.6.2.4. a cylindrical surface **B_1 C_1 C_2 B_2**, perpendicular to the reference plane, having a radius of 900 mm extending forward for 400 mm and tangential to the plane defined in 1.6.2.1 above along line B_1B_2;

1.6.2.5. an inclined plane **C_1 D_1 D_2 C_2**, perpendicular to the reference plane, joining the surface defined in 1.6.2.4 above and passing 40 mm from the forward external edge of the steering wheel. In the case of a high steering wheel position, this plane extends forward from line B_1B_2 tangentially to the surface defined in 1.6.2.4 above;

1.6.2.6. a vertical plane **D_1 E_1 E_2 D_2** perpendicular to the reference plane 40 mm forward of the external edge of the steering wheel;

1.6.2.7. a horizontal plane **E_1 F_1 F_2 E_2** passing through a point (90 - a_v) mm below the Seat Index Point;

1.6.2.8. a surface **G_1 F_1 F_2 G_2**, if necessary curved from the bottom limit of the plane defined in 1.6.2.2 above to the horizontal plane defined in 1.6.2.7 above, perpendicular to the reference plane, and in contact with the seat backrest throughout its length;

1.6.2.9. vertical planes **J_1 E_1 F_1 G_1 H_1** and **J_2 E_2 F_2 G_2 H_2**. These vertical planes shall extend upwards from plane **E_1 F_1 F_2 E_2** for 300 mm; the distances **E_1 E_0** and **E_2 E_0** shall be 250 mm;

1.6.2.10. parallel planes **A_1 B_1 C_1 D_1 J_1 H_1 I_1** and **A_2 B_2 C_2 D_2 J_2 H_2 I_2** inclined so that the upper edge of the plane on the side on which the force is applied is at least 100 mm from the vertical reference plane.

1.6.3. Determination of clearance zone for tractors with a reversible driver's position

For tractors with a reversible driver's position (reversible seat and steering wheel), the clearance zone is the envelope of the two clearance zones defined by the two different positions of the steering wheel and the seat.

1.6.4. Optional seats

1.6.4.1. In case of tractors that could be fitted with optional seats, the envelope comprising the Seat Index Points of all options offered shall be used during the tests. The protective structure shall not enter the larger clearance zone which takes account of these different Seat Index Points.

1.6.4.2. In the case where a new seat option is offered after the test has been performed, a determination shall be made to see whether the clearance zone around the new SIP falls within the envelope previously established. If it does not, a new test must be performed.

1.6.4.3. Optional seat does not include a seat for a person in addition to the driver and from

where the tractor cannot be controlled. The SIP shall not be determined because the definition of the clearance zone is in relation to the driver seat.

1.7. ***Mass***

1.7.1. Unballasted Mass

The mass of the tractor without ballasting devices and, in the case of tractors with pneumatic tyres, without liquid ballast in the tyres. The tractor shall be in running order with tanks, circuits and radiator full, protective structure with cladding and any track equipment or additional front wheel drive components required for normal use. The operator is not included.

1.7.2. Maximum Permissible Mass

The maximum mass of the tractor stated by the manufacturer to be technically permissible and declared on the vehicle's identification plate and/or in the Operator's Handbook;

1.7.3. Reference Mass

The mass selected by the manufacturer for calculation of the energy inputs and crushing forces to be used in the tests. Must not be less than the unballasted mass and must be sufficient to ensure the Mass Ratio does not exceed 1.75 *(see Section 1.7.4).*

1.7.4. Mass Ratio

The ratio of $\left(\frac{\text{Max. Permissible Mass}}{\text{Reference Mass}}\right)$ This must not be greater than 1.75.

1.8.

Permissible measurement tolerances

Time	± 0.1 s
Distance	± 0.5 mm
Force	± 0.1 % (of the sensor full scale)
Angle	± 0.1°
Mass	± 0.2 % (of the sensor full scale)

1.9. ***Symbols***

a_h	(mm)	Half of the horizontal seat adjustment
a_v	(mm)	Half of the vertical seat adjustment
D	(mm)	Deflection of the protective structure at the point of and in line with the load application
D'	(mm)	Deflection of the protective structure for the calculated energy required
E_{IS}	(J)	Energy input to be absorbed during side loading
E_{IL1}	(J)	Energy input to be absorbed during longitudinal loading
E_{IL2}	(J)	Energy input to be absorbed in case of a second longitudinal loading
F	(N)	Static load force
F_{max}	(N)	Maximum static load force occurring during loading, with the exception of the overload
F'	(N)	Force for the calculated energy required
M	(kg)	Reference mass used for calculating energy inputs and crushing forces

2. FIELD OF APPLICATION

2.1. This Annex is applicable to tractors having at least two axles for pneumatic tyred wheels or having tracks instead of wheels and with an unballasted tractor mass not less than 600 kg. The Mass Ratio (Maximum Permissible Mass / Reference Mass) must not be greater than 1.75.

2.2. The minimum track width of the rear-wheels should generally be greater than 1 150 mm. It is recognised that there may be designs of tractors, for example, lawn mowers, narrow vineyard tractors, low profile tractors used in buildings with limited overhead clearance or in orchards, high-clearance tractors and special forestry machines, such as forwarders and skidders, for which this Annex is not applicable.

3. RULES AND DIRECTIONS

3.1. *General regulations*

3.1.1. The protective structure may be manufactured either by the tractor manufacturer or by an independent firm. In either case a test is only valid for the model of tractor on which it is carried out. The protective structure must be retested for each model of tractor to which it is to be fitted. However, testing stations may certify that the strength tests are also valid for tractor models derived from the original model by modifications to the engine, transmission and steering and front suspension. On the other hand, more than one protective structure may be tested for any one model of tractor.

3.1.2. The protective structure submitted for static test must be supplied attached in the normal manner to the tractor or tractor chassis on which it is used. The tractor chassis shall be complete including attaching brackets and other parts of the tractor that may be affected by loads imposed on the protective structure.

3.1.3. Where a "tandem" tractor is concerned, the mass of the standard version of that part to which the protective structure is fitted is to be used.

3.1.4. A protective structure may be designed solely to protect the driver in the event of the tractor overturning. Onto this structure it may be possible to fit weather protection for the driver, of a more or less temporary nature. The driver will usually remove this in warm weather. There are protective structures however, in which the cladding is permanent and warm weather ventilation provided by windows or flaps. As the cladding may add to the strength of the structure and if removable may well be absent when an accident occurs, all parts that can be so taken away by the driver will be removed for the purpose of the test. Doors, roof hatch and windows that can be opened shall be either removed or fixed in the open position for the test, so that they do not add to the strength of the protective structure. It shall be noted whether, in this position, they would create a hazard for the driver in the event of overturning.

Throughout the remainder of these rules, reference will only be made to testing the protective structure. It must be understood that this includes cladding not of a temporary nature.

A description of any temporary cladding supplied is to be included in the specifications. All glass or similar brittle material shall be removed prior to the test**.** Tractor and protective structure components which might sustain needless damage

during the test and which do not affect the strength of the protective structure or its dimensions may be removed prior to the test if the manufacturer wishes. No repairs or adjustment may be carried out during the test.

3.1.5. Any component of the tractor contributing to the strength of the protective structure such as mud-guards, which has been reinforced by the manufacturer, should be described and its measurements given in the test report.

3.2. ***Apparatus***

For verifying that the clearance zone has not been entered during the test, means shall be used as described in point 1.6, figures 4.11 to 4.13 and Table 4.2.

3.2.1. **Horizontal loading tests** (figures 4.1 to 4.5)

The following shall be used in horizontal loading tests:

3.2.1.1. material, equipment and means of attachment to ensure that the tractor chassis is firmly fixed to the ground and supported independently of the tyres;

3.2.1.2. device for applying a horizontal force to the protective structure; provision shall be made so that the load can be uniformly distributed normal to the direction of loading;

3.2.1.2.1. a beam of length not less than 250 mm nor more than 700 mm in exact multiples of 50 mm between these lengths shall be used. The beam shall have a vertical dimension of 150 mm;

3.2.1.2.2. the edges of the beam in contact with the protective structure shall be curved with a maximum radius of 50 mm;

3.2.1.2.3. universal joints or the equivalent shall be incorporated to ensure that the loading device does not constrain the protective structure in rotation or translation in any direction other than the direction of loading;

3.2.1.2.4. where the straight line defined by the appropriate beam on the protective structure is not normal to the direction of application of load the space shall be packed so as to distribute the load over the full length;

3.2.1.3. equipment for measuring force and deflection in the load direction, relative to the tractor chassis. To ensure accuracy, measurements shall be taken as continuous readings. The measuring devices shall be located so as to record the force and deflection at the point of, and along the line of, loading.

3.2.2. **Crushing tests** (figures 4.6 to 4.8)

The following shall be used in crushing tests:

3.2.2.1. material, equipment and means of attachment to ensure that the tractor chassis is firmly fixed to the ground and supported independently of the tyres ;

3.2.2.2. device for applying a downward force to the protective structure, including a stiff beam

with a width of 250 mm ;

3.2.2.3. equipment for measuring the total vertical force applied.

3.3. ***Test conditions***

3.3.1. The protective structure shall be to production specifications and shall be fitted to the appropriate tractor model chassis in accordance with the manufacturer's declared method of attachment.

3.3.2. The assembly shall be secured to the bedplate so that the members connecting the assembly and the bedplate do not deflect significantly in relation to the protective structure under load. The assembly shall not receive any support under load other than that due to the initial attachment.

3.3.3. An adjustable track width setting for the wheels or tracks, if present, shall be chosen such that no interference exists with the protective structure during the tests.

3.3.4. The protective structure shall be instrumented with the necessary equipment to obtain the required force-deflection data.

3.3.5. All tests shall be performed on the same protective structure. No repairs or straightening of any members shall be carried out between any parts of the test

3.3.6. On completion of all tests, permanent deflections of the protective structure shall be measured and recorded.

3.4. ***Sequence of tests***

Tests shall be conducted in the following sequence:

3.4.1. **Longitudinal loading**

For a wheeled tractor with at least 50 % of its mass on the rear axle and for track-laying tractors, the longitudinal loading shall be applied from the rear. For other tractors the longitudinal loading shall be applied from the front.

3.4.2. **First crushing test**

The first crushing test shall be applied at the same end of the protective structure as the longitudinal loading

3.4.3. **Loading from the side**

In the case of an offset seat or non-symmetrical strength of the protective structure, the side loading shall be on the side most likely to lead to infringement of the clearance zone.

3.4.4. **Second crushing test**

The second crushing test shall be applied at the end of the protective structure opposite from that receiving the first longitudinal loading. In the case of two-post designs, the second crush may be at the same point as the first crush.

3.4.5. **Second longitudinal loading**

3.4.5.1. A second longitudinal loading shall be applied to tractors fitted with a folding (e.g. two posts) or tiltable (e.g. non-two posts) protective structure, if one or more of the following conditions exists:

Temporary folding for special operating conditions;

Structures designed to tilt for service, unless the tilt mechanism is independent from the structural integrity of the roll-over protective structure.

3.4.5.2. For folding protective structures, if the first longitudinal loading was applied in the folding direction then a second longitudinal loading is not required.

3.5. ***Horizontal loading tests from the rear, front and side***

3.5.1. **General provisions**

3.5.1.1. The load applied to the protective structure shall be distributed uniformly by means of a stiff beam, normal to the direction of load application (see 3.2.1.2). The stiff beam may be equipped with a means of preventing its sideways displacement. The rate of load application shall be such that it can be considered static. As the load is applied, force and deflection shall be recorded as a continuous record to ensure accuracy. Once the initial application has commenced, the load shall not be reduced until the test has been completed. The direction of the applied force shall be within the following limits:

at start of test (no load): ± 2°;

during test (under load): 10° above and 20° below the horizontal.

The rate of load application shall be considered static if the rate of deflection under loading is not greater than 5 mm/s.

3.5.1.2. If no structural cross member exists at the point of load application, a substitute test beam which does not add strength will be utilised.

3.5.2. **Longitudinal loading** (figures 4.1 and 4.2)

The load shall be applied horizontally and parallel to the median plane of the tractor. If the load is applied from the rear (Section 3.4.1), the longitudinal load and the lateral load shall be applied on different sides of the median plane of the tractor. If the longitudinal load is applied from the front, it shall be on the same side as the side load.

The load shall be applied to the uppermost transverse structural member of the protective structure (i.e. that part which would be likely to strike the ground first in an

overturn).

The point of application of the load shall be located at one sixth of the width of the top of the protective structure inwards from the outside corner. The width of the protective structure shall be taken as the distance between two lines parallel to the median plane of the tractor touching the outside extremities of the protective structure in the horizontal plane touching the top of the uppermost transverse structural members.

In the event that the ROPS is formed of curved members and no appropriate corners exist, the following general procedure shall apply for determining W. The test engineer shall identify the curved member most likely to first strike ground in the event of an asymmetrical rear or front overturn (e.g. an overturn to the front or rear where one side of the ROPS is likely to bear the initial loading). The endpoints of W shall be the mid-points of the external radii created between other straight or curved members which form the uppermost ROPS structure. In the event that multiple curved members could be selected, the test engineer shall establish ground lines for each possible member to determine which surface is most likely to strike ground first. See figures 4.3 a) and b) for examples.

NOTE In the event of curved members, only the width at the end of the structure to which the longitudinal load is to be applied need be considered

The length of the load distribution device (see 3.2.1.2) shall be not less than one third of the width of the protective structure and not more than 49 mm greater than this minimum.

The longitudinal loading shall be stopped when:

3.5.2.1. the energy absorbed by the protective structure is equal to or greater than the required energy input**,** E_{IL1} where:

$$E_{IL1} = 1.4\,M$$

3.5.2.2. the protective structure infringes on the clearance zone or leaves the clearance zone unprotected (Condition of acceptance in 3.8 below).

3.5.3. **Side loading** (figures 4.4 and 4.5)

The side loading shall be applied horizontally at 90° to the median plane of the tractor. It shall be applied to the upper extremity of the protective structure at a point (160 - a_h) mm forward of the Seat Index Point.

For tractors with a reversible driver's position (reversible seat and steering wheel), it shall be applied to the upper extremity of the protective structure at the mid-point between the two Seat Index Points.

If it is certain that any particular part of the protective structure will touch ground first when the tractor overturns sideways, the loading shall be applied at that point, provided that this permits uniform distribution of the load as specified in 3.5.1.1. In the case of a two-post protective structure, side loading shall be applied at the structural member uppermost on the side, regardless of the seat index position.

Specifications for the load distribution beam are given in Section 3.2.1.2.1.

The side loading shall be stopped when:

3.5.3.1. The energy absorbed by the protective structure is equal to or greater than the required energy, E_{IS} , where:

$$E_{IS} = 1.75\ M$$

3.5.3.2. The protective structure infringes on the clearance zone or leaves the clearance zone unprotected (Condition of acceptance in 3.8 below).

3.6. ***Crushing tests***

3.6.1. **Crushing at the rear** (figures 4.6, 4.7.a to 4.7.e)

3.6.1.1. The crushing beam shall be positioned across the rear uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane of the tractor. The crushing force **F** shall be applied where:

$$F = 20\ M.$$

This force shall be maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.6.1.2. Where the rear part of the protective structure roof will not sustain the full crushing force, the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the protective structure with that part of the rear of the tractor capable of supporting the tractor when overturned. The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force **F = 20 M** shall then be applied.

3.6.2. **Crushing at the front** (figures 4.6 to 4.8)

3.6.2.1. The crushing beam shall be positioned across the front uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane of the tractor. The crushing force **F** shall be applied where:

$$F = 20\ M.$$

This force shall be maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.6.2.2. Where the front part of the roof of the protective structure will not sustain the full crushing force (figures 4.8.a and 4.8.b), the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the protective structure with that part of the front of the tractor capable of supporting the tractor when overturned. The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force **F = 20 M** shall then be applied.

3.7. ***Second longitudinal loading test***

The load shall be applied in the opposite direction to and at the corner farthest from the point of application of the first longitudinal load (figures 4.1 and 4.2).

The longitudinal loading shall be stopped when:

3.7.1. The energy absorbed by the protective structure is equal to or greater than the required energy, $\mathbf{E_{IL2}}$ **,** where :

$$E_{IL2} = 0.35\ M.$$

3.7.2. The protective structure infringes on the clearance zone or leaves the clearance zone unprotected (Condition of acceptance in 3.8 below

3.8. ***Conditions for acceptance***

For the protective structure to be accepted it shall fulfil the following conditions during and after completion of the tests:

3.8.1. no part shall enter the clearance zone during any part of the tests. No part may strike the seat during the tests. Furthermore, the clearance zone shall not be outside the protection of the protective structure. For this purpose, it shall be considered to be outside the protection of the structure if any part of it would come in contact with flat ground if the tractor overturned towards the direction from which the test load is applied. For estimating this, the tyres and track width setting shall be the smallest standard fitting specified by the manufacturer;

3.8.2. for the articulated tractors, the median planes of the two parts shall be assumed to be in line;

3.8.3. after the final crushing test, the permanent deflection of the protective structure shall be recorded. For this purpose, before the start of the test, the position of the main protective structure members in relation to the Seat Index Point must be recorded. Then any displacement of the members resulting from the loading tests and any change of the height of the front and back members of the roof of the protective structure shall be recorded;

3.8.4. at the point where the required energy absorption is met in each of the specified horizontal loading tests the force shall exceed $\mathbf{0.8\ F_{max}}$;

3.8.5. an overload test shall be required if the applied force decreases by more than 3 % over the last 5 % of the deflection attained when the energy required is absorbed by the structure (Figures 4.14 to 4.16). Description of the overload test:

3.8.5.1. an overload test shall consist of continuing the horizontal loading in increments of 5 % of the original required energy, up to a maximum of 20 % additional energy;

3.8.5.2. the overload test shall be successfully completed if after the absorption of 5, 10 or 15 % additional energy the force drops by less than 3 % for each 5 % energy increment whilst remaining greater than **0.8 F_{max}** or if, after the absorption of 20 % additional energy the force is greater than **0.8 F_{max}**;

3.8.5.3. additional cracks or tears or entry into or lack of protection of the clearance zone, due to elastic deformation, are permitted during the overload test. After removing the load, however, the protective structure shall not infringe on the clearance zone, which shall be completely protected;

3.8.6. the required force must be sustained in both crushing tests;

3.8.7. there shall be no protruding member or component which would be likely to cause serious injury during an overturning accident or which, through the deformation occurring, might trap the operator, for example by the leg or foot;

3.8.8. there shall be no other components presenting a serious hazard to the operator.

3.9. ***Extension to other tractor models***

3.9.1. [Not applicable]

3.9.2. Technical extension

When technical modifications occur on the tractor, the protective structure or the method of attachment of the protective structure to the tractor, the testing station that has carried out the original test can issue a “technical extension report” in the following cases:

3.9.2.1. Extension of the structural test results to other models of tractors

The loading and crushing tests need not be carried out on each model of tractor, provided that the protective structure and tractor comply with the conditions referred to hereunder 3.9.2.1.1 to 3.9.2.1.5

3.9.2.1.1. The structure shall be identical to the one tested;

3.9.2.1.2. The required energy shall not exceed the energy calculated for the original test by more than 5 %. The 5 % limit shall also apply to extensions in the case of substituting tracks for wheels on the same tractor;

3.9.2.1.3. The method of attachment and the tractor components to which the attachment is made shall be identical;

3.9.2.1.4. Any components such as mud-guards and bonnet that may provide support for the protective structure shall be identical;

3.9.2.1.5. The position and critical dimensions of the seat in the protective structure and the

relative position of the protective structure on the tractor shall be such that the clearance zone would have remained within the protection of the deflected structure throughout all tests (this shall be checked by using the same reference of clearance zone as in the original test report, respectively Seat Reference Point [SRP] or Seat Index Point [SIP]).

3.9.2.2. Extension of the structural test results to modified models of the protective structure.

This procedure has to be followed when the provisions of paragraph 3.9.2.1 are not fulfilled, it may not be used when the method of attachment of the protective structure to the tractor does not remain of the same principle (e.g. rubber supports replaced by a suspension device)

3.9.2.2.1. Modifications having no impact on the results of the initial test (e.g. weld attachment of the mounting plate of an accessory in a non-critical location on the structure), addition of seats with different SIP location in the protective structure (subject to checking that the new clearance zone(s) remain(s) within the protection of the deflected structure throughout all tests).

3.9.2.2.2. Modifications having a possible impact on the results of the original test without calling into question the acceptability of the protective structure (e.g. modification of a structural component, modification of the method of attachment of the protective structure to the tractor). A validation test can be carried out and the test results will be drafted in the extension report.

The following limits for this type extension are fixed.

3.9.2.2.2.1. No more than 5 extensions may be accepted without a validation test;

3.9.2.2.2.2. The results of the validation test will be accepted for extension if all the acceptance conditions of this Annex are fulfilled and if the force measured when the required energy level has been reached in the various horizontal load tests does not deviate from the force measured when the required energy has been reached in the original test by more than ± 7% and the deflection measured[3] when the required energy level has been reached in the various horizontal load tests does not deviate from the deflection measured when the required energy has been reached in the original test report by more than ± 7%.

3.9.2.2.2.3. More than one protective structure modifications may be included in a single extension report if they represent different options of the same protective structure, but only one validation test can be accepted in a single extension report. The options not tested shall be described in a specific section of the extension report.

3.9.2.2.3. Increase of the reference mass declared by the manufacturer for a protective structure already tested. If the manufacturer wants to keep the same approval number it is possible to issue an extension report after having carried out a validation test (the limits of ± 7% specified in 3.9.2.2.2.2 are not applicable in such a case).

3.10. [Not applicable]

3.11. ***Cold weather performance of protective structures***

3.11.1. If the protective structure is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details that shall be included in the report.

3.11.2. The following requirements and procedures are intended to provide strength and resistance to brittle fracture at reduced temperatures. It is suggested that the following minimum material requirements shall be met in judging the protective structure's suitability at reduced operating temperatures in those countries requiring this additional operating protection.

3.11.2.1. Bolts and nuts used to attach the protective structure to the tractor and used to connect structural parts of the protective structure shall exhibit suitable controlled reduced temperature toughness properties.

3.11.2.2. All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the protective structure material as given in 3.11.2.3 below.

3.11.2.3. Steel materials for structural members of the protective structure shall be of controlled toughness material exhibiting minimum Charpy V-Notch loading energy requirements as shown in Table 4.1. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003.

Steel with an as-rolled thickness less than 2.5 mm and with a carbon content less than 0.2 % is considered to meet this requirement. Structural members of the protective structure made from materials other than steel shall have equivalent low temperature loading resistance.

3.11.2.4. When testing the Charpy V-Notch loading energy requirements, the specimen size shall be no less than the largest of the sizes stated in Table 4.1 that the material will permit.

3.11.2.5. The Charpy V-Notch tests shall be made in accordance with the procedure in ASTM A 370-1979, except for specimen sizes that shall be in accordance with the dimensions given in Table 4.1.

3.11.2.6. Alternatives to this procedure are the use of killed or semi-killed steel for which an adequate specification shall be provided. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003.

3.11.2.7. Specimens are to be longitudinal and taken from flat stock, tubular or structural sections before forming or welding for use in the protective structure. Specimens from tubular or structural sections are to be taken from the middle of the side of greatest dimension and shall not include welds.

Specimen size	**Energy at**	**Energy at**
	-30 °C	**-20 °C**
mm	**J**	**J[b)]**

10 x 10[a)]	11	27.5
10 x 9	10	25
10 x 8	9.5	24
10 x 7,5[a)]	9.5	24
10 x 7	9	22.5
10 x 6.7	8.5	21
10 x 6	8	20
10 x 5[a)]	7.5	19
10 x 4	7	17.5
10 x 3.5	6	15

Table 4.1
Minimum Charpy V-notch impact energies

a) Indicates preferred size. Specimen size shall be no less than largest preferred size that the material permits.

b) The energy requirement at –20 °C is 2.5 times the value specified for –30 °C. Other factors affect impact energy strength, i.e. direction of rolling, yield strength, grain orientation and welding. These factors shall be considered when selecting and using steel.

3.12. [Not applicable]

Figure 4.1
Front and rear load applications,
protective cab and rear roll bar frame

Dimensions in mm

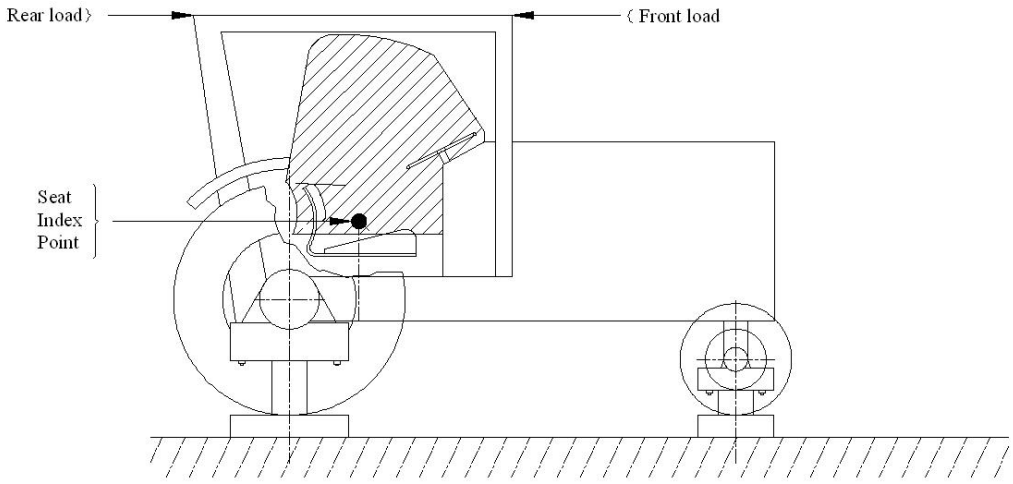


Figure 4.1.a Protective cab

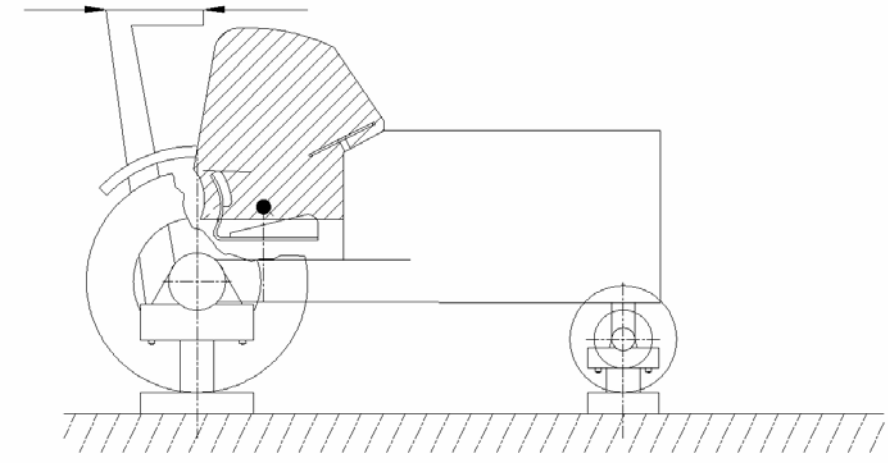


Figure 4.1.b Rear roll bar frame

Figure 4.2
Longitudinal load applications

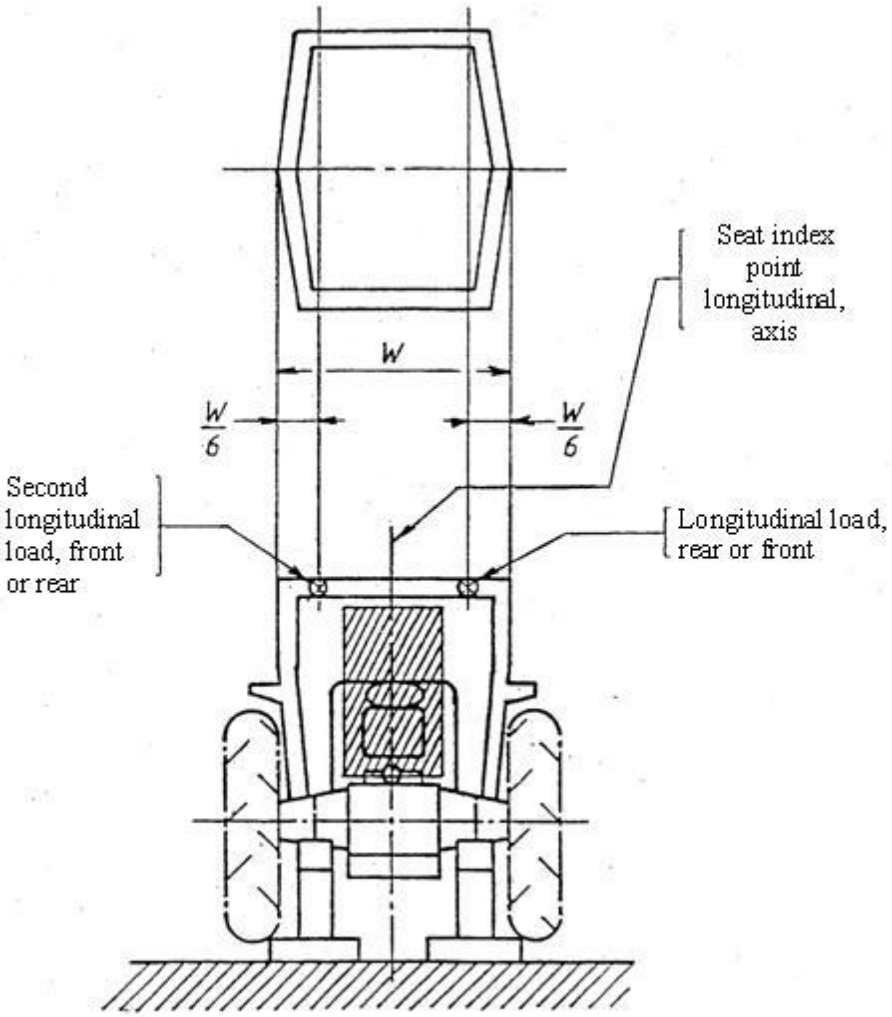


Figure 4.3

Examples of 'W' for ROPS with curved members

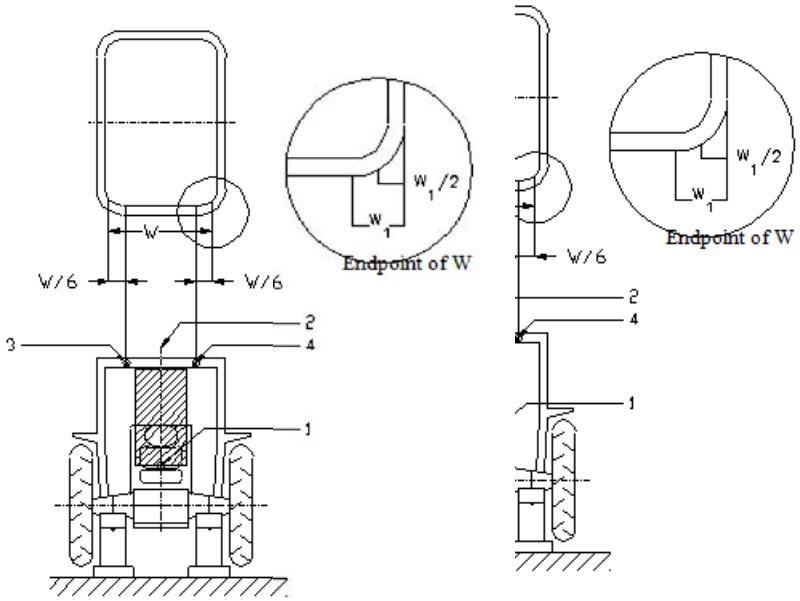


Figure 4.3.a Four-post ROPS

KEY

1 – Seat index point

2 – SIP, longitudinal centre-plane

3 – Point of second longitudinal load application, front or rear

4 – Point of longitudinal load application, rear or front

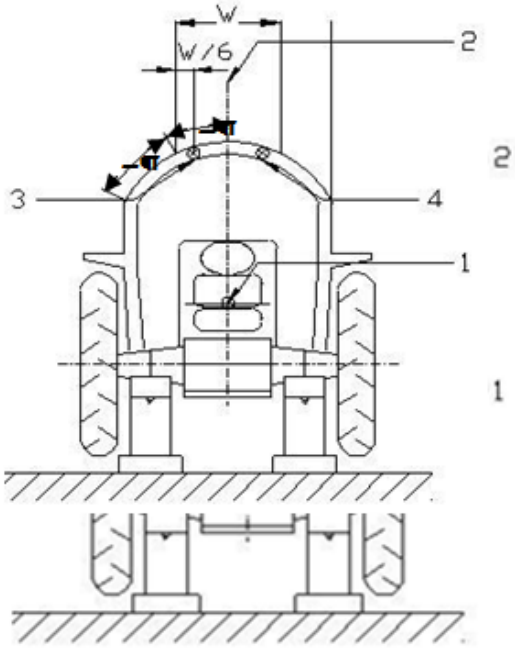


Figure 4.3.b Two-post ROPS

KEY

1 – Seat index point (SIP)

2 – SIP, longitudinal centre-plane

3 – Point of second longitudinal load application, front or rear

4 – Point of longitudinal load application, rear or front

Figure 4.4
Side load application (side view),
protective cab and rear roll bar frame

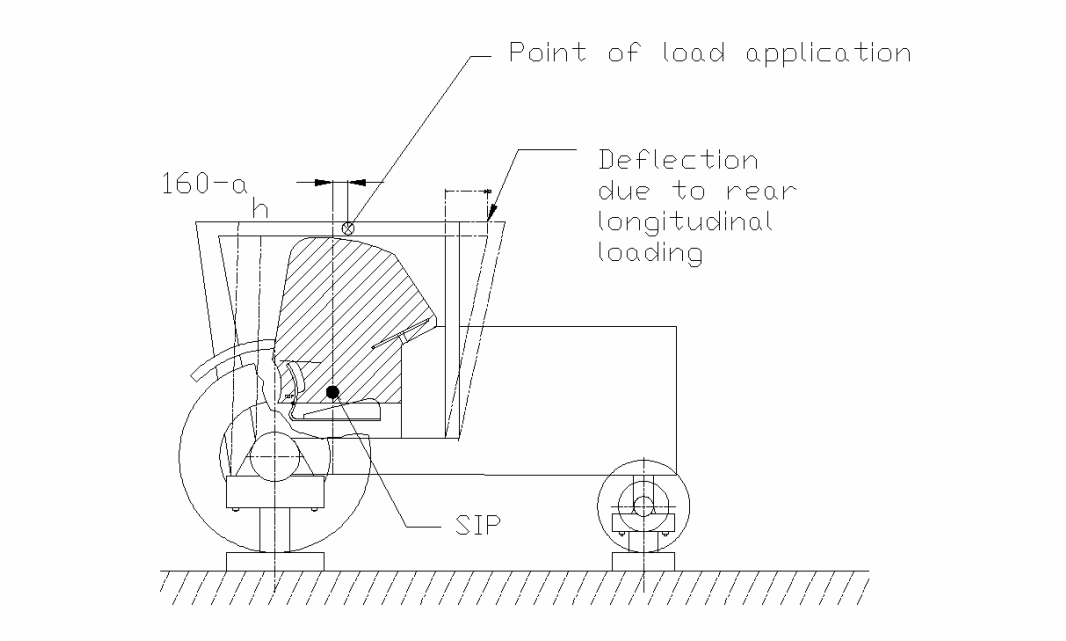


Figure 4.4.a Protective cab

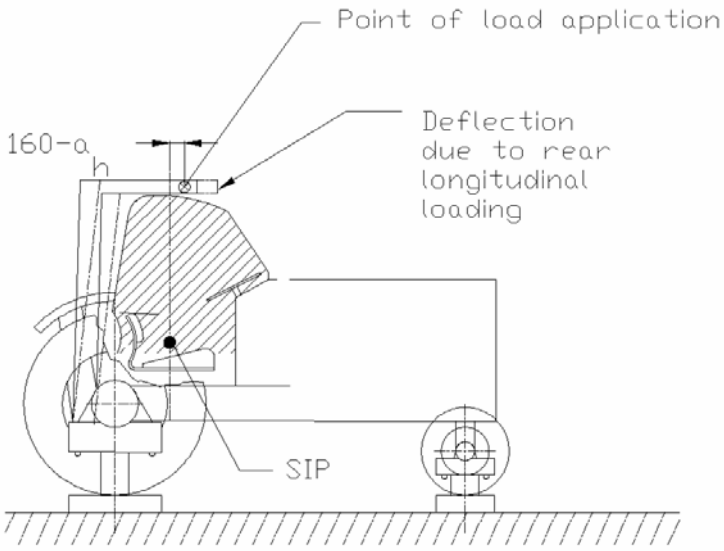
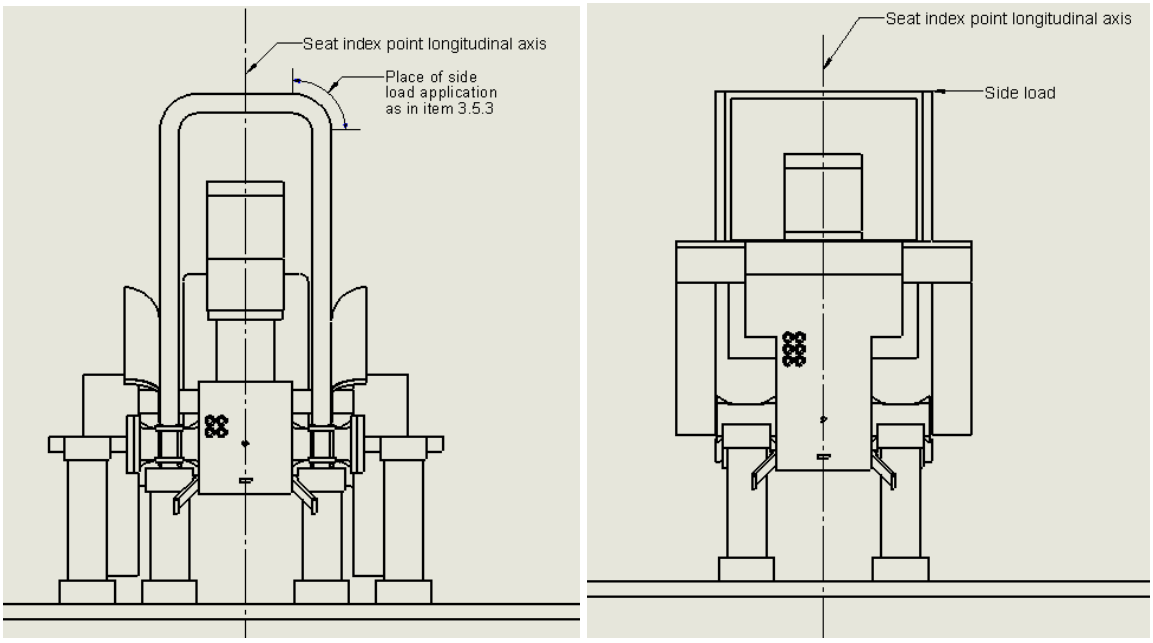


Figure 4.4.b Rear roll bar frame

Figure 4.5
Side load application (rear view)



(a) (b)

Figure 4.6

Example of arrangement for crushing test

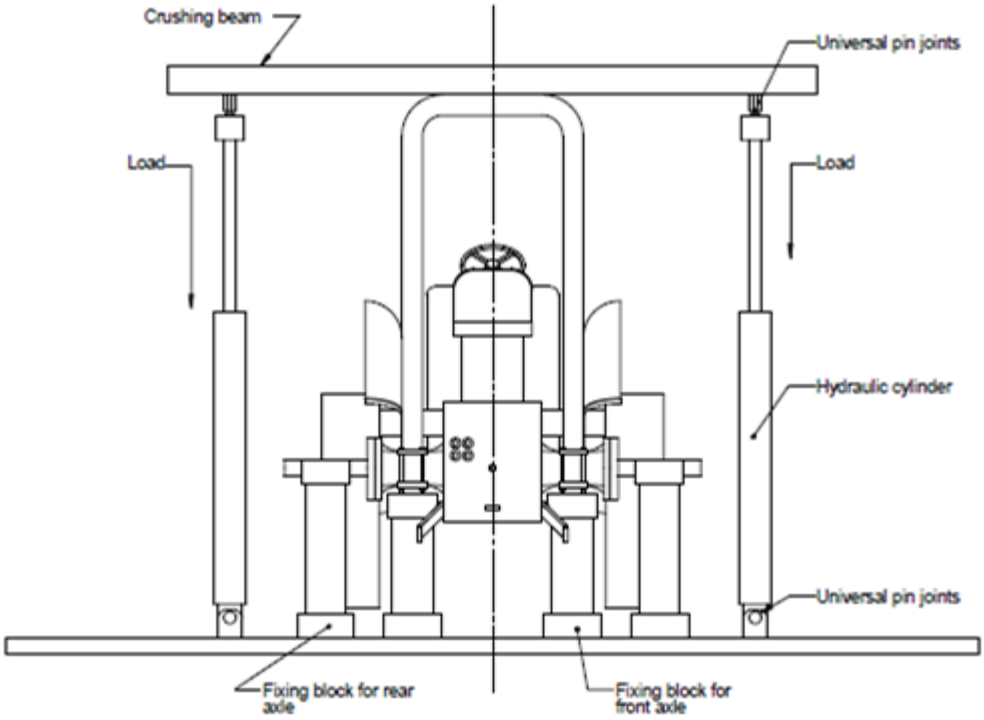


Figure 4.7

Position of beam for front and rear crushing tests, protective cab and rear roll bar frame

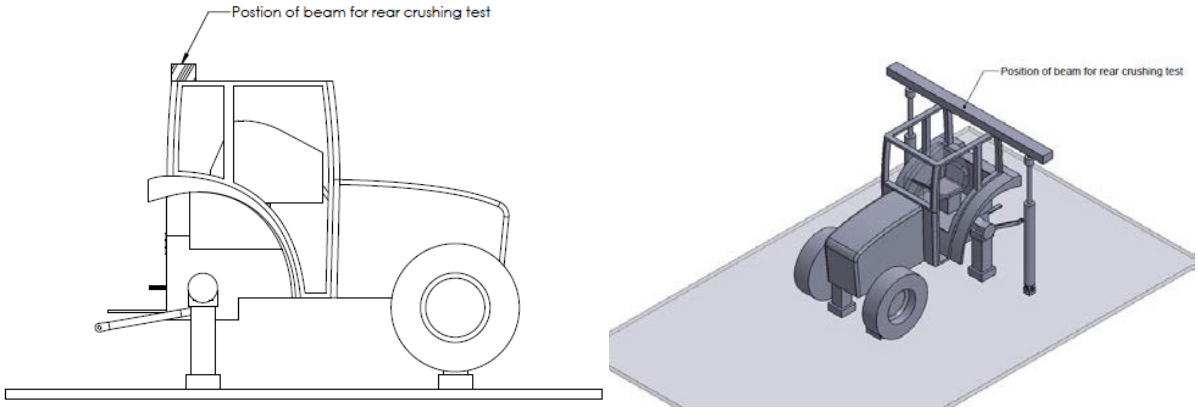


Figure 4.7.a

Rear

Crush

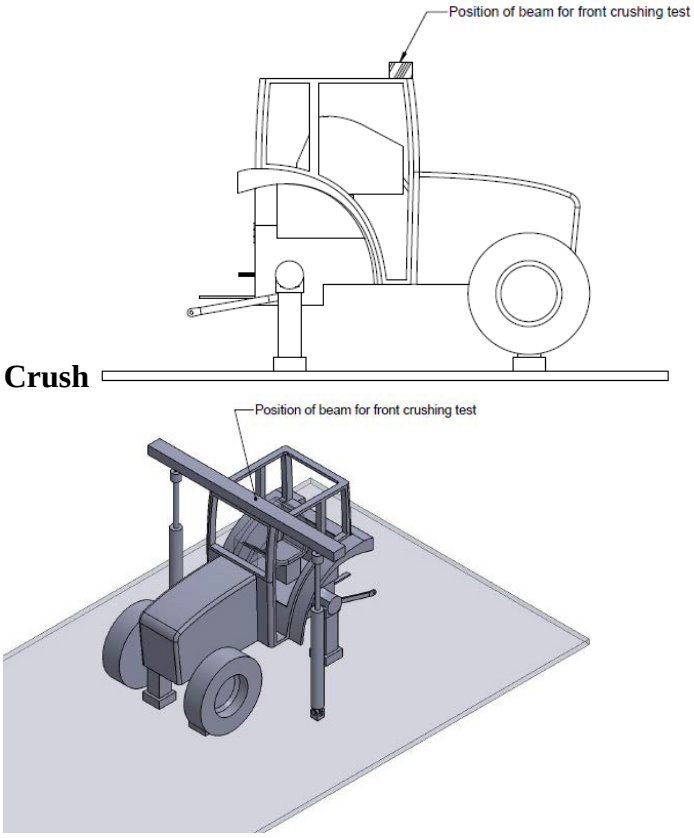


Figure 4.7.b

Front Crush

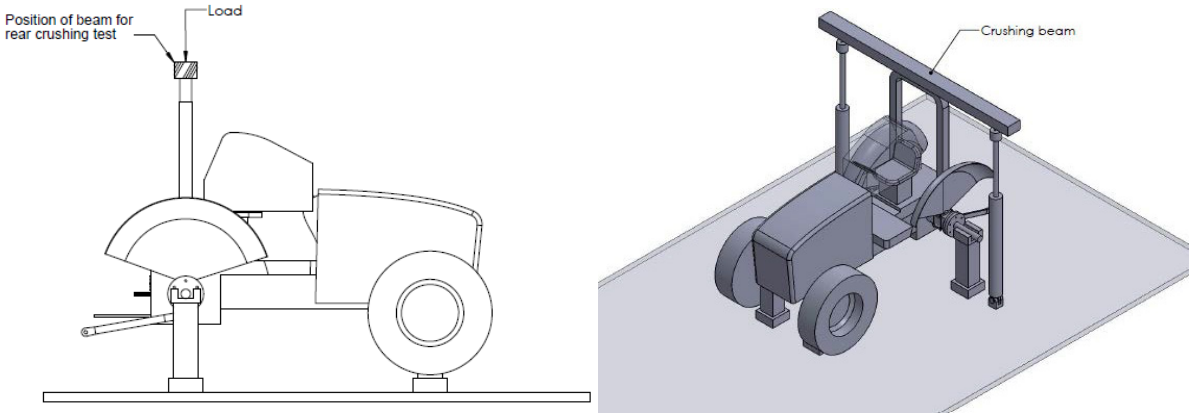


Figure 4.7.c

Crush test for rear roll bar

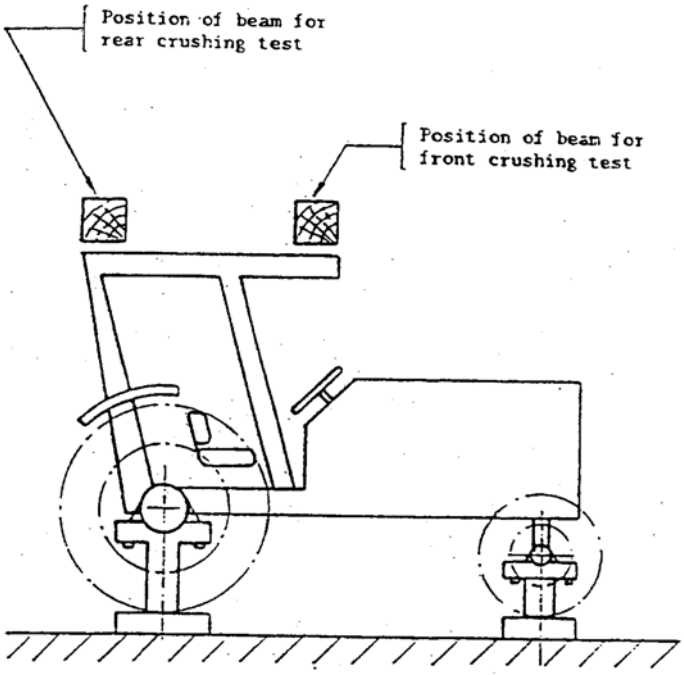


Figure 4.7.d Protective cab

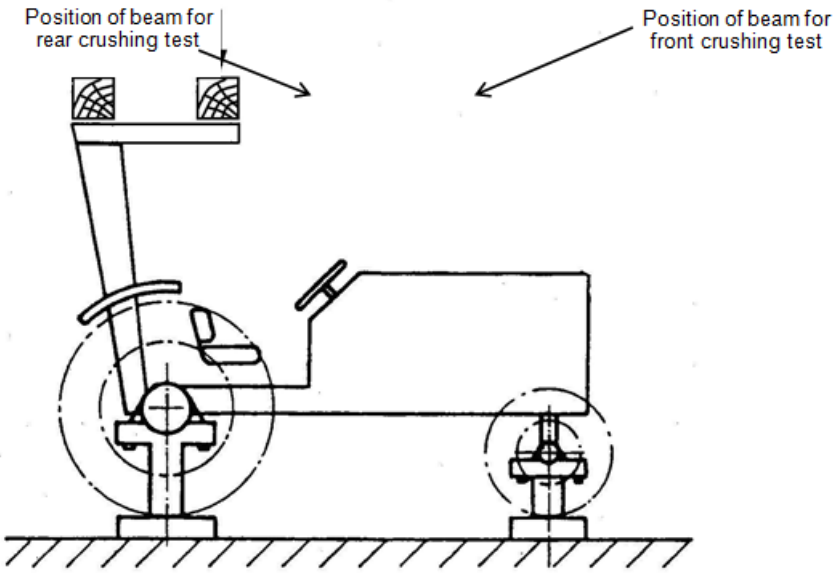


Figure 4.7.e Rear roll bar frame

Figure 4.8
Position of beam for front crushing test
when full crushing force not sustained in front

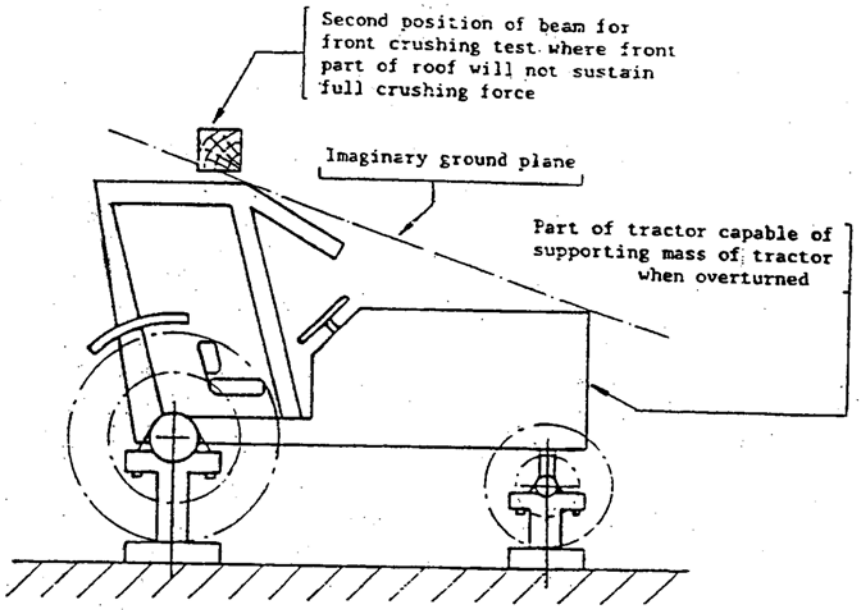


Figure 4.8.a Protective cab

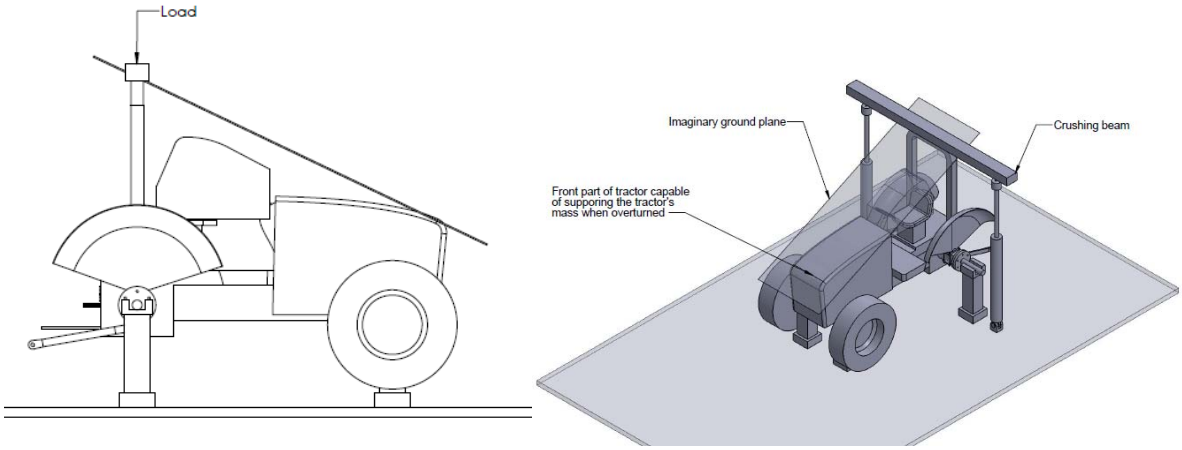


Figure 4.8.b Rear roll bar frame

Figure 4.9

The crushing force is applied with the beam having its centre point passing in the vertical reference plane of the tractor (being also that of the seat and steering wheel).

Case 1.- when the ROPS, the seat and the steering wheel are rigidly fixed to the tractor body;

Case 2.- when the ROPS is rigidly fixed to the tractor body, and the seat and the steering wheel are located on a floor (suspended or not) but they are **NOT** connected to the ROPS.

In these cases, the vertical reference plane referred to the seat and steering wheel includes normally also the centre of gravity of the tractor *during the execution of the entire series of loadings.*

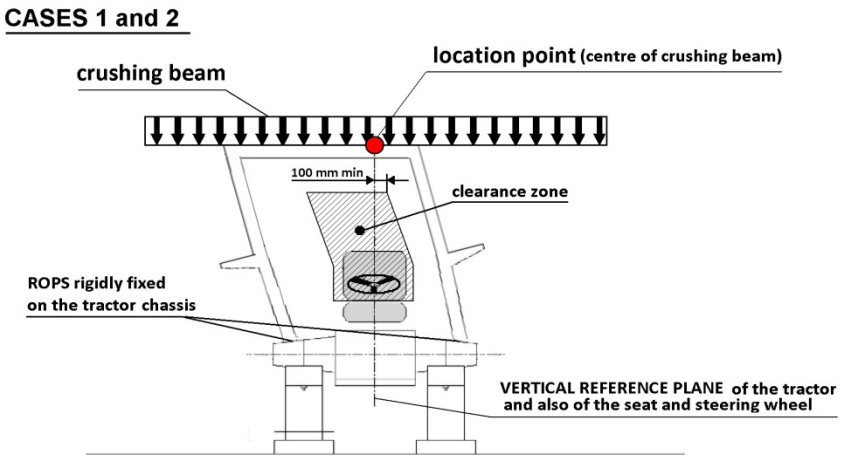
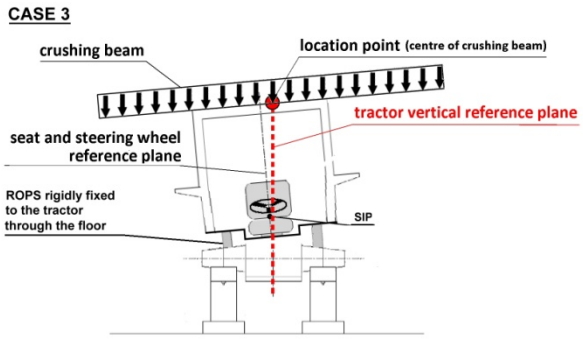


Figure 4.10

The crushing force is applied with the beam having its centre point passing only in the vertical reference plane of the tractor.

Cases 3 and 4 can be defined, in which the ROPS is fixed to a platform, rigidly fixed (case 3) or suspended (case 4) in respect to the tractor chassis. *These joining or linkage solutions cause different movements to cabs and clearance zone as well as the vertical reference plane.*



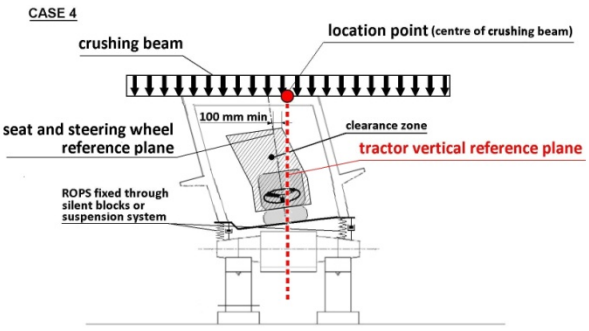
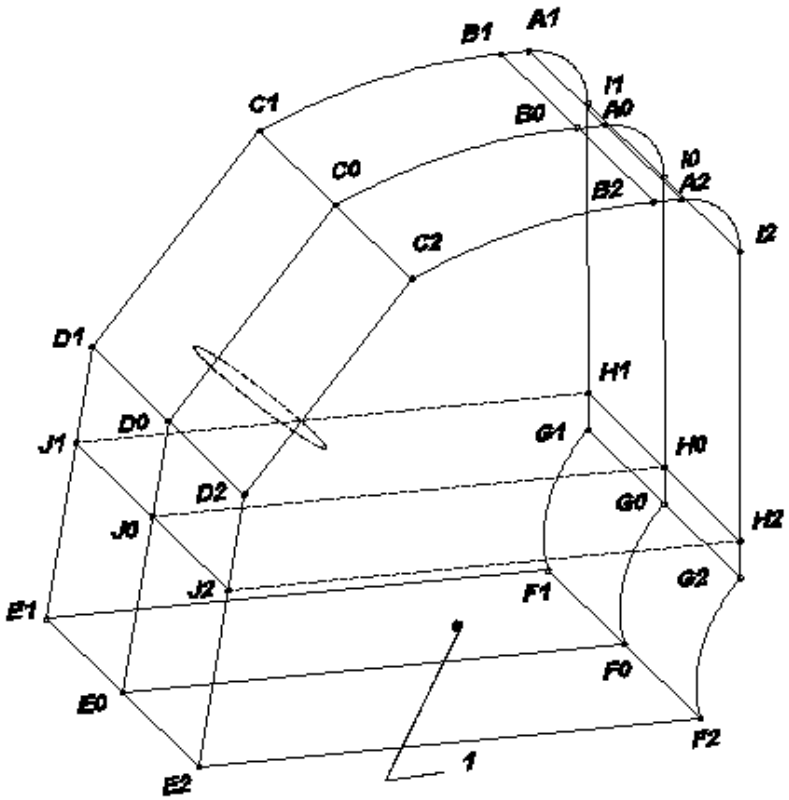


Table 4.2
Dimensions of the clearance zone

Dimensions	mm	Remarks
A_1 A_0	100	minimum
B_1 B_0	100	minimum
F_1 F_0	250	minimum
F_2 F_0	250	minimum
G_1 G_0	250	minimum
G_2 G_0	250	minimum
H_1 H_0	250	minimum
H_2 H_0	250	minimum
J_1 J_0	250	minimum
J_2 J_0	250	minimum
E_1 E_0	250	minimum
E_2 E_0	250	minimum
D_0 E_0	300	minimum
J_0 E_0	300	minimum
A_1 A_2	500	minimum
B_1 B_2	500	minimum
C_1 C_2	500	minimum
D_1 D_2	500	minimum
I_1 I_2	500	minimum
F_0 G_0	-	depending on the tractor
I_0 G_0	-	
C_0 D_0	-	
E_0 F_0	-	

Figure 4.11
Clearance zone



KEY
1 – Seat index point

Note: for dimensions, see Table 4.2 above

Figure 4.12
Clearance zone

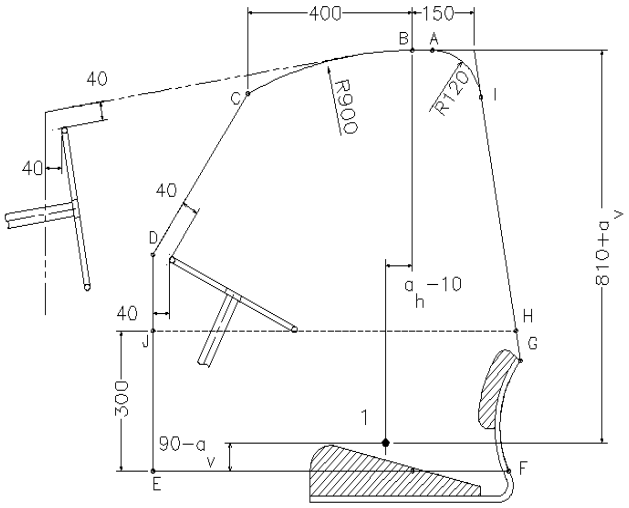


Figure 4.12.a
side view
section in reference plan

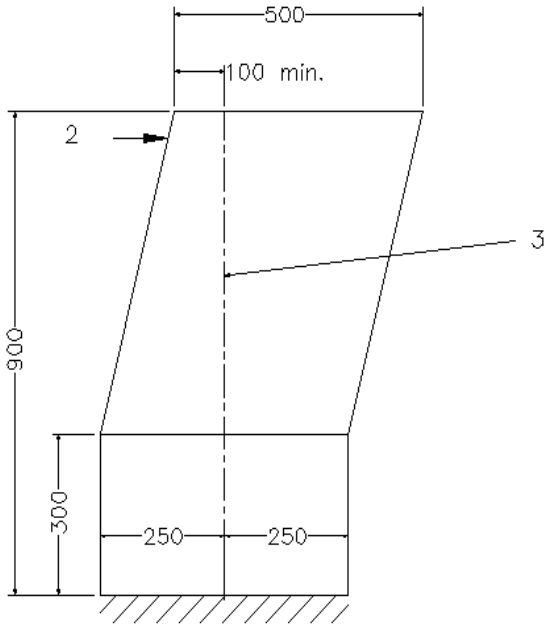


Figure 4.12.b
rear or front view

KEY
1 – Seat index point
2 – Force
3 – Vertical reference plane

Figure 4.13
Clearance zone for tractor with reversible seat and steering wheel, protective cab and rear roll bar frame

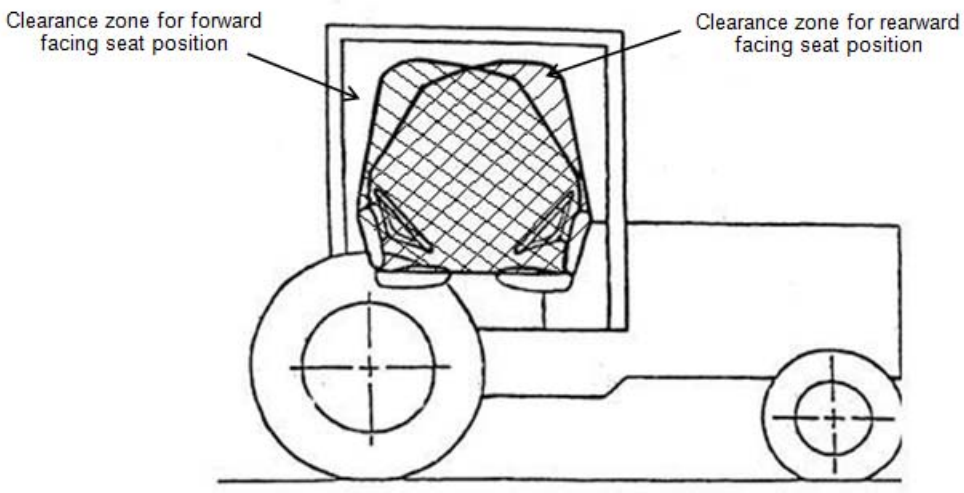


Figure 4.13.a Protective cab

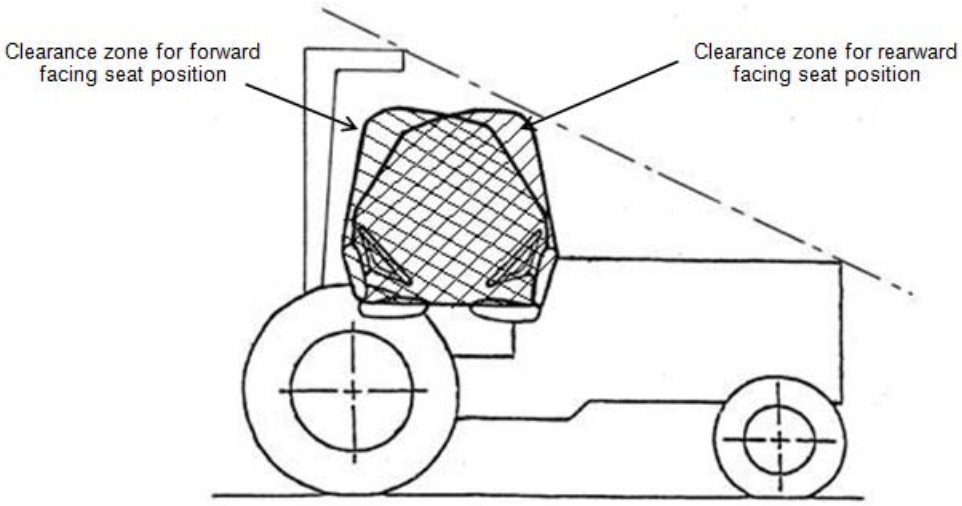
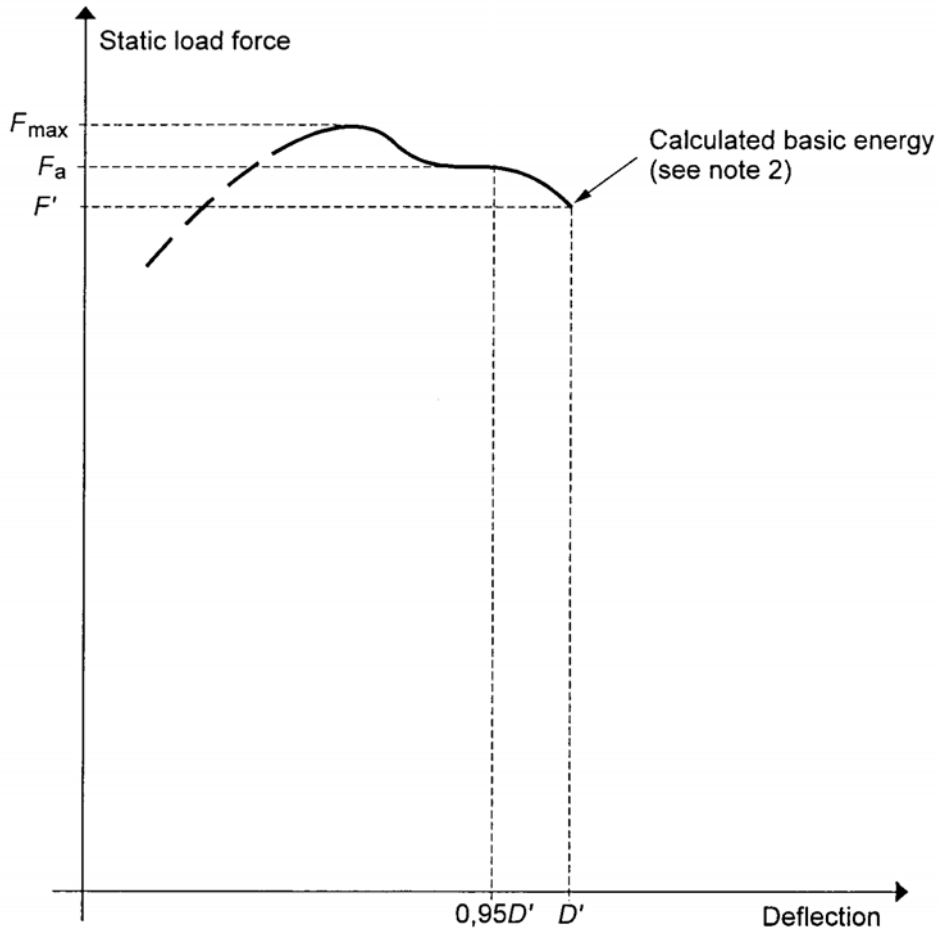


Figure 4.13.b Rear roll bar frame

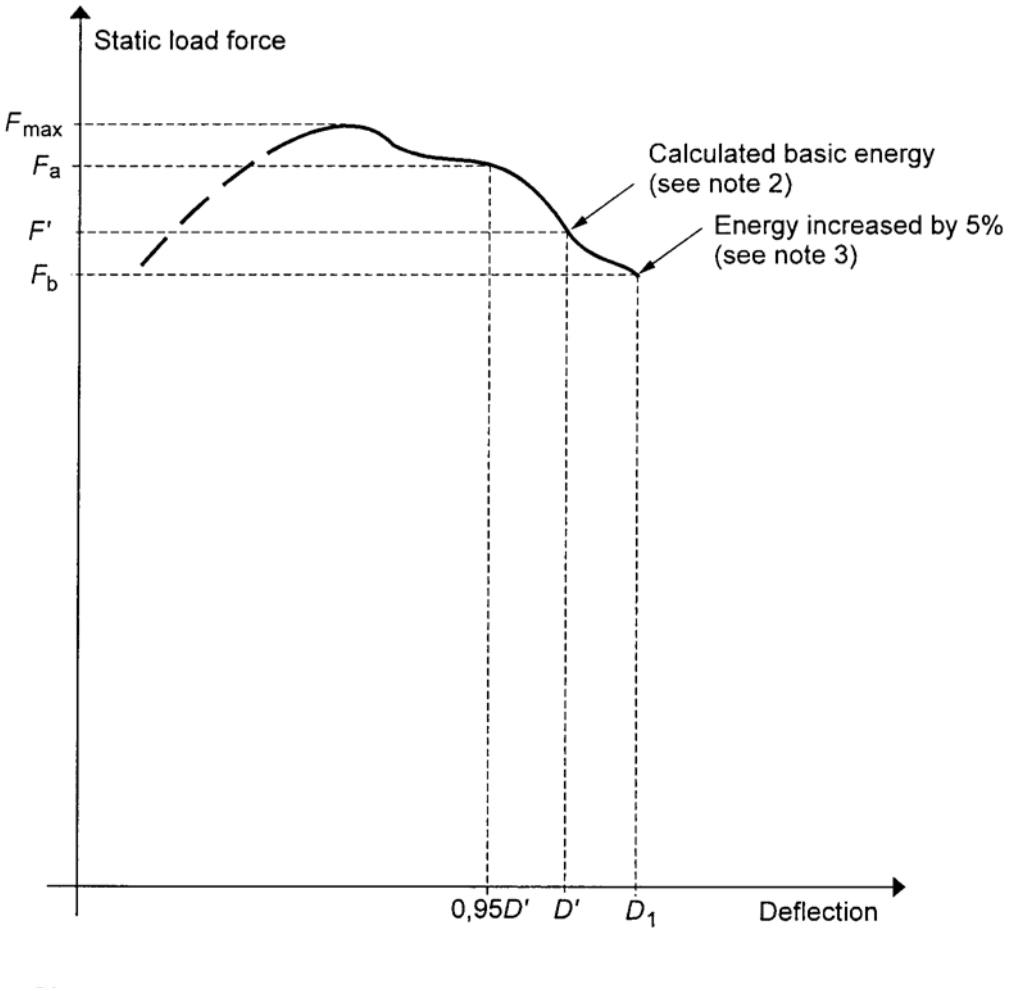
Figure 4.14
Force / deflection curve
Overload test not necessary



Notes:

1. Locate F_a in relation to 0,95 D'
2. Overload test not necessary as $F_a \leq 1{,}03\ F'$

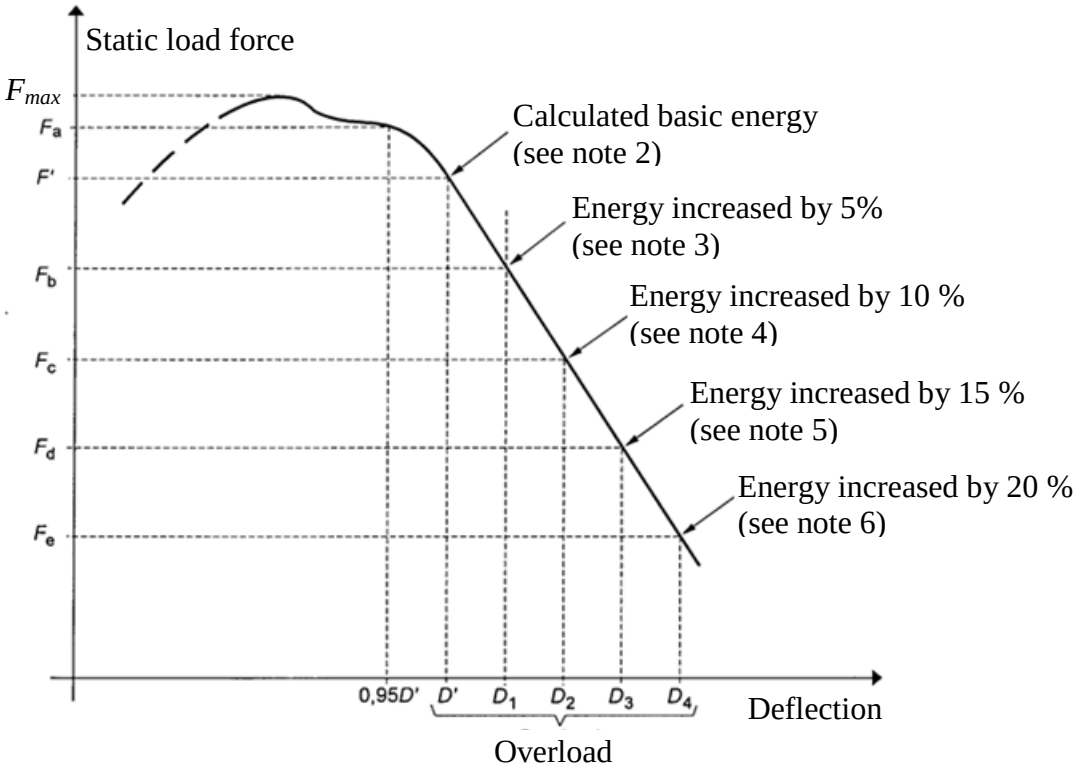
Figure 4.15
Force / deflection curve
Overload test necessary



Notes:

1. Locate Fa in relation to 0,95 D'
2. Overload test necessary as $F_a > 1,03$ F'
3. Overload test performance satisfactory as Fb > 0,97F' and Fb > 0,8F max

Figure 4.16
Force / deflection curve
Overload test to be continued



Notes:

1. Locate F_a in relation to 0,95 D'
2. Overload test necessary as $F_a > 1,03$ F'
3. $F_b < 0,97$ F' therefore further overload necessary
4. $F_c < 0,97$ Fb therefore further overload necessary
5. $F_d < 0,97$ Fc therefore further overload necessary
6. Overload test performance satisfactory, if Fe > 0,8 F max
7. Failure at any stage when load drops below 0,8 F max

Explanatory notes to Annex VIII

(1)

Unless otherwise stated, the text of the requirements and the numbering set out in point B are identical with the text and numbering of the OECD standard Code for the official testing of protective structures on agricultural and forestry tractors (static test), OECD Code 4, Edition 2015 of July 2014.

(2)

Users are reminded that the seat index point is determined according to ISO 5353 and is a fixed point with respect to the tractor that does not move as the seat is adjusted away from the mid-position. For purposes of determining the clearance zone, the seat shall be placed in the rear and uppermost position.

(3)

Permanent + elastic deflection measured at the point when the required energy level is obtained.