SURFACE VEHICLE STANDARD

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Superseding J386 AUG2012

(R) Occupant Restraint System for Off-Road Work Machines

RATIONALE

Revision of this document includes updates for external document references to industry accepted ISO standards. Additional details were added to incorporate the current state of the art for restraint systems including retractor and latch plate specific requirements. Anchorage test requirements were updated to accommodate testing equipment. Center of gravity testing was added for seating systems with mass in excess of 70 kg.

1. SCOPE

This SAE Standard establishes the minimum performance requirements for pelvic restraint systems (seat belts, anchorages, and the fastening elements of seat belts) necessary to restrain an operator or rider within a roll-over protective structure (ROPS) in the event of a machine roll-over, as defined in ISO 3471, ISO 8082-1, ISO 8082-2, ISO 12117-2, and ISO 13459, or tip-over protection structure (TOPS), in the event of a machine tip over as defined in ISO 12117. This standard provides guidance and recommendations for information included in the machine operator manual.

NOTE: Upper torso restraint requirements are defined in SAE J2292.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J2292 Combination Pelvic and Upper Torso Operator and Occupant Restraint Systems for Off-Road Work Machines

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
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For more information on this standard, visit
https://www.sae.org/standards/content/J386_202204/

2.1.2 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 3411 Earth-Moving Machinery - Human Physical Dimensions of Operators and Minimum Operator Space Envelope

ISO 3471 Earth-Moving Machinery ROPS - Laboratory Tests and Performance

ISO 5353 Earth-Moving Machinery - Seat Index Point

ISO 6683 Earth-Moving Machinery - Seat Belts and Seat Anchorages - Perfomance Requirements and Test

ISO 8082-1 Self-Propelled Machinery for Forestry - Laboratory Tests and Performance Requirements for Roll-Over Protective Structures - Part 1: General Machines

ISO 8082-2 Self-Propelled Machinery for Forestry - Laboratory Tests and Performance Requirements for Roll-Over Protective Structures - Part 2: Machines Having a Rotating Platform with a Cab and Boom on the Platform

ISO 11112 Earth-Moving Machinery - Operator's Seat-Dimensions and Requirements

ISO 12117 Earth-Moving Machinery - Tip-Over Protection Structure (TOPS) for Compact Excavators - Laboratory Tests and Performance Requirements

ISO 12117-2 Earth-Moving Machinery - Laboratory Tests and Performance Requirements for Protective Structures of Excavators - Part 2: Roll-Over Protective Structures (ROPS) for Excavators over 6 t

3. DEFINITIONS

3.1 ADJUSTMENT HARDWARE

Hardware designed for adjusting the belt assembly to fit the user, including such hardware that may be integral with a buckle, attachment hardware, or retractor.

3.2 SEAT BELT ANCHORAGE

The point where the seat belt assembly or extension (tether) belt is mechanically attached to the seat system or the machine.

3.3 ATTACHMENT HARDWARE

Hardware for securing a seat belt assembly to an anchorage on a seat system or on a machine.

3.4 STRAP (WEBBING)

A flexible belt to restrain the body and for transmission of the forces to the attachment hardware.

3.5 PELVIC BODY BLOCK

The test device used to apply the seat belt force to the seat system (see Figure 2).

3.6 BUCKLE

A quick release component of a seat belt assembly which accepts and connects to a latch plate, and is intended to facilitate wearing and removal of the seat belt by an occupant.

3.7 MICRO-SLIP (CREEP)

The amount of unintentional lengthening of the seat belt assembly loop during use that is caused by motion of the machine, the seat, and the seat belted occupant.

3.8 EXTENSION (TETHER) BELT

Any strap, belt, or similar device (webbing, wire cable, solid link, etc.) that aids in the transfer of seat belt forces.

3.9 HARDWARE

Any metal or rigid plastic part of the occupant restraint system.

3.10 LATCH PLATE

A load bearing device through which the seat belt webbing either passes or is permanently attached. Allows the webbing to change direction and connect with the buckle. Also known as a Tongue, tip, or simply as a Latch. Latch Plate variants include free falling/dropping, sliding, cinching/locking, semi-cinching, sewn-in.

3.10.1 SEWN-IN TYPE

A latch plate that is sewn directly to the lap portion of the webbing thus prohibiting webbing transfer through the latch plate.

3.10.2 LOCKING, OR CINCHING TYPES

A latch plate which limits transfer of the webbing through the latch plate in at least one direction in response to loading sufficient to meet the loop load requirements of this standard.

3.10.3 SEMI-CINCHING TYPE

A latch plate which limits transfer of the webbing through the latch plate in at least one direction in response to loading sufficient to meet the requirements defined in this document, but is not intended to limit the transfer of webbing during dynamic (rollover or crash) loading.

3.10.4 FREE FALLING/DROPPING AND SLIDING TYPE

A latch plate which permits webbing transfer through the latch plate in two directions in response to loading and will fall under its own weight along a vertical length of webbing.

3.11 LOOP

The portion of the seat belt assembly as it would be installed around the seat occupant.

3.12 OCCUPANT RESTRAINT SYSTEM

The total system composed of the seat belt assembly, seat system, anchorages, and extension (tether) belts, if applicable, which transfers the seat belt force to a machine.

3.13 POLYESTER YARN

Yarns spun from polyethylene terephthalate.

3.14 RETRACTORS

Devices for storing all or part of the strap material of a seat belt assembly.

3.15 AUTOMATIC LOCKING RETRACTOR (ALR)

A retractor incorporating a positive self-locking mechanism that remains engaged, locked, and capable of withstanding restraint forces once webbing has initially been extracted. This locking mechanism is reset when the webbing is allowed to retract into the retractor. The retractor may allow up to 76 mm, of webbing movement before retracting webbing to the next locking position.

3.16 EMERGENCY LOCKING RETRACTOR (ELR)

A retractor incorporating adjustment hardware by means of a locking mechanism that is activated by vehicle acceleration or rollover (single sensitivity), strapping acceleration, or other automatic action during an emergency (multiple sensitivity) and is capable when locked of withstanding restraint forces.

3.17 NONLOCKING RETRACTOR

A webbing stowage device from which the strap is extracted to its full length by a small external force and which provides no adjustment for the length of the extracted strap and no means for locking any strap not extracted from the mechanism at any time including an emergency.

3.18 ROPING

Tendency of a piece of material to twist upon itself or roll up transversely, remaining in the form of a rope instead of staying in its original strap form.

3.19 SEAT BELT ASSEMBLY (Type 1)

Any strap, webbing, or similar flexible device across the lap or pelvic girdle area designed to provide occupant restraint in a machine. It includes buckles, retractors (if equipped), or other features, and includes the attachment hardware for installing the seat belt assembly to an anchorage.

3.20 SEAT INDEX POINT (SIP)

The point in the central, vertical plane of the SIP measuring device when installed in the seat as defined in ISO 5353.

3.21 SEAT SYSTEM

The total support mechanism between the machine and the seated occupant. This would include any seat assembly, fixed or adjustable seat support, or seat suspension (flexible seat support).

3.22 SEAT UPPER

The portion of the seat system above any fore-aft, vertical, or rotational adjustments. Typically includes the seat back, seat cushion, head rest, recliners, arm rest, etc.

3.23 TRANSLATING SEAT INDEX POINT (TSIP)

Location of the SIP throughout the seat upper total range of motion (fore/aft, up/down, side to side, and rotational). The TSIP is identical to the SIP measured when the seat system is in the center travel position.

4. TECHNICAL REQUIREMENTS, MACHINE RELATED

4.1 Anchorages

4.1.1 Seat belt anchorages shall permit the seat belt assembly to be readily installed or replaced and shall comply with the strength requirements of 4.4.

4.1.2 If the seat system does not swivel nor has a suspension system, the seat belt assembly shall be anchored to the seat or to the machine at any point within the cross hatched zones shown in Figure 1.

4.1.3 If the seat upper assembly is supported by a swivel and/or suspension system, the seat belt assembly shall be attached in such a way that the loop size of the belt does not change as the seat oscillates through its travel. The seat belt assembly shall be anchored to the seat system at any point within the cross-hatched zones shown in Figure 1.

4.2 Extension (Tether) Belts

4.2.1 Belts, cables, or similar flexible devices may be used to transfer the seat belt assembly forces from the seat belt anchorages to the machine. The extension belt length may be adjustable.

4.2.2 Extension belts shall meet the seat belt assembly force requirements of 4.4 in all operating positions.

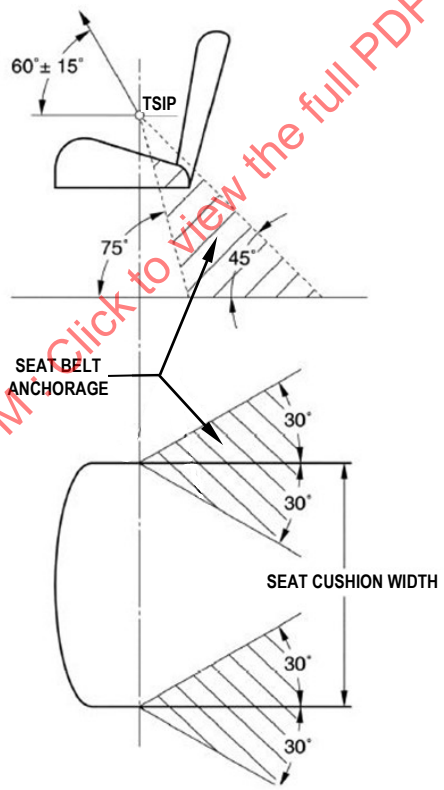


Figure 1 - Location of seat belt anchorage with respect to translating seat index point

4.3 Seat Belt Assembly Installation

4.3.1 The full range of the TSIP shall be determined. The anchorages of the seat belt assembly shall be located such that when the seat belt is in a straight line through the full range of the TSIP, the angle formed from the horizontal shall be in the range of 60 degrees ± 15 degrees as shown in Figure 1. Where practical, the preferred angle through the TSIP is toward the more vertical.

4.3.2 The seat belt assembly is intended to remain in the pelvic girdle area under operating, collision, and rollover conditions, thereby restraining the occupant's hips and lower torso to the seat system.

4.3.3 Machine operator's manual shall include recommendations and guidelines for seat belt assembly including extension (tether) belts usage, inspections and maintenance including:

a. The seat belt assembly has a finite life and shall be replaced as recommended throughout the life of the machine.

b. Seat belt assemblies shall be inspected by the user periodically. If replacement of any part of the seat belt assembly is indicated, the entire seat belt assembly shall be immediately replaced.

1. Inspection and replacement guidelines for visible degradation shall be included such as: worn/damaged hardware, nicked/frayed strap, buckle/retractor malfunction or difficulty in operation, or loose stitching. Guidelines shall also be provided for interlocks/passive warning systems, that are part of the seat belt assembly.

2. Severe envirionmental or vocational conditions can reduce seat belt assembly life and require more frequent inspections. Conditions to consider may include:

i. High degree of average annual usage.

ii. Highly repetitive seat belt latching.

iii. Environmental exposures including ultraviolet, corrosive, chemical, temperature, humidity, and foreign materials (dust/debris).

c. If a machine is involved in an accident involving seat belt assembly loading, the entire occupant restraint system shall be replaced prior to placing the machine back in service.

4.4 Machine Related Testing and Performance

4.4.1 The occupant restraint system shall be tested on-machine or in a manner equivalent to an on-machine condition.

4.4.2 The seat system shall be adjusted to the operating position which produces the most severe loading condition to the occupant restraint system, prior to any subsequent structural deflection. The seat back, if adjustable, shall be positioned in its most upright work position.

4.4.3 After the force is applied to the occupant restraint system, the force application device shall not be repositioned to compensate for any changes that can occur to the force application angle.

4.4.4 The seat belt assembly force shall be applied using a pelvic body block similar to that shown in Figure 2. If a retractor is included in the assembly, see 5.4.

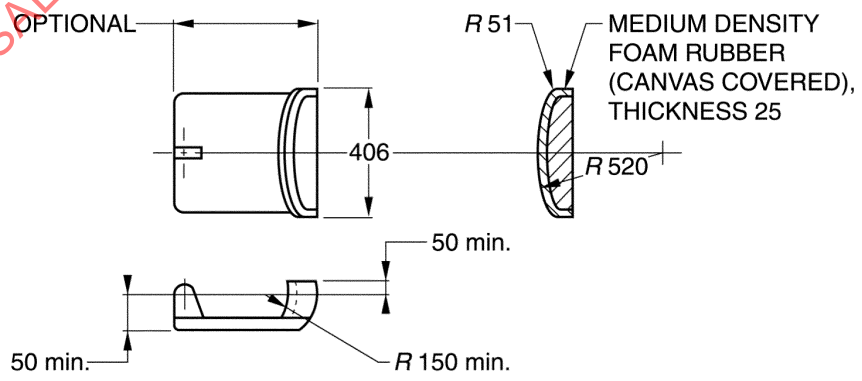


Figure 2 - Pelvic Body block
(dimensions in mm)

4.4.5 For an occupant restraint system with the seat adjusted as described in 4.4.2, apply a force of 15.0 kN to a pelvic body block in the direction in which the occupant faces. With the test setup free of slack, the initial force application angle shall be 60 ± 15 degrees above the horizontal, as shown in Figure 3. All test forces shall be attained in not more than 30 seconds and maintained for not less than 10 seconds.

4.4.6 For an occupant restraint system with a mass greater than 70 kg, such as those that include add-on control modules, an additional simultaneous load shall be applied. The force applied shall be calculated as follows: 10 times 0.0098 kN/kg multiplied by any mass (kg) of the seat system greater than 70 kg. The force shall be applied in the direction the occupant faces with an initial force application of 60 ±15 degrees above the horizontal.

The additional force shall be applied to the pelvic body block as shown in Figure 3.

EXAMPLE: If a seat system has a 70 kg mass but an 18 kg seat mounted control is added then the total applied force is:

$$15\ kN + (10)\ (0.0098\ kN/kg)\ (18\ kg) = 16.76\ kN \quad \text{(Eq. 1)}$$

Alternatively, the additional force shall be applied at any point above and behind the following two planes (see shaded zone in Figure 4):

A horizontal plane through the occupant restraint system center of gravity

A plane with 60 degree incline from the horizontal passing through the occupant restraint system center of gravity.

NOTE: Center of gravity location shall be determined with the seat adjustments in the as tested position.

EXAMPLE: If a seat system has a 70 kg mass but an 18 kg seat mounted control is added then the applied forces are:

15 kN – Applied to pelvic body block (see 4.4.5)

(10) (0.0098 kN/kg) (18 kg) = 1.76 kN - Applied in zone defined in Figure 4 (Eq. 2)

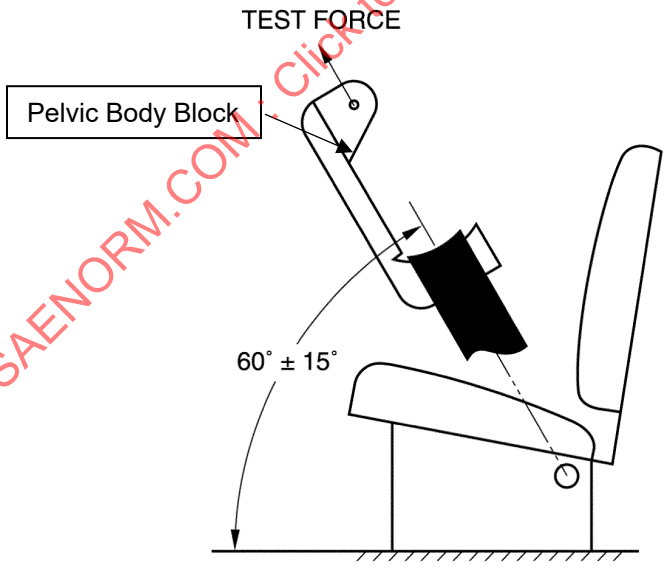


Figure 3 - Construction and general purpose industrial machines test procedure

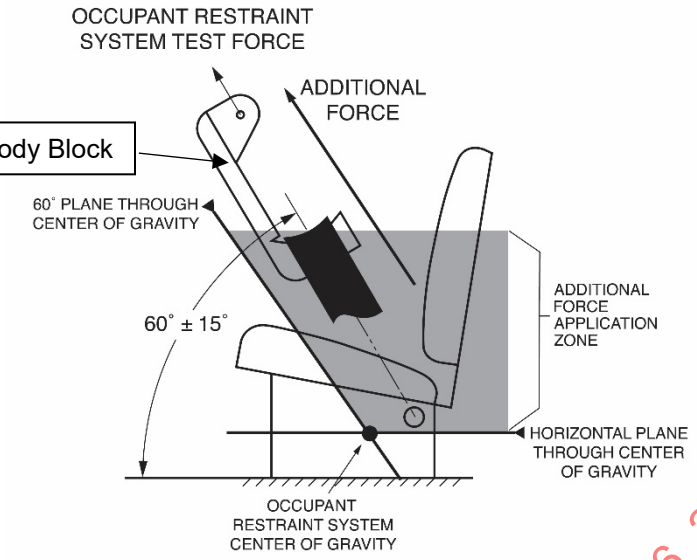


Figure 4 - Location of additional force relative to occupant restraint system center of gravity

4.4.7 There shall be no rupture, release, or other failure of any element in the occupant restraint system. Permanent deformation of any elements shall not constitute failure.

5. RESTRAINT SYSTEM COMPONENT REQUIREMENTS

5.1 Seat Belt Assembly Specifications

5.1.1 Single Occupancy

A seat belt assembly shall be designed for use by one, and only one, person at any time.

5.1.2 Release

The seat belt assembly shall be provided with a buckle readily accessible to the occupant and designed to provide easy and rapid release of the assembly with a single motion. It shall also be capable of being released with either hand, bare or mittened. The buckle shall be designed to minimize the possibility of accidental release due to occupant movement, inertia, or external forces. The buckle shall meet all the requirements described in 5.3.

5.1.3 Adjustment

The seat belt shall be self-adjusting or readily adjustable by a means within easy reach of the occupant. In all operating positions, adjustment to a snug condition shall at least accommodate the 5th percentile occupant to the 95th percentile occupant; refer to ISO 3411, including accomodation for arctic clothing.

5.1.4 Micro-Slip

Two seat belt assemblies of the same part number, with adjusting devices included, shall be tested in accordance with the requirements outlined below. The micro-slip shall not exceed 25 mm for each adjusting device in the assembly. The sum of micro-slip amounts for all adjusting devices in the belt assembly shall not exceed 40 mm.

5.1.4.1 Conditions

The seat belt assemblies shall be conditioned for 24 hours and tested at a temperature of 20 °C ± 5 °C and 65% ± 5% relative humidity. The test apparatus shall conform to that shown in Figure 5.

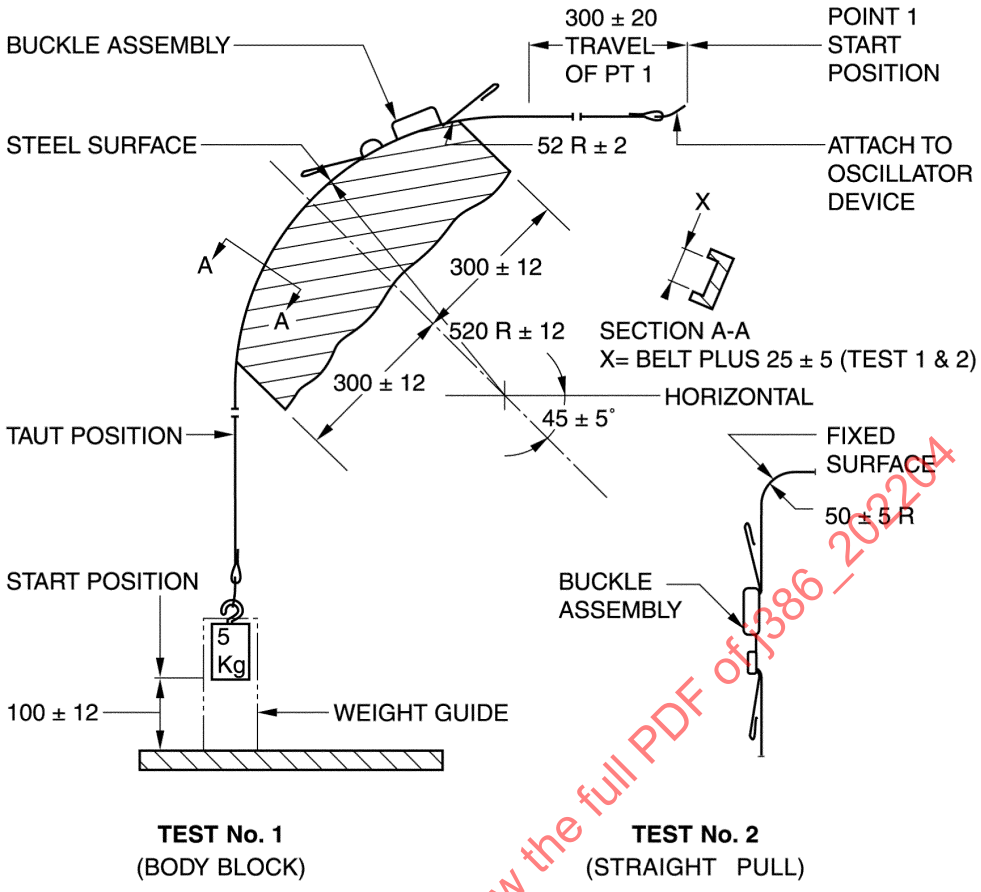


Figure 5 - Micro-slip test apparatus (dimensions in mm)

5.1.4.2 Test Procedure

Mount the belts as shown in Figure 5 for Test 1 and Test 2. Apply the following procedure:

a. Apply a 5 kg mass to the lower end of each belt assembly;

b. Apply a reciprocating motion, total amplitude of 300 mm ± 20 mm to the top end of each belt assembly;

c. If there is a free end serving as reserve strap, it shall not be fastened or clipped to the section subjected to the 5 kg mass;

d. Ensure that on the test bench, the strap in the slack position maintains contact with the full length of the body block;

e. Guide the 5 kg mass vertically in a manner to prevent swaying of the mass and twisting of the belt during test;

f. The attachment shall be fixed to the 5 kg mass as in the machine;

g. Before start of test, complete 20 cycles of the reciprocating motion to remove initial slack;

h. Mark the force-bearing strap material at each adjuster in preparation for measuring slip;

i. Complete 1000 cycles at a frequency of 0.5 Hertz at the reciprocating motion of 300 mm ± 20 mm. The 5 kg mass shall be applied only during the time corresponding to a shift of 100 mm ± 12 mm of each half cycle. (see Figure 5.);

j. Measure the distance the strap material has moved at each adjusting device.

5.1.5 Breaking Strength

5.1.5.1 The complete seat belt assembly, including strapping, straps, buckles, adjustment and attachment hardware, and retractors, shall withstand a tensile force of not less than 11.1 kN, that is, each structural component of the assembly shall withstand a force of 11.1 kN when tested by the procedures specified in 5.1.5.2.

5.1.5.2 All components of three seat belt assemblies shall be tested as specified in 5.1.5.2.1 and 5.1.5.2.2.

5.1.5.2.1 The pelvic restraint between seat belt anchorages shall be adjusted to a length between 914 mm and 1219 mm, or as near to this length as possible if the design of the pelvic restraint does not permit its adjustment to this length. An automatic locking or emergency locking retractor, when included in a seat belt assembly, shall be locked at the start of the test with a tension in the strapping slightly in excess of the retractile force in order to keep the retractor locked. The attachment hardware shall be oriented to the strapping as specified in 5.1.5.2.2 and illustrated in Figure 6. A tensile force of 11.1 kN ± 0.1 kN shall be applied to the components in any convenient manner and the extension between anchorages under this force shall not increase more than 500 mm. The force shall be reduced and the buckle release force shall meet the requirements of 5.3.6.

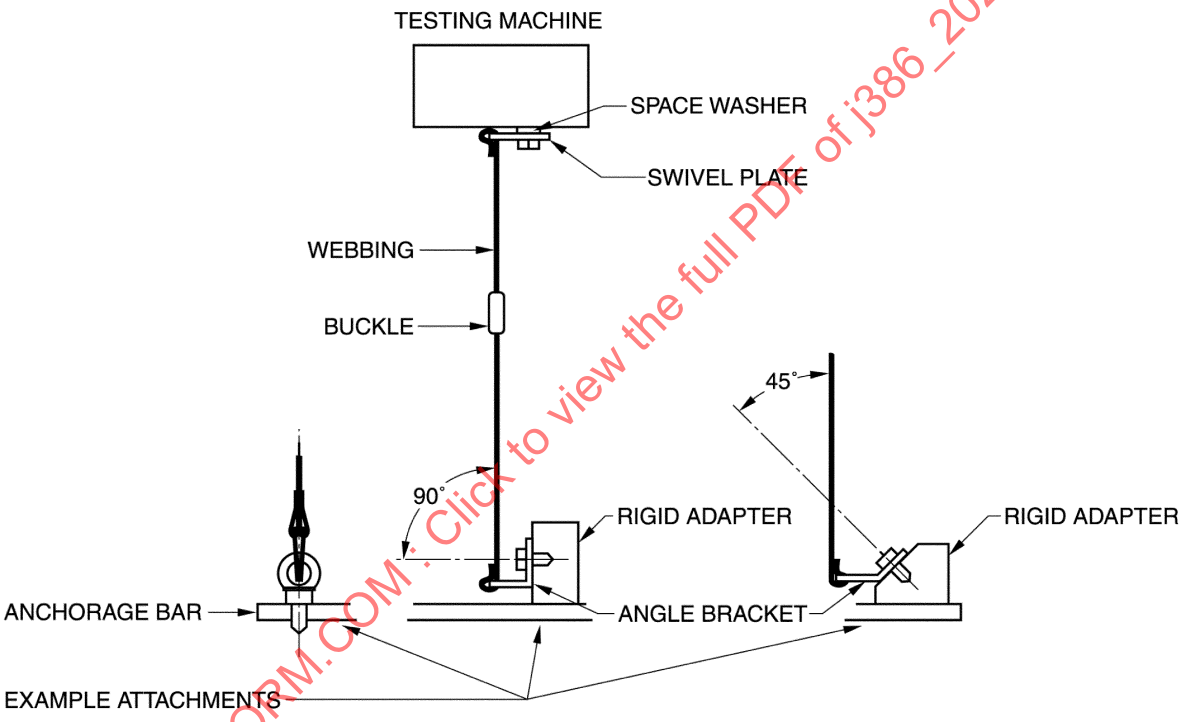


Figure 6 - Tensile force testing machine

5.1.5.2.2 The attachment hardware furnished with the seat belt assembly shall be attached to the anchorage bar. The attaching bolt shall be parallel, or at an angle of 45 degrees or 90 degrees to the strapping, whichever results in the greatest angle between strapping and attachment hardware. Eye bolts shall be vertical, and attaching bolts of a seat belt assembly designed for use in specific models of machines shall be installed to produce the maximum angle in use indicated by the installation instructions.

5.1.6 Marking (Labeling)

Each seat belt assembly or the individual sections of an assembly shall be permanently and legibly labeled with year of manufacture, model or style number, and name or trademark of manufacturer or importer, and shall state compliance with SAE J386.

5.1.7 Usage and Maintenance Instructions

Seat belt assemblies, shall be accompanied by written instructions for:

a. Proper installation, including the proper manner of threading the strap into the attachment hardware when threadable hardware is supplied.

b. Proper wearing of the installed assembly.

c. Proper maintenance (including cleaning procedures) and periodic inspection for wear or damage (as described in 4.3.3).

5.2 Strap Material Specifications

5.2.1 Material

The strap material shall have resistance to abrasion, temperature, mild acids, alkalies, mildew, aging, moisture and sunlight equal to or better than that of untreated polyester fiber.

5.2.2 Stiffness

To minimize roping, the strap material shall be woven and/or treated to produce stiffness in the transverse direction. The stiffness shall be effective for the usable life of the strap. The strap shall be flexible in the longitudinal direction to permit adjustment at –40 °C.

5.2.3 Color

Preferred colors are those which are recommended by the strap material manufacturer as being less sensitive to ultraviolet rays.

5.2.4 Width

The strap material shall not be less than 46 mm in width when measured under a no-force condition.

5.2.5 Ends

The ends shall be protected or treated to prevent unraveling, and shall not pull out of the adjustment hardware at maximum size adjustment.

5.2.6 Strength

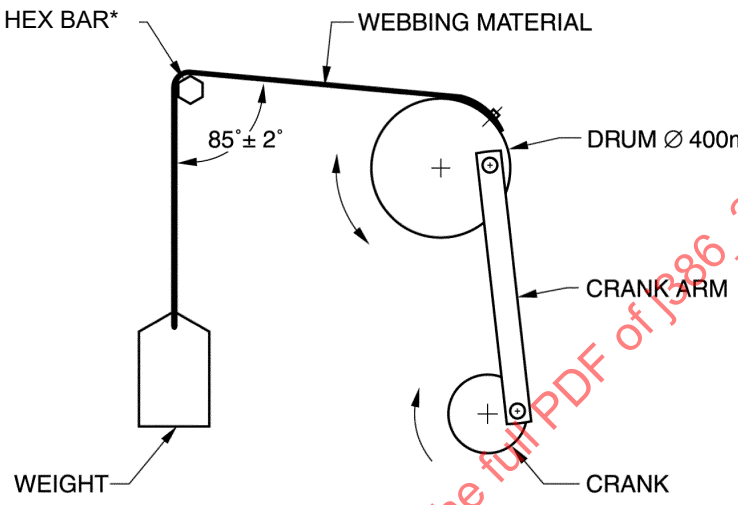
Condition three specimens for at least 24 hours in an atmosphere having a relative humidity between 65% ± 5% and a temperature of 20 °C ± 5 °C. After conditioning three specimens, the new material shall have a tensile breaking strength of not less than 26.7 kN. The testing machine shall be verified to have an error of not more than 1% in the range of the tensile strength of the strap material. The distance between centers of the grips of the machine at the start of the test shall be between 100 and 250 mm. After placing the specimen in the grips, the strap material shall be stretched continuously at a uniform rate to failure. The rate of grip separation shall be 50 to 100 mm/min. Each failure force value shall not be less than 26.7 kN tensile breaking strength requirement.

5.2.7 Elongation

Elongation shall not exceed 20% at 11.1 kN when measured during the test for strap material breaking strength as in 5.2.6.

5.2.8 Abrasion

The strap material from three seat belt assemblies shall be tested for resistance to abrasion by rubbing over the hexagon bar prescribed in Figure 7 in the following manner. The strap material shall be mounted in apparatus shown schematically in Figure 7. One end of the strap material, A, shall be attached to a weight, B, which has a mass of 2.3 kg ± 0.05 kg. The strap material shall be passed over the new abrading edges of the hexagon bar, C, and the opposite end attached to an oscillating drum, D, which has a stroke of 330 mm. Suitable guides shall be used to prevent movement of the strap material along the axis of the hexagon bar, C. The drum shall be oscillated for 5000 strokes (2500 cycles) at a rate of 60 strokes ± 2 strokes (30 cycles ± 1 cycle) per minute. The median value for the breaking strength determined on three abraded specimens shall be not less than 20 kN tensile strength when tested as described in 5.2.6.



* STEEL, SAE 51416 ROCKWELL HARDNESS, B-97 TO B-101 SURFACE, COLD DRAWN FINISH SIZE, 6.35 ± 0.1

Figure 7 -Abrasion test for strap material (dimensions in mm)

5.3 Buckle Specifications

5.3.1 Buckle Components

Applicable buckle components shall meet the corrosion requirements of Appendix A and shall meet the temperature requirements of Appendix D.

5.3.2 Buckle Compression

5.3.2.1 A buckle shall withstand a compressive force of 1780 N ± 90 N applied as prescribed below. Upon removal of the compressive force, it shall be operable and meet the applicable requirements of 5.3.4 and the requirements for release effort after tensile force in 5.3.6.

5.3.2.2 The buckle shall be subjected to the specified compressive force applied anywhere on the longitudinal centerline of the buckle and anywhere along lines at approximately 60 degrees to this centerline, with the point of intersection of these lines centered over the release mechanism. The force shall be applied through a cylindrical bar 19 mm in diameter, at least 100 mm long, and curved to a radius of 150 mm. The bar shall be placed with the longitudinal centerline of the bar directly above the lines through the longitudinal centerline of the buckle and at 60 degrees to it (Figure 8).

5.3.2.3 The buckle and latch plate shall be assembled and a tensile force of 333 N ± 22 N shall be applied to the connected assembly during the application of the compressive force.

5.3.2.4 The latch plate shall be disengaged from the buckle and the compressive force applied to the buckle again.

5.3.3 Buckle Latch Operation

5.3.3.1 The buckle-latch plate assembly of a seat belt assembly when tested by the procedure as prescribed in 5.3.3.2 shall not fail, gall, nor wear to an extent that normal latching and unlatching is impaired. The buckle-latch plate assembly shall be separable by a force of not more than 22 N when tested according to the procedure specified in 5.3.3.2.

5.3.3.2 The buckles from three seat belt assemblies shall be fully latched with their latch plates and unlatched at least 10 times. Each buckle shall then, with the latch plate withdrawn from the buckle, be clamped or firmly held against a solid surface so as to permit normal movement of buckle parts without movement of the buckle assembly. The release mechanism shall be moved 200 times through the maximum possible travel against its stop with a force of 133 N ±13 N at a rate not to exceed 30 cpm, actuating the mechanism in a manner which simulates actual usage. After completion of this portion of the test, the 133 N force shall be reduced to a force of just sufficient magnitude to assure full travel to the stop for an additional 10000 cycles. The performance of each buckle shall then be evaluated with respect to 5.3.3.1.

5.3.4 Adjustment Force

5.3.4.1 The buckle or other manual-adjusting device normally used to adjust the length of the assembly shall be subjected to the adjustment force test. This force shall not exceed 50 N when measured by the procedure specified in 5.3.4.2.

5.3.4.2 Three buckles or other manual adjusting devices normally used to adjust the length of the assembly shall be tested. This test shall be conducted within 1 hour after conditioning under laboratory ambient conditions. With no load on the anchor end, the strapping shall be drawn through the adjusting device at a rate of 500 mm ± 50 mm per minute, and the maximum force shall be measured to the nearest 1 N after the first 25 mm of strapping movement. The strapping shall be precycled 10 times prior to measurement.

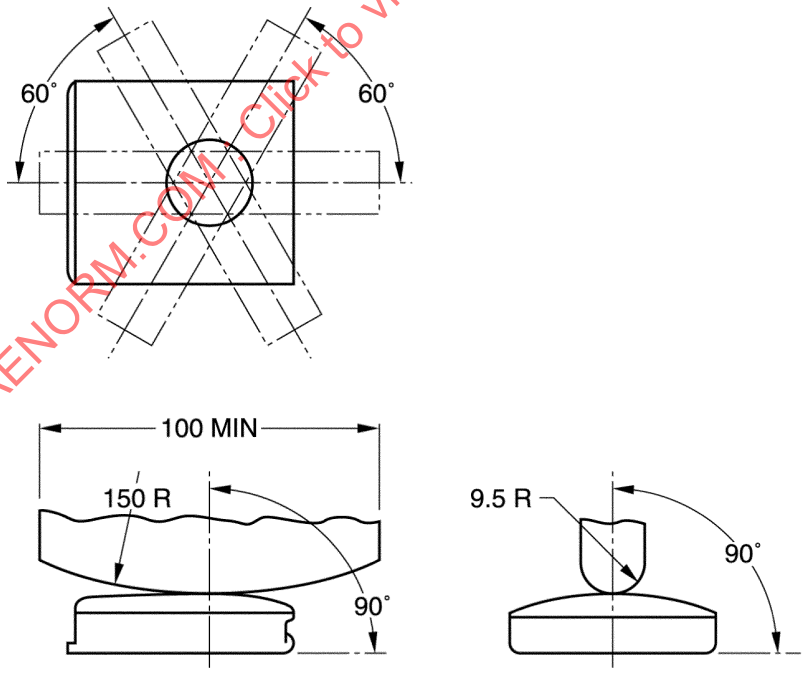


Figure 8 - Buckle compression
(Dimensions in mm)

5.3.5 Tilt Lock Adjustment

5.3.5.1 Buckles or other manual adjustment devices having tilt lock adjustment normally used to adjust the length of the assembly shall lock the strapping when tested by the procedure specified below at an angle of not less than 30 degrees between the buckle and the anchor strapping.

5.3.5.2 This test shall be conducted on buckles or other manual adjusting devices employing a tilt-lock feature to adjust the length of the assembly, using strapping intended for use in the adjusting device. Three buckles or devices shall be tested within 1 h after conditioning the strapping for 4 hours at laboratory ambient conditions. The base of the adjustment mechanism and the anchor end of the strapping shall be oriented in planes normal to one another with the strapping vertical as in Figure 9. The buckle base shall be horizontal and downward at the start of the test. The strapping shall be drawn through the adjustment mechanism so as to increase belt length at a rate of 500 mm ± 50 mm per minute, while the plane of the base is rotated at a speed of 1.1 rpm ± 0.2 rpm in a direction so as to lock the strapping. Rotation shall be stopped when the strapping locks and subsequently supports a 9 kg mass, but the pull on the strapping shall be continued until there is a resistance of at least 89 N. The locking angle between the anchor end of the strapping and the base of the adjustment mechanism shall then be measured to the nearest degree. The strapping shall be precycled 10 times prior to measurement.

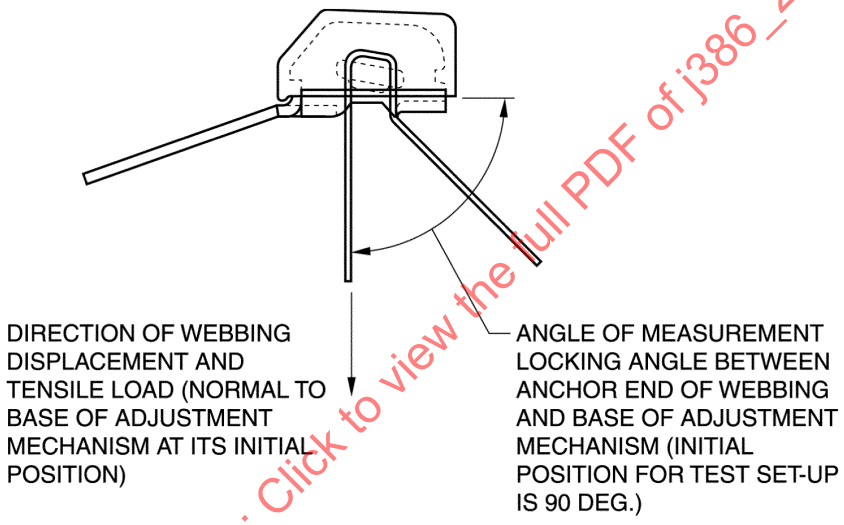


Figure 9-Tilt lock adjustment

5.3.6 Release

5.3.6.1 The buckle of the seat belt assembly shall release when a force of not more than 130 N is applied to the releasing mechanism.

5.3.6.2 Three samples of a given buckle shall be tested. After subjection to the force described in 5.1.5, the force shall be reduced and maintained at a tensile force of 335 N. The buckle release force shall be measured by applying a force on the buckle in a manner and direction typical of that employed by a seat belt user.

5.3.6.3 A buckle designed for lift lever application of buckle release shall at least permit the insertion of a cylinder 10 mm in diameter and 38 mm in length to at least the midpoint of the cylinder along the lift lever's entire length in the actuating portion of the buckle release. The release force shall be applied on the centerline of the buckle lever or finger tab in a direction that produces maximum releasing effect.

5.3.6.4 Buckles having other designs for release shall have adequate access to actuate release with the mittened hand.

5.3.7 Padding

If a buckle is used which is less than the width of the strap material, and in an area that may be uncomfortable to the occupant, a pad shall be provided under the buckle. This pad shall cover the entire buckle area and is to be the full width of the strap. It shall be permanently fastened to the assembly in such a manner that it is not injurious or uncomfortable to the occupant, does not hinder operation of any part of the seat belt, and does not expose any rough surfaces to the occupant's clothing.

5.4 Retractors (If Equipped)

5.4.1 General

Retractors shall meet the seat belt assembly strength requirements of 5.1.5. When an automatic locking or emergency locking retractor is included in a seat belt assembly, it shall be locked at the start of the test with a tension in the strapping slightly in excess of the retractile force in order to keep the retractor locked. A seat belt assembly shall not utilize a nonlocking retractor.

5.4.2 Automatic Locking Retractors (ALR)

ALRs shall comply with the following requirements:

a. The retracting force of the strap shall be not less than 3 N. Begin the measurement with no strapping on the retractor and continue to monitor the retraction force until there is 300 mm on the retractor. Compute the average of the reading from 0 mm to 300 mm.

b. After the corrosion resistance test given in Appendix A, the strap shall be withdrawn from the retractor and allowed to retract at a rate of not more than 30 cycles per minute, until 2500 cycles have been completed.

c. The retractor shall then be subjected to the temperature resistance conditioning as described in Appendix D. It shall be subjected to an additional 2500 cycles of webbing withdrawal and retraction.

d. The retractor shall then be subjected to the dust resistance test as described in Appendix C. It shall then satisfactorily complete a further 5000 cycles of withdrawal and retraction.

After the above tests the retractor shall operate correctly and still meet the requirements of a) above.

5.4.3 Emergency Locking Retractors (ELR)

5.4.3.1 An emergency locking retractor, when tested in accordance with 5.4.3.2 shall satisfy the conditions below:

a. The locking shall have occurred when the deceleration of the machine reaches 0.7 g.

b. The retractor shall not lock for values of acceleration of the strap measured in the direction of the extraction of the strap of less than 1 g.

c. The retractor shall not lock when its sensing device is tilted 12° or less in any direction from the installation position specified by its manufacturer.

d. The retractor shall lock when its sensing device is tilted by more than 40°.

e. In cases where the operation of the retractor depends on an external signal or power source, the design shall ensure that the retractor locks automatically upon failure or interruption of that signal or power source.

f. Retractors sensitive to strap acceleration only shall not be used for pelvic restraint.

g. Retractors sensitive to vehicle tilt must function at the machines extreme operating angles when the machine is idle.

5.4.3.2 In the case of the requirements mentioned in 5.4.3.1 above, the amount of strap movement which may occur before the retractor locks shall not exceed 50 mm. Also, locking must not occur during the 50 mm of strap movement in the case of the test mentioned in 5.4.3.1.(b) above. These tests are conducted when the strap has been unwound to full length less 300 mm ± 3 mm.

a. In case of a retractor actuated by strap movement, the extraction shall be in the direction in which it normally occurs when the retractor is installed in a machine.

b. When retractors are being tested for sensitivity to machine deceleration they shall be tested at the above extraction along two perpendicular axes, which are horizontal if the retractor is installed in a machine. One of these axes shall be in the direction giving the most adverse conditions with respect to actuation of the locking mechanism.

5.4.3.3 The retracting force of the strap shall be not less than 3 N when measured as follows. Start the measurement with no strapping on the retractor and continue to monitor the retraction force until there is 300 mm on the retractor. Compute the average of the reading from 0 mm to 300 mm.

5.4.3.4 The emergency locking retractor shall comply with the following:

a. After completion of the corrosion resistance test given in Appendix A, the strap shall be withdrawn from the retractor and allowed to retract at a rate of not more than 30 cycles per minute, until 2500 cycles have been completed.

b. The retractor shall then be subjected to the temperature resistance conditioning as described in Appendix D. It shall be subjected to an additional 2500 cycles of webbing withdrawal and retraction.

c. The retractor shall then be subjected to the dust resistance test as described in Appendix C.

d. It shall then satisfactorily complete a further 45000 cycles of withdrawal and retraction between 50 and 100 percent extension. The locking mechanism of emergency locking retractor shall be actuated at least 10000 times within 50 to 100 percent extension during the 50000 cycles.

e. After completing the conditioning of item (a) through (d) above, the retractor shall operate correctly and still meet the requirements of 5.4.3.1 through 5.4.3.3.

5.4.3.5 A suitable apparatus for the tests specified in 5.4.3.2 above is described in Appendix E to this Standard. The design of any such test apparatus shall ensure that the required acceleration is given before the strapping is withdrawn out of the retractor by more than 5 mm and that the withdrawal takes place at an average rate of increase of acceleration of at least 25 g/s and not more than 150 g/s (g = 9.81 m/s²).

5.4.3.6 To check conformity with the requirements of 5.4.3.1.(c) and 5.4.3.1.(d), the retractor shall be mounted on a horizontal table and the table tilted with a speed not exceeding 2° per second until locking has occurred. The test shall be repeated with tilting in other directions to ensure that the requirements are fulfilled.

5.5 Hardware Specifications

5.5.1 General

All hardware which contacts, under normal usage, an occupant, the occupant's clothing, or the seat belt assembly strap shall be free from burrs and sharp edges, and shall be designed and located in the assembly such that the possibility of injury to the occupant shall be minimized.

5.5.2 Corrosion Resistance

Applicable hardware components shall meet the corrosion requirements of Appendix A.

5.5.3 Temperature Resistance

Plastic or other nonmetallic hardware parts of a seat belt assembly when subjected to the conditions specified in Appendix D, shall not deteriorate in any manner to cause the seat belt assembly to operate improperly or fail to comply with applicable requirements of clause 5.

5.5.4 Attachment Hardware

5.5.4.1 The attachment hardware shall be designed to prevent attaching bolts and other parts from becoming inadvertently disengaged from the machine.

5.5.4.2 Attaching bolts shall have threads, having a fit equivalent to or tighter than 7/16-20 UNF-2A or ½-13 UNC-2A or the metric (ISO) equivalent, M12.

5.5.4.3 Applicable test procedures 5.5.4.4 shall be used to determine attachment hardware strength. When more than one attachment bolt is used to secure a single piece of hardware to the machine, they shall be tested as a system and shall withstand the following applicable specified forces.

5.5.4.3.1 Attachment hardware other than the attaching bolts shall withstand the following tensile forces:

a. One end of the pelvic portion of a seat belt assembly, 11.1 kN;

b. Ends of two separate seat belt assemblies, 26.7 kN;

5.5.4.3.2 Attaching bolts used to secure the ends of seat belts to the seat belt anchorages shall withstand the following tensile forces:

a. One end of the pelvic portion of a seat belt assembly, 22.2 kN.

b. Ends of two separate seat belt assemblies, 40 kN.

5.5.4.4 Attaching bolts or other substitute attachment means used to secure the pelvic restraint of a seat belt assembly to a machine shall be tested in a manner similar to that shown in Figure 10. The force shall be applied at an angle of 45 degrees to the axis of the bolt through attachment hardware from the seat belt assembly, or through a special fixture, which simulates the loading, applied by the attachment hardware. When bolts are used, the attachment hardware or simulated fixture shall be fastened by the bolt to the anchorage shown in Figure 10, which has a standard 7/16-20 UNF-2B or ½-13 UNC-2B or the metric equivalent, M12 threaded hole in a hardened steel plate of at least 10 mm in thickness. The bolt shall be tested when installed two full turns from the fully seated position, see Figure 10. The appropriate force required by 5.5.4.3 shall be applied. The bolts or other attachment means from each of three seat belt assemblies shall be tested. Other attachment means shall be tested in a manner, which simulates usage.

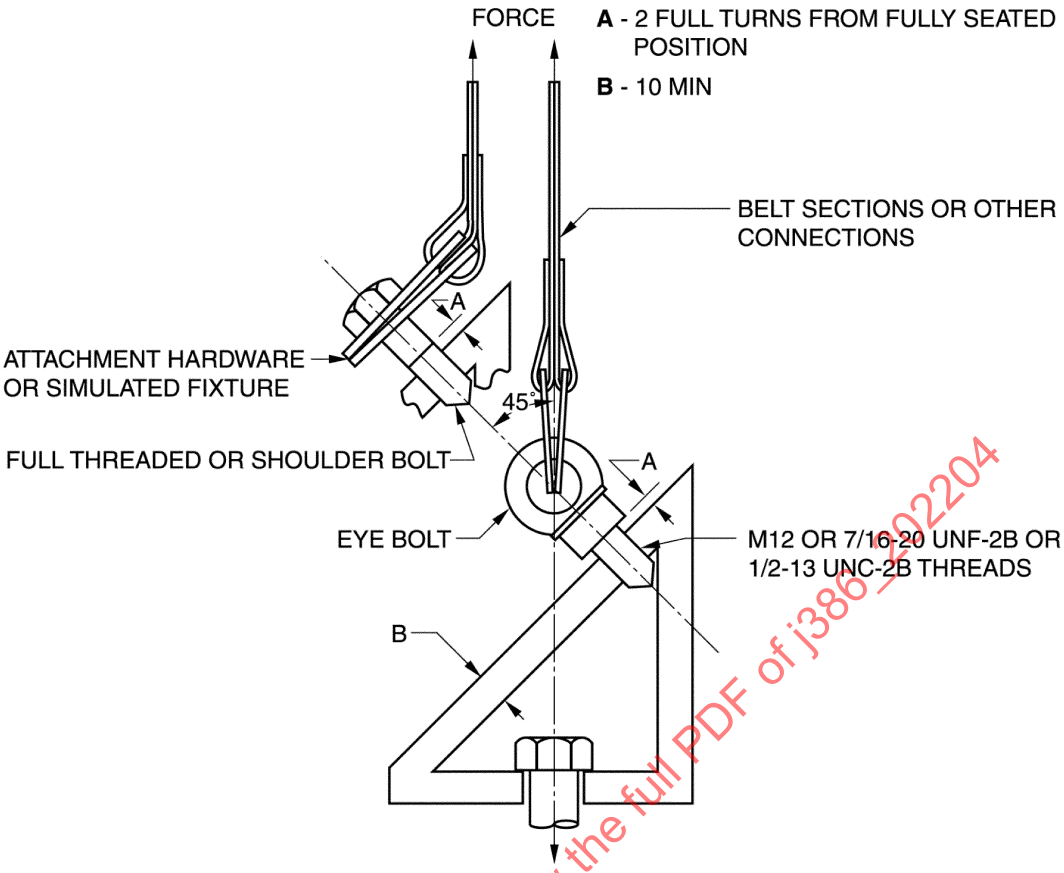


Figure 10 - Attaching bolts test fixture (Dimensions in mm)

5.5.4.5 A seat belt assembly, having single attachment hooks of the quick disconnect type of connecting strap to an eye bolt, shall be provided with a retaining latch or keeper which shall not move more than 2 mm in either the vertical or horizontal direction when tested. The test shall be performed using three single attachment hooks for connecting strapping to an eye bolt. The test shall be conducted as follows:

a. The hook shall be held rigidly so that the retainer latch or keeper, with cotter pin or other locking device in place, is in a horizontal position as shown in Figure 11;

b. A force of 665 N ± 9 N shall be applied vertically upward as near as possible to the free end of the retainer latch, and the movement of the latch at the point of force application shall be measured;

c. The vertical force shall be released, and a force of 665 N ± 9 N shall be applied horizontally as near as possible to the free end of the retainer latch;

d. The movement of the latch at the point of force application shall be measured;

e. Alternatively, the hook may be held in other positions, provided that the forces and the movements of the latch are measured at the points indicated in Figure 11.

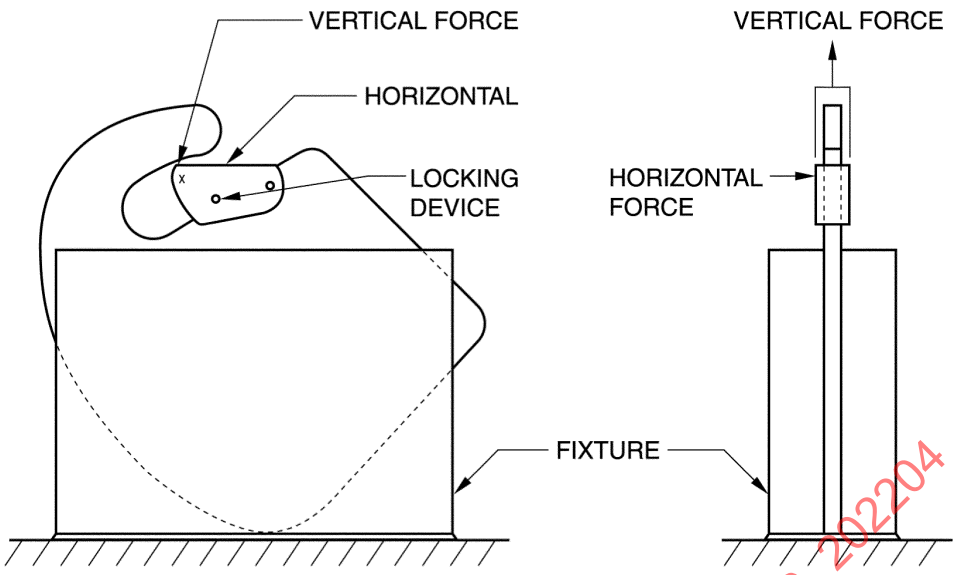


Figure 11 - Single attachment hook retention

5.6 Latch Plate Requirements

5.6.1 Latch plates shall be capable of maintaining strap tension and limiting extension in the pelvic portion of the seat belt assembly. Dropping, free falling, sliding, free running, self-parking, or semi-cinching type latch plates shall not be used.

5.6.2 Locking and cinching latch plates shall meet the requirements for adjustment force and tilt lock adjustment specified in 5.3.4 and 5.3.5.

6. NOTES

6.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE HFTC4, OPERATOR SEATING AND RIDE COMMITTEE

APPENDIX A
(NORMATIVE)

GENERAL/CORROSION

A.1 GENERAL

The rigid parts of the seat belt, such as buckles, adjusting devices, attachments and the like, shall not have sharp edges liable to cause wear or breakage of the straps by chafing.

A.2 CORROSION RESISTANCE

A.2.1 All parts of the belt assembly liable to be affected by corrosion shall be suitably protected against it. After undergoing the corrosion resistance test prescribed in A.3 below, neither signs of deterioration likely to impair the proper functioning of the device nor any significant corrosion shall be visible to the unaided eye of a qualified observer.

A.2.2 Other hardware shall be examined for ferrous and nonferrous corrosion, which may be transferred either directly or by means of the strapping to a person or his or her clothing during use of a seat belt assembly incorporating the hardware.

A.3 CORROSION RESISTANCE TEST

A.3.1 Three complete seat belt assemblies shall be positioned in a test chamber for salt spray exposure, as prescribed in Appendix B. In the case of an assembly incorporating a retractor, the strap shall be unwound to full length less 300 mm ± 3 mm. Except for short interruptions that may be necessary, for example, to check and replenish the salt solution, the exposure test shall proceed continuously for a period of 50 hours.

A.3.2 Each assembly shall then be gently washed or dipped in clean running water having a temperature not higher than 38 °C to remove any salt deposit that may have formed. The assemblies shall then be allowed to dry at room temperature for 24 hours before inspection in accordance with A.2 above.