1. SAE J684

TRAILER COUPLINGS, HITCHES, AND SAFETY CHAINS—AUTOMOTIVE TYPE

1. Scope—This SAE Standard includes couplings, hitches, and safety chains used in conjunction with all types of trailers or towed vehicles whose Gross Vehicle Weight Rating (GVWR) does not exceed 4540 kg (10000lb). This includes such types as utility, boat, camping, travel, and special purpose trailers which are normally towed by conventional passenger cars, light-duty commercial vehicles, light trucks, and multipurpose passenger vehicles. This document is intended primarily for ball-and-socket type of couplings and hitches. It should not be construed as a limitation to this type alone but should apply where appropriate to ring-and-pintle, clevis-and-pin, or any other draft means designed to serve this purpose.

2. ***References***

2.1 Applicable Publications—There are no referenced publications specified herein.

3. ***Definitions*****—Coupling and Hitch Nomenclature**—The following nomenclature has been adopted for uniformity in the terms used for the component parts of the trailer-coupling mechanism:

3.1 Hitch—That part of the connecting mechanism including the ball support platform and ball and those components that extend and are attached to the towing vehicle, including bumpers intended to serve as hitches.

3.1.1 WEIGHT DISTRIBUTING HITCH (OR EQUALIZING HITCH)—A mechanical device that connects the trailer to the towing vehicle and by means of leverage applied on both trailer and towing vehicle structures, when properly adjusted, distributes the imposed vertical load at the hitch and coupling connection between structures of towing vehicle and trailer.

3.1.2 WEIGHT CARRYING HITCH—A mechanical and/or structural device that connects the trailer to the towing vehicle, and that does not employ features designed to redistribute the load imposed at the hitch and coupling connection.

3.2 Coupling—That part of the trailer connecting mechanism by which the connection is actually made to the trailer hitch. This does not include any structural member, extension of the trailer frame, or brake actuator.

4. ***Trailer Classification***

4.1 Class 1—All types of trailers with a trailer Gross Vehicle Weight Rating (GVWR) (trailer weight including its load) not to exceed 910 kg (2000 lb).

4.2 Class 2—All types of trailers with a trailer GVWR of over 910 kg (2000 lb) and not to exceed 1590 kg (3500 lb) GVWR.

4.3 Class 3—All types of trailers with a trailer GVWR of over 1590 kg (3500 lb) and not to exceed 2270 kg (5000lb) GVWR.

4.4 Class 4—All types of trailers with a trailer GVWR of over 2270 kg (5000 lb) and not to exceed 4540 kg (10000lb) GVWR.

5. *Couplings*

5.1 Coupling Classification—There shall be four designations of couplings to cover all trailers up to 4540 kg (10000 lb) GVWR. The designated classification of the coupling shall be based on the GVWR of the trailer rather than the weight imposed vertically down on the ball by the coupling. The Class 1 coupling shall be used on Class 1 trailers; the Class 2 coupling, on Class 2 trailers; the Class 3 coupling, on Class 3 trailers; and the Class 4 coupling, on Class 4 trailers. This is not intended to limit the number or variety of couplings in a given class or to restrict the use of a heavier-duty coupling or hitch ball being used on a lighter class of trailer.

5.2 Attachment of Couplings—All couplings are to be attached to the trailer's structural attaching member by bolting, welding, or riveting in such a manner that the loads indicated in Table 1 may be applied without incurring loss of attachment or distortion or failure which would affect the safe towing of trailers.

5.2.1—Manufacturers of trailer couplings shall provide instructions for the attachment of coupling housings to trailers.

TABLE 1—STRENGTH TEST LOADS FOR COUPLING ATTACHMENTS

Mode	Minimum Static Test Load
Longitudinal Tension and Compression	1.5 x Maximum Trailer GVWR
Transverse Thrust	0.5 x Maximum Trailer GVWR
Vertical Tension and Compression	0.5 x Maximum Trailer GVWR

5.3 Provision for Safety—Couplings in all classes shall be equipped with a manually operated mechanism so adapted as to prevent disengagement of the unit while in operation.

5.4 Identification—Trailer couplings which meet the minimum standards set forth in Table 2 shall be permanently marked with the following information:

5.4.1—Coupling manufacturer's name, initials, or trademark.

5.4.2—Part, style, or model number.

5.4.3—SAE coupling classification and maximum trailer GVWR.

5.4.4—Ball diameters for which coupling is designed.

TABLE 2—STRENGTH TEST LOADS FOR BALLS AND TRAILER COUPLINGS (1)(2)

Trailer Classification	Trailer Coupling Designation	Typical Ball Diameter, mm (in) (where ball-type hitch is used)	Minimum Test Load Requirements, kN (lb)
Class 1	Class 1	47.6 (1-7/8)	Longitudinal Tension: 26.7 (6000) Longitudinal Compression: 26.7 (6000) Transverse Thrust: 8.9 (2000) Vertical Tension: 11.1 (2500) Vertical Compression: 11.1 (2500)
Class 2	Class 2	50.8 (2)	Longitudinal Tension: 46.7 (10 500) Longitudinal Compression: 46.7 (10 500) Transverse Thrust: 13.3 (3000) Vertical Tension: 20.0 (4500) Vertical Compression: 20.0 (4500)
Class 3	Class 3	50.8 (2)	Longitudinal Tension: 66.7 (15 000) Longitudinal Compression: 66.7 (15 000) Transverse Thrust: 17.8 (4000) Vertical Tension: 31.1 (7000) Vertical Compression: 31.1 (7000)
Class 4	Class 4	Ball and bolt shall be of such size and strength as to conform to the minimum breaking strength requirements of the mating coupling required for the specific load of Class 4 trailer	Longitudinal Tension: Gross trailer Weight, N (lb) x 3 Longitudinal Compression: Gross trailer weight, N (lb) x 3 Transverse Thrust: Gross trailer weight, N (lb) x 1 Vertical Tension: Gross trailer weight, N (lb) x 1.3 Vertical Compression: Gross trailer weight, N (lb) x 1.3

1. Vertical Tension Load Requirement—The vertical tension load requirement is extremely important because of the mechanics of holding the ball in the socket. On vertical-tension (or pullout) testing, the major portion of the tensile load is transferred from the lip of the coupling to the ball clamp and its supporting bolt, rivet, or inclined plane. While relatively little distortion occurs in the coupling housing, the ball clamp is forced back and downward until the final restricting force retaining the ball is lost and pullout occurs. The load at which retention is maintained is highly critical and loss of purchase on the ball occurs suddenly, going from safe retention to complete separation.

2. Coupling versus Hitch Static Bench Test Load Requirements—Coupling strength design criteria are necessarily different than those for hitches and will be greater because of the stresses to which each is subjected. Couplings are welded or bolted to trailer tongues with only the socket and latching mechanism exposed. The coupling socket must take the concentrated dynamic shock load as well as the varying stresses induced from normal trailering, and is the point of highest stress. The hitch load is distributed through the hitch components, spring deflections in the towing vehicle, shock absorbers, and the vehicle structure, and is affected by entirely different force distribution than the coupling. Hitches are actually subjected to much lower unit forces than are the coupling and the ball.

5.5 Coupling Ratings—There shall be a minimum strength test for couplings by class as indicated in Table 2.

5.6 Test Fixture—Basic drawings of typical test fixtures (Figure 1) for use in determining conformance of couplings to the minimum strength test load requirements of Table 2 are included in this document to promote uniformity in test results by various testing laboratories.

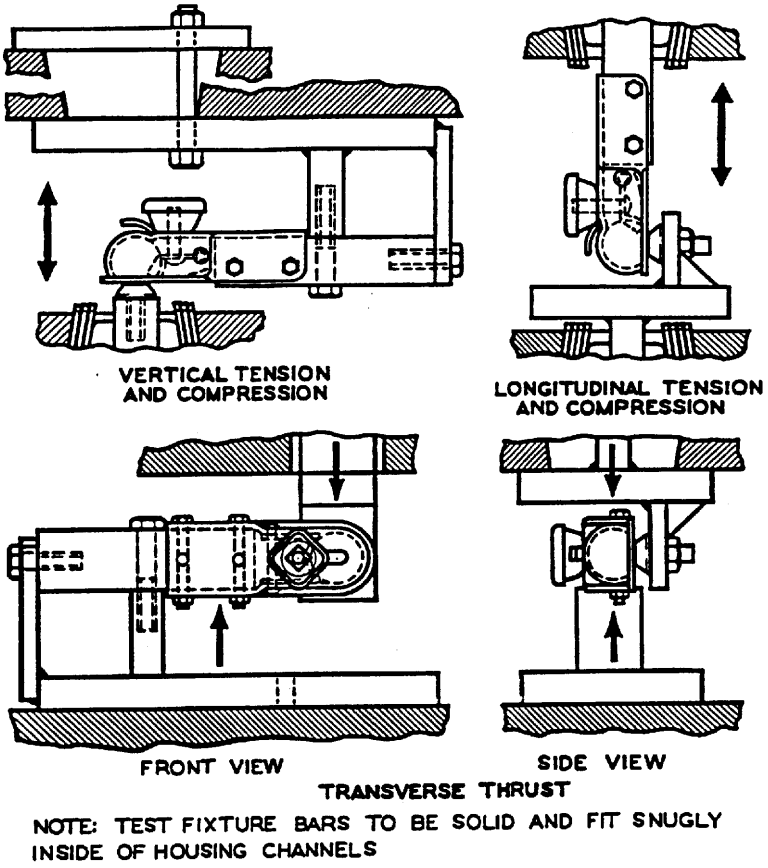

FIGURE 1—TYPICAL TRAILER COUPLING TEST FIXTURE ARRANGEMENT

5.7 Coupling Test Procedure—A coupling or ball shall withstand the test loads indicated in Table 2 without incurring failure. For the purpose of this section, failure is defined as the point at which the coupling or ball will accept no additional test load without separation of the ball from the coupling ball socket, or the occurrence of a metal fracture of either coupling ball or coupling assembly which results in separation of the ball from the coupling ball socket. Distortion or bending of the ball or of a coupling assembly component occurring during testing does not constitute a failure as defined herein unless actual separation of the ball from the coupling socket occurs prior to the designated test loads indicated in Table 2. When conducting tests, a new coupling or ball shall be used for each mode of load application.

6. Hitches

6.1 Hitch Strength Requirements—The hitch shall meet the test load requirements indicated in Table 3 of this document.

TABLE 3—HITCH TEST LOADS [(1)(2)]

Step	Weight Carrying Hitch Force, kN (lb)	Weight Carrying Hitch Direction	Weight Distributing Hitch Force, kN (lb)	Weight Distributing Hitch Direction
a	V = 0.47R + 2.135 (480) L = 0.47R + 2.135 (480)	Downward Compressive	V = 0.045R + 7.339 (1650) M = 5762 (51 000)	Downward See Figure 2
B	L = 0.23R + 6.805 (1530) V = 0.15R	Tensile Downward	L = 0.067R + 9.207 (2070) V = 0.15R	Tensile Downward
c	L = 0.23R + 6.805 (1530) V = 0.15R	Compressive Downward	L = 0.067R + 9.207 (2070) V = 0.15R	Compressive Downward
d	T = 0.20R + 2.24 (500)	Leftward	T = 0.20R + 2.224 (500)	Leftward
e	T = 0.20R + 2.224 (500)	Rightward	T = 0.20R + 2.224 (500)	Rightward
f	Not applicable	Not applicable	M = 2.367X + 2372 (93.2X + 21 000) V = 0.15R	See Figure 2 Downward

1. V = Vertical Force (N [lb])
   L = Longitudinal Force (N [lb])
   T = Transverse Force (N [lb])
   M = Spring Bar Moment (N · m [in-lb]) (Leveling Force Couple)
   R = Hitch Rating in terms of trailer GVWR (N [lb]) (Gross Vehicle Weight Rating)
   X = Hitch Rating for Maximum Vertical Load on Hitch (N [lb]) (Tongue Weight)

2. Notes—Hitch Test Force Applications—(See Table 3 and Figure 2)
   Apply the forces in any sequence as follows:

   a. Apply the specified downward vertical force concurrently with the specified compressive longitudinal force or spring bar moment.

   b&c. Apply the specified tensile or compressive longitudinal force concurrently with the specified downward vertical force.

   d&e. Apply the specified transverse force.

   f. For hitches with weight distributing capability, apply the specified spring bar or leveling moment (leveling force couple) concurrently with the specified downward vertical force.

   All forces in steps (a) through (e) are to be applied along an axis which intersects the center of the ball. All forces are to be applied with an onset rate of not more than 0.667 kN/s (150 lb/s), and maintained at the maximum specified force level for at least 5 s.

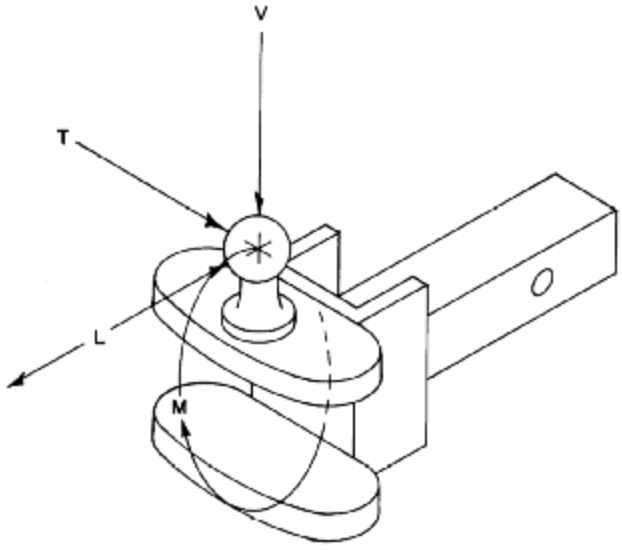

FIGURE 2—HITCH TEST FORCES APPLICATION

6.2 Attachment of Hitch—The hitch shall be attached by bolting or other means to the towing vehicle frame, body, bumper structure, or to a combination of these or other points in such a manner that the loads indicated in Table 3 are transferred to the towing vehicle without incurring loss of attachment. This section is not intended to require that specific hitches shall be tested on the actual vehicles for which they were designed. (See 6.3.1.)

6.3 Hitch Test Procedure

6.3.1 ASSEMBLY AND INSTALLATION—The hitch shall be assembled and installed on the vehicle, vehicle simulating fixture, or other non-yielding fixture according to the hitch manufacturer's installation instructions.

6.3.2—The hitch shall withstand the applied forces indicated in Table 3 without incurring permanent deformation such that the position of the ball axis, at the completion of each test step, shall not depart more than 5degrees from the original, nominally vertical, position.

6.4 Hitch Identification—The hitch shall be permanently marked by the manufacturer to show the following:

6.4.1—Hitch manufacturer's name, initials, or trademark.

6.4.2—Part, style, or model number.

6.4.3—Maximum trailer GVWR to be drawn.

6.4.4—Maximum vertical tongue weight to be imposed on the ball or other point of connection.

6.5 Hitch Balls

6.5.1 DIMENSIONAL TOLERANCE ON BALL DIAMETERS—The allowable finished dimensional tolerance on all ball diameters shown in Table 2 shall be +0.000 mm (0.000 in) and –0.76 mm (0.030 in). By "diameter" is meant the through dimension taken on any plane passing through the center of the ball on its spherical surface.

6.5.2 BALL STRENGTH REQUIREMENTS—There shall be a minimum strength test for balls by class as indicated in Table 2.

6.5.3 BALL IDENTIFICATION—The nominal diameter of the ball and the maximum trailer GVWR for which the ball is designed shall be permanently marked on the ball. The markings shall be clearly visible when the ball is attached to the hitch.

7. *Safety Chains*

7.1 Definitions and Purpose—"Safety Chain" is defined as an assembly which provides a secondary means of connection between the rear of the towing vehicle and the front of the trailer (or towed vehicle); it includes link chain and all attaching means, or an alternative system (see 7.6). The purpose of Safety Chain is to retain connection between the towing vehicle and trailer in the event of separation of the trailer coupling from the ball or the ball from

the hitch, long enough to bring the vehicles to a stop. It should not be construed that safety chains can ensure that vehicle control or connection will be maintained in the vent of vehicle incidents such as loss of control, rollover, jackknife, collision, etc.

For the purpose of this section:

a. The "hitch" assembly (including ball and ball support platform) is considered part of the towing vehicle.

b. The "safety chain" is considered part of the trailer.

c. "Attaching means" are defined as the hooks, bolts, anchorages, or other devices used to fasten or connect link chain, or its equivalent, to the trailer tongue and to the rear of the towing vehicle including hitch assembly devices provided for such connection.

7.2 Strength Requirements—Each individual safety chain, and all attaching means, shall meet the minimum breaking force tensile load as indicated in Table 4, and where applicable such load shall be applied in a direction parallel to the trailer's or towing vehicle's longitudinal axis. Any operation performed on safety chain subsequent to its manufacture shall not reduce its strength below the requirements of Table 4.

TABLE 4—STRENGTH REQUIREMENTS FOR SAFETY CHAIN AND ATTACHING MEANS [1]

Safety Chain or Trailer Classification	Breaking Force—Minimum
Class 1	8.9 kN (2000 lb)
Class 2	15.6 kN (3500 lb)
Class 3	22.2 kN (5000 lb)
Class 4	The strength rating of each length of safety chain or its equivalent and its attachments shall be equal to or exceed in minimum breaking force the GVWR of the trailer.

1. When conducting a tensile strength test of a length of chain or equivalent and its attaching means, when the minimum load specified in Table 4 is applied, such load shall be maintained for a minimum of 1 min.

7.3 Wire Rope Thimbles—When wire rope is used as safety chain, the strands of the rope shall be protected from damage by use of a wire rope thimble in the areas of its attaching means.