

Draft (TÜV Bayern e.V., Part A  
and Rheinisch-Westfälischer TÜV e.V., Part B)

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Technical requirements for the type approval of vehicle  
components acc. to § 22a StVZO,  
No. 31: Devices for road vehicle connections.

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Part A: General Requirements

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## 1. Definitions

1.1. Devices for the connection of vehicles within the meaning of the § 22a Abs.1 Nr. 6 StVZO together with § 43 StVZO are all parts and devices between the frames, the carrying car body parts and / or the running gears of the vehicles, with which a tractor and a trailer have to be connected in order to perform the desired following of the trailer.  
Also such parts belong here which are required to attach or to adjust the abovementioned connecting devices, removable or fixed mounted, even if they have no supporting function.

1.2 An articulated or hinged towing device is a vertical to the trailer frame freely movable towing attachment (on a trailer) which cannot transfer vertical loads to the towing vehicle.

A rigid towing device is a vertical to the trailer frame not freely movable towing attachment (on a trailer) which can transfer vertical loads to the towing vehicle.

The towing devices can be of various design, e.g. A-frame drawbars, pole arm type etc.

2. Test procedures

- 2.1 It is usually sufficient that the tests with coupling and towing equipment and comparable devices shall be performed with specimen. Basically functional tests are required.
- 2.2 The strength of devices for vehicle connection shall be verified. Primarily fatigue tests shall be performed ( in specific cases, additional static tests may be necessary). Only for simple shaped units and, if according to general experience their strength can be reliably determined without dynamic testing, a static test or a calculation is sufficient. In case of doubt the results of a dynamic test will be conclusive. The test procedure will be established by the competent Technical Service.
- 2.3 Other loads to be transmitted by the connecting device, increased nominal values or differing adjustments provided for other applications have to be considered for the test procedure.
- 2.4 Calculations are to be performed only if the the results are comparable to those of dynamic or static tests.
- 2.5 The dynamic forces applied during the fatigue test shall be as sinusoidal as possible (alternating and/ or pulsating) carried out with a number of stress cycles depending from the type of material to be tested. The test must not cause breaks or cracks. When cracks are traced after performing the required number of fatigue cycles, improvements of design, material or manufacturing process are required. A repetition of the endurance test can only be waived when the cracks are of no importance with respect to the stability of the unit because of their little size and location and if it is safe to say that modifications will ensure a sufficient fatigue strength.

- 2.6 Only insignificant permanent deformations are permissible as a result of static tests.
- 2.7 The basis for test load assumptions is the horizontal load component along the longitudinal vehicle axis and the vertical load component. Horizontal components transversal to the longitudinal vehicle axis will be neglected provided that they are of secondary importance. The horizontal load component along the longitudinal vehicle axis will be represented by a comparative value determined by calculation: the D-value. For devices designed to couple vehicles - except fifth wheels for semitrailer tractors and comparably operated trucks - the D-value shall be equivalent to:

$$D = g * \frac{m_K * m_A}{m_K + m_A}$$

For fifth wheels on semi-trailer tractors and other comparably operated vehicles - the D-value shall be calculated as follows:

$$D = g * \frac{0.6 * m_K * m_A}{m_K + m_A - A}$$

where

$m_K$  = Total weight of towing vehicle (also semi-trailer tractor)

$m_A$  = Trailing weight of trailer (resp. semi-trailer) (for trailers with rigid towing device the trailing weight means total weight of trailer less a vertical load on towing device)

$A$  = vertical load on fifth wheel

$g$  = 9.80665 m/sec<sup>2</sup>

(All weight- and load dimensions to be inserted in units of mass)

Vehicle weights may be derived from 3.5.1 and 3.5.2 combined with paragraphs 34 and 42 StVZO.

3. General requirements

3.1 Any component of equipment for connecting vehicles whose failure would cause a separation of the connection or a reduced articulation must be made of steel or cast steel. Use of other materials is subject to approval by the approval authority \*).

3.2 All devices for the connection of vehicles shall be designed in a manner, that it's intended application is easy and safe without the aid of tools. Operating elements must be permanently attached.

3.3 All connections must be positively interlocking and, in addition to it, must be secured by a positive interlocking securing device. A connection is defined as positively interlocking if no forces will be effective to unlock the device also without the effect of frictional and/or spring forces.

If a positively interlocking securing device is retained by means of spring force, it shall remain in its locked position also if an acceleration of  $3 * g$  would be effective in the most adverse direction.

An obvious indication of the locked and secured position must be provided.

\*) General instructions for other materials and their use and processing as well as for steel and cast steel have been published by the 'Kraftfahrt-Bundesamt'.

3.4 Linch pins and spring cotters used as positively locking securing devices must conform to DIN 11023/ October 1979 and/or DIN 11024/ January 1973. If necessary for reasons of design and for securing not cylindrical parts other safety devices are admitted if at least the same reliability can be achieved. A safety device actuated in service must be easy to install and attached so that it cannot get lost.

Their attaching elements (e.g. steel chains or plastic cords) must have a minimum resistance to tearing of 2000 N. The stability must be maintained under all operating and environmental conditions.

3.5 Connection devices for vehicles shall be provided with a name plate on a spot where it is protected against damage and can be seen after attachment of the device to the vehicle. The name plate must be easily readable and permanently show data as required by section 3.5.1 and 3.5.2 below besides the mark of conformity. This mark must additionally and well legibly be imprinted upon one, respectively upon the essential components of the device. If indicated in the type approval document all data as required for the name plate may be imprinted to the assembly. In this case an additional imprinting of the mark of conformity is not necessary.

It must clearly appear from the drawing set where the name plate and the additional mark of conformity will be attached to the device or, if applicable, where the imprinted data can be found.

3.5.1 At trailer couplings:

- Description
- Manufacturer
- if applicable: holder of approval
- Type, model, respectively sign for model
- max. permissible speed (only if speed is limited)
- characteristic parameters and/or range of application

Depending from the character of the connecting device the following parameter and/or range of application statements shall be made:

1. for automatic trailer couplings:

- type and weight category acc. to DIN 74051/ August 1978 or DIN 74052/ August 1978 provided that a coupling meets one of these standards in every respect.  
If a coupling does not comply with one of these standards the D-value shall be specified.
- permissible vertical load or a note:  
"not approved for vertical load"
- if applicable: permissible total weight of trailers with rigid towing device (drawbar).

2. for non-automatic trailer couplings and automatic trailer couplings for agricultural and forestry applications:

- permissible total weight of towing vehicle
- permissible vertical load or a note:  
"not approved for vertical load".

3. for non-automatic trailer couplings attached to trailers:

- permissible total trailing weight
- permissible vertical load or a note:  
"not approved for vertical load".

4. for fifth wheels:

- D-value
- permissible vertical load
- if applicable: "not approved for positive steering"

5. for king pins:

- permissible D-value

6. for king pin and fifth wheel mounting plates:

- permissible D-value
- permissible vertical load

7. for coupling balls with bracket:

- permissible vertical load
- D-value

3.5.2 At towing devices (on trailer) including ball type couplings heads:

- Description
- Manufacturer
- if applicable: holder of approval
- Type, model, respectively sign for model
- max. permissible speed (only if speed is limited)
- permissible total weight of trailer  
(if applicable at rigid towing equipment: max. ... kg depending upon cantilevered length)
- permissible vertical load at drawbar eye or at point of coupling (only for rigid towing devices)
- D-value



3.5.3 At height adjusting devices:

- Description
- Manufacturer
- if applicable: holder of approval
- Type, model, respectively sign for model
- max. permissible speed (only if speed is limited)
- range of application

3.6 Additional particulars besides the parameters mentioned will be stipulated in the type approval documents if this is regarded to be necessary, e.g. identification of coupling pins for not automatic trailer couplings by manufacturer's brand.

4. Automatic trailer couplings

Dimensions of the jaw guide are stipulated within DIN 74051/ January 1989, DIN 74052/ January 1989 or DIN 15170 form E/ March 1987 or for tractors and selfdriving agricultural machines where the coupling procedure can be watched from the operator's seat within DIN 11025/ May 1980 or DIN 11029 form B/ April 1989.

The design of the jaw guide must assure to lead an appropriate drawbar eye safely into the coupling position.

4.2 Coupling and uncoupling the drawbar eye must be possible also when the longitudinal axis of the drawbar eye is rotated in relation to the centerline of the the jaw:

- a) horizontally 50° rotated to the left or right,
- b) vertically 10° inclined up or down
- c) axially 10° rotated to the left or right.

- 4.3 It must be assured that a drawbar coupled to a coupling complying with DIN 11025/ May 1989, will be free to swivel horizontally at least 90° to both sides of the center axis of the coupling when not installed to the vehicle. Furthermore a free inclination of both 20° vertically up- and downwards and a rotation around a horizontal axis passing through the coupling of 25° to both sides is required.
- 4.4 A horizontal rotation of the jaw guide around its vertical axis must only be possible if the coupling bolt is in its locked position; a vertical inclination around a horizontal axis however may be possible independent from this position. The jaw guide must automatically adjust itself into its normal position and must be locked non-positively or positively in this position in order that the drawbar eye can be safely introduced.
- 4.5 The maximum permissible axial rotation of the jaw guide is 30 degrees to both directions; however, more than 30 degrees are permissible if there is a limiting moment of at least 100 Nm. Deviating from this an axial rotation around the horizontal axis passing through the coupling of at least 90 degrees to both sides are required for agricultural- or forestry tractors. An arresting friction moment of 100 to 150 Nm shall be provided for these couplings. For applications at agricultural- or forestry tractors with a wheel track of less than 1150 mm, this moment shall be reduced to 30 to 100 Nm.

- 4.6 When in locked position, the coupling pin of the coupling device shall be positively secured by two safety locks. It is admitted, that the second safety lock is engaging the first safety lock and not directly the coupling pin.
- 4.7 The locking position of the coupling must be obviously indicated. It must then be assured by constructional features that the positive safety locks are effective.
- 4.8 Operating handles must be pointing upwards. A handle pointing downwards is only permissible for rear dumpers, towing vehicles with rear opening, elevating platform or similar equipment, as far as such handles are required for technical reasons. The opening direction of an operating handle is optional. A handy design is required. The operating force for releasing - measured (without drawbar eye) at an angle of max. 30° inclined in relation to the horizontal must not exceed 200 N.
- 4.9 For other automatic trailer couplings except fifth wheels for semi-trailer tractors, where the connecting elements are not a coupling pin and a drawbar eye (special designs) the foregoing regulations shall apply accordingly.

5. Non-automatic trailer couplings

- 5.1 For the minimum dimensions of the jaw guide (drawbar guiding funnel) the dimensions acc. to DIN 11025/ May 1980 resp. DIN 11029 form A issue April 1989 or DIN 15170 form A or B, / March 1987 applies. Hitches acc. to DIN 9878 do not require a jaw guide.
- 5.2 Coupling and uncoupling of the drawbar must also be possible when the longitudinal axis of the drawbar eye is misaligned in relation to the centerline of the jaw:
- a) rotated  $50^\circ$  horizontally to right or left
  - b) inclined  $10^\circ$  vertically up or down
  - c) rotated  $10^\circ$  axially to right or left
- 5.3 The coupled drawbar eye must be able to rotate at least  $\pm 60^\circ$  to both sides from the centerline of a trailer coupling not attached to the vehicle. Simultaneously it must be possible for the drawbar eye to be inclined  $20^\circ$  up or down.
- 5.4 The jaw must admit an axial rotability of the drawbar eye of at least  $\pm 90^\circ$  about the longitudinal axis of the trailer coupling, which is arrested by a friction moment 100 to 150 Nm. If used with agricultural or forestry tractors with a track of less than 1150 mm, the arresting moment must be reduced to 30 to 100 Nm. For trailer couplings to be used on trailers and electro industrial trucks or comparable other vehicles an axial rotability is not necessary, if the possible axial roll of the drawbar eye in the jaw to both directions is  $25^\circ$ .

5.5 Coupling pins and other pins serving the purpose of connecting vehicles must be positively secured. The coupling pin must be prevented from falling through its bearing in the coupling body.

5.6 For other not automatic trailer couplings the foregoing requirements shall apply accordingly.

6. King pins, fifth wheels, steering wedges.

6.1 King pins must comply with DIN 74080/ January 1984 resp. DIN 74084/ January 1984.

6.2 Fifth wheels must be equipped with a guide corresponding to DIN 74081/ January 1984 or DIN 74084/ January 1984 which ensures safe and secure engagement of the coupling pin.

6.3 Fifth wheel couplings must be suitable for the positive steering of semi-trailers by means of steering wedges corresponding to DIN 74085/ January 1984. Fifth wheels unsuitable for positive steering must be marked accordingly.

6.4 Devices for the transmission of steering forces for positive steering of semi-trailers (steering wedges) must conform to DIN 74085/ January 1984.

6.5 With the king pin engaged, fifth wheels must permit the following minimum rotation values in the travelling position:

- a)  $\pm 90^\circ$  about the vertical axis and simultaneously
- b)  $\pm 15^\circ$  about the horizontal axis transverse to the direction of travel. A roll angle about the longitudinal axis of up to  $\pm 3^\circ$  is permitted.

6.6 Fifth wheels must be automatic in operation. The locking mechanism must positively secure the king pin. The secured position must be visually and obviously indicated.

6.7 In the locked position the operating elements must be secured to prevent inadvertent operation and it must be possible to lock it against unauthorized operation. Thereby it must be assured that the king pin is securely engaged by the coupling locks.

7. Coupling heads (ball type couplings), coupling balls with bracket.

7.1 Shape, dimensions and attachments of coupling balls must conform to DIN 74058/ September 1988. Other sizes are permitted if confusion with similar designs is excluded.

7.2 Coupling and uncoupling of the coupling ball must also be possible when the longitudinal axis of the coupling head in relation to the centerline of the coupling ball is

- a) rotated  $50^\circ$  horizontally to right or left
- b) inclined  $10^\circ$  vertically up or down
- c) rotated  $10^\circ$  axially to right or left.

7.3 The coupled coupling head must be able to rotate at least  $\pm 90^\circ$  to both sides from the centerline of a coupling ball not attached to the vehicle. Simultaneously it must be possible for the coupling head to be inclined  $20^\circ$  up or down. Furthermore it must be possible that the coupling head, when horizontally rotated  $\pm 90^\circ$ , can simultaneously be rotated  $\pm 25^\circ$  about its longitudinal axis. The following combined movements must be performed:

vertical inclination  $\pm 15^\circ$  with simultaneous axial rotation  $\pm 25^\circ$

axial rotation  $\pm 10^\circ$  with simultaneous vertical inclination  $\pm 20^\circ$

at all horizontal rotation angles.

7.4 If coupling balls with bracket are supplied, they must be accompanied with a mounting instruction and a manufacturer's declaration to confirm that the fixing points comply with the dimensions provided by the vehicle manufacturer and determined during the type approval procedure and that, if applicable, required reinforcements at fixing areas of the bracket have been considered for the vehicle models listed.

When fixing points were not determined or published by the vehicle manufacturer they may be determined in collaboration with the locally responsible manufacturer's agent and the Technical Service conforming to paragraph 4 of the "Fahrzeugteilverordnung" (Regulation for vehicle parts).

7.5 The clearance dimensions for free movement as stated in DIN 74058/ September 1988 must be considered and confirmed.

7.6 Ball type coupling devices must permit safe operation within the free space as stated in DIN 74058/ September, 1988. The hand lever must be adequately designed as to grant sufficient free space for handling including uncoupling the coupling head.

8. Towing devices

8.1 Drawbar eyes must conform to DIN 74053 part 1/ Jan. 1989, DIN 74054 part 1/ January 1989, DIN 74054 part 2/ August-1977, DIN 11026/ April 1989, DIN 11043/ April 1989, DIN 8454/ June 1962 or DIN 9678/ Dec. 1983.

Other drawbar eyes are permitted if they are associated to particular designs of trailer couplings and any confusion with the abovementioned drawbar eyes is excluded; such drawbar eyes must be marked accordingly.

8.2 Drawbar eyes must not be able to rotate axially unless they are exclusively provided for trailer couplings which cannot be rotated axially.



8.3 Hinged drawbars must be clear of the ground; the distance must be 200 mm minimum. This requirement is conformed if a drawbar does not fall below a height of 200 mm when released from the horizontal position. In the case of drawbar with adjustable length, the maximum length will be considered.

8.4 In the case of drawbars combined with overrun brakes the distance between the center of the drawbar eye and the end of the free drawbar shank must not be less than 200 mm. With the shank of the drawbar fully pushed in the distance must be not less than 150 mm.

9. Other connecting devices

9.1 For other connecting devices the beforementioned regulations apply accordingly. If any deviations from these regulations should be inevitable his must be discussed with one of the Technical Services for Vehicle connecting devices listed in paragraph 4 of " Fahrzeugteileverordnung ".

9.2 If connecting devices are attached to special vehicles, motorcycles, single axle tractor units etc. the specific application must especially be considered, for instance with respect to the motion angles required.

10. Height adjusting devices

10.1 Height adjusting devices designed to align the drawbar eye with the height of the jaw or guiding devices for positive feeding of the jaw must be attached so that they cannot get lost and designed so, that the towing device may be adjusted by a single person without excessive effort, tools or other aids.

10.2 The effectiveness of specified brake systems must not be affected by the height adjusting device.

10.3 Height adjusting devices must be able to adjust the drawbar eyes from the horizontal at least 300 mm upwards, and downwards. Within this range the drawbar must be continuously adjustable or in maximum steps of 50 mm measured at the drawbar eye.

In special applications, e.g. for trailers according to paragraph 18 item 2 No. 6 StVZO these regulations shall be applied as far as it appears appropriate.

10.4 Easy movement of the drawbar after coupling-up must be automatically performed.

Part B: Testing requirements

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5 Annexes

Symbols and definitions

- D = D-value, amplitude of horizontal drawbar load  
V = V-Value, amplitude of vertical drawbar load  
X = Diminution coefficient  
m<sub>k</sub> = Total weight of towing vehicle, (vertical drawbar load of trailer with rigid drawbar included)  
m<sub>A</sub> \*) = Trailer weight (not for semi-trailers)  
m<sub>A1</sub> = Total trailer weight with trailer coupling attached  
m<sub>A2</sub> \*) = Trailer weight of second trailer coupled to train  
m<sub>N</sub> = Total payload for pole dolly trains  
A<sub>v</sub> = Axle load  
A<sub>N</sub> = Payload portion of axle load  
S = Static vertical drawbar load  
A = Static vertical load on fifth wheel  
F<sub>A</sub> = lifting force  
F<sub>s</sub> = Vertical component of test load  
F<sub>h</sub> = Horizontal component of test load  
F<sub>q</sub> = Lateral horizontal component of test load  
F<sub>h s res</sub> = Resultant load from F<sub>h</sub> and F<sub>s</sub>  
M<sub>p</sub> = Test torque  
g = 9,80665 m/s<sup>2</sup>  
c = Coefficient for uneven pavement  
h = Distance of gravity center above road level, height of load base for pole dollies  
l = Effective drawbar length from coupling center to axle center  
d = Correction factor for velocity and braking  
f = Impact coefficient  
H = Offset dimension of cranked section  
L = Length of hinged towing devices respectively cantilever length of rigid towing devices  
R = Scrub radius  
M<sub>b</sub> = Bending moment

- Subindex: w = oscillating, alternating  
sch = pulsating U = for minimum load  
stat = static a = for amplitude  
O = for maximum load m = for average value

\*) for trailers with rigid towing device: trailer weight = total trailer weight less vertical static load on towing device.

1. Preliminary remarks

- 1.1 Part B refers to the selection of materials, production processes and the design of components as well as the verification of strength and the respective state of the art.
- 1.2 If a modification of parameters would increase the test load values not more than 5 per cent there is a possibility to waive a repetition of the fatigue test or static load test under consideration of the previous test result; in the case of stress calculations the permissible stress limits must be observed.

2 Selection of Material, production processes and design of components.

2.1 Only materials with standardized minimum values of tensile strength, yield point, elongation at fracture and notched bar impact work must be used.

For welded components only materials with unrestricted weldability are permitted; these materials, among other parameters, are characterized by the following limiting values of their chemical composition:

carbon  $C_{max} = 0.22 \%$ ;

$$\text{carbon equivalent } K = C + \frac{\text{Cr} + \text{Mo} + \text{V}}{5} + \frac{\text{Mn}}{6} + \frac{\text{Ni} + \text{Cu}}{15}$$

where  $K_{max} = 0.50 \%$ .

Fine-grained steel of minor strength up to StE 380 included may be used. Depending from the material and part thickness pre-heating before welding may be necessary. Hard regions in the heat affected zone must not exceed a Vickers pyramid hardness of 300.

2.3 The welding design (position, length, form of welds, edge preparation, material gap etc.) must comply with the usual welding standards, notwithstanding the result of a fatigue test.

2.4 Without special measures of precaution only welding processes with reliable results are permissible; special measures are, for instance, necessary for friction welding etc.

2.5 Abrupt changes of diameter, of section moduli or cross sectional inertia have to be considered with regard to the nominal strains; in the case of doubt the result of a fatigue test shall be decisive (see also Annex 1).

2.6 Press fits of sections subject to bending must have an adequate length (see annex 2).

3 Verification of strength

3.1 General

The verification of strength is effected by endurance tests, static load test and/or calculation.

3.2 Load assumptions and test loads

3.2.1 Fundamentals

The design loads are based, among other parameters, on coefficients for the condition of pavement, as  $c_{max} = 0,3$  (maximum gradient of undulation),  $c_m = 0,18$  (medium assumption for a steady oscillating work), and an impact coefficient  $f$  for longitudinal forces. For special conditions specific design loads may be derived on this basis.

3.2.2 Longitudinal load

Basis: D-Value acc. to section A paragraph 2.7

Test load:  $F_{hw} = \pm 0,6 * D$  (alternating)

in certain cases also:

$F_{hsch} = 0,8$  respectively  $1,0 * D$  (pull or push, pulsating)

$F_{hresw} = \pm 0,6 * D$  (alternating)

Remarks:

- a) The formula for the D-value already includes an coefficient for uneven pavement and for the maximum difference of acceleration of the coupled masses resulting from this ( $c = 0,6$ ) and an impact coefficient ( $f = 1,67$ ); the factor  $1,0 (= 0,6 * 1,67)$  is an empirically determined coefficient for trains. It is applicable to a total train weight ( $m_k + m_A$ )  $\leq 48$ tons and

for  $\frac{m_A}{m_k} \leq 1,6$ ; above this limit, the factor X ("diminution coefficient") shall be used:

$$D = X * g * \frac{m_k * m_A}{m_k + m_A}, \text{ where}$$

for  $\frac{m_A}{m_k} = 1,6 \dots 4$   $X = 1,2 - 0,125 * \frac{m_A}{m_k}$

for  $\frac{m_A}{m_k} > 4$   $X = 0,7$

- b) When 3 vehicles are connected, the mass coupled to the second coupling point will affect the dynamic forces at the first coupling point less than it would be expected from the total combined mass of both trailers. Therefore, it is justifiable to neglect the mass of a second trailer coupled to the first one for the test of a towing device as long as the second trailer is not heavier than the first one.

3.2.3 Vertical load component

a) Basis: D-Value, static vertical drawbar load S

Test load:  $F_{s1} = g * 1,5 * S$

b) Basis: Total weight of trailer  $m_A + S$  and static vertical drawbar load S

Test load:  $F_{s2}$

Brakes	Speed km/h	$F_{s2} =$	but not below:
with	exceeding 25	$g * (0.27 * m + S)$	$g * 0.36 * m$
with	up to 25	$g * (0.18 * m + S)$	$g * 0.27 * m$
without	exceeding 25	$g * (0.14 * m + S)$	$g * 0.24 * m$
without	up to 25	$g * (0.12 * m + S)$	$g * 0.22 * m$

(  $m = m_A + S$ , total weight of trailer)





3.2.4 Transverse load

Basis: Axle load of steered axles  $A_v$

Scrub radius  $R$  (for axle pivot steering)  
respectively wheel track  $2 * R$

effective draw bar length  $l$

Test load:  $F_{q w} = \pm g * 0.18 * A_v * \frac{R}{l}$

$$F_{q sch} = g * 0.30 * A_v * \frac{R}{l}$$

### 3.3 Test procedures

#### 3.3.1 General

When dynamic or static tests have to be performed the specimen must be placed in a suitable setup and by selection of adequate means of force application it must be ensured that the test specimen is not subjected to any additional moments or forces normal to and apart from the specified test load. The direction of force application must not deviate by more than  $\pm 1.5^\circ$  when alternating load tests are performed; in the case of pulsating or static tests the angle must be set for top load. This will usually require a joint at the point of load application (= coupling point) and a second joint in an adequate distance before or behind the test cylinder.

The test frequency must not exceed 35 cps. In the case of asynchronous testing the frequencies of both force components must deviate abt. 1 to 3% maximum. For parts made of steel and cast iron the number of load cycles is  $2 * 10^6$ . For crack testing basically dye-penetration methods are employed. In particular cases other methods may be used.

With an alternating test force (or test force component) the mean force is zero, with pulsating tests, the test force is defined as the top force, the bottom force may be up to 5% of the top force, unless stated otherwise.

When static tests are performed, the test force shall be applied quickly and smoothly and maintained 5 seconds.

If applicable item 2.3 of section A has to be considered.

3.3.2 Coupling devices (on towing vehicles)

3.3.2.1 General: As a general principle, an endurance test is performed.

When testing with  $F_{hs\ res\ w}$ , the load application line is pointing inclined downwards to the rear; when unsymmetrical devices are to be tested, e.g. ball couplings with the ball center situated below the mounting level of its upper of the backmost fixings it is absolutely necessary to check additionally whether the same load figure can be tolerated downwards to the front/ upwards to the rear. In case of a verification by calculation the permissible stress limits acc. to annex 4 shall apply.

3.3.2.2 Couplings for pulling trailers with rigid drawbar up to 3500 kg and all ball type couplings (except agricultural and forestry equipment)

D-Value and static vertical drawbar load as proposed by manufacturer.

Synchronous dynamic fatigue test with a resultant test load and, if applicable, an additional test as per 3.3.2.1

$$F_{hs\ res\ w} = \pm \sqrt{(0.6 * D)^2 + (F_{s1})^2}$$

3.3.2.3 Other trailer couplings (except agricultural and forestry equipment, max. speed 40 km/h)

D-value, if required, static vertical load S and trailer total weight for trailers with rigid towing device  $m_A'$ ;  $m_A'$  as proposed by manufacturer

a) dynamic fatigue test

$$F_{hw} = \pm 0.6 * D$$

and if necessary as a test supplementary to a) for approval of a trailer with rigid towing equipment:

b) asynchronous fatigue test

$$F_{hw} = \pm 0.6 * D' \quad \text{where} \quad D' = g * \frac{m_k * m_A'}{m_k + m_A'}$$

$$F_s = F_{s4}$$

(  $m_k$  = max. weight acc. to § 34 StVZO at present 32 tons; but  $D'$  not more than  $D$ ; for  $m_A' > 8$  tons the max. weight acc. to § 34 StVZO for  $(m_k + m_A')$  is sufficient, currently 40 tons)

(Combining tests a) and b) is admissible)

3.3.2.4 Trailer couplings for agricultural or forestry applications ; for trailers above 3500 kg with rigid towing device: speed limit 40 km/h.

Total weight of tractor  $m_K$  and static vertical drawbar load  $S$ , for special cases also trailer weight  $m_A$ ; usually  $m_A$  will be:  $m_A = 40 \text{ tons} - m_K$

$$D = \frac{m_K * m_A}{m_K + m_A} * g$$

Synchronous fatigue test with resultant test load  
a) for push-pull range

$$F_{h w} = \pm 0.6 * D$$

$$F_{s w} = \pm F_{s 1}$$

or, when an oscillating test load cannot be applied due to constructive characteristics of the towing device after consulting the manufacturer:

b) pulsating pull- or push- test load (depending upon what causes more strain in the structure)

$$F_{h s c h} = 1.0 * D$$

$$F_{s s c h} = F_{s 1}$$

3.3.2.5 Trailer couplings on trailers

$m_{A1}$  and  $m_{A2}$  as proposed by manufacturer ( $m_{A2} \leq m_{A1}$ )  
or  $m_{A1}$  max. value acc. to § 34 StVZO, currently 24 tons

$$D = g * \frac{m_{A1} * m_{A2}}{m_{A1} + m_{A2}}$$

fatigue tests as per 3.3.2.2 , 3.3.2.3 or 3.3.2.4

3.3.2.6 Automatic trailer couplings

For automatic trailer couplings an additional test is required for the locking and safety mechanism by applying a static load of  $0.25 * D$  towards opening sense. The system must not unlock during this test and no damage must occur. In the case of cylindrical coupling pins, a test force of  $0.1 * D$  is sufficient.

3.3.2.7 Towing attachments on tractors

Towing attachments and brackets on tractors designed to fit specific trailer couplings will be tested with the same loads as the trailer coupling. Towing brackets which are not designed for specific trailer couplings will be subjected a worst case test (to be usable with any towing vehicle with maximum load figures acc. to § 34 StVZO and a specifically vertical drawbar load to be proposed).

3.3.2.8 Fifth wheels for semi-trailers

D-Value and vertical load A as proposed by manufacturer

Asynchronous fatigue test:

- a) For fifth wheels not intended to be used for positive steering of semi-trailers:

$$\begin{aligned}F_{hw} &= \pm 0.6 * D \\F_{so} &= g * 1.2 * A \\F_{su} &= g * 0.4 * A\end{aligned}$$

- b) For fifth wheels intended to be used for positive steering of semi-trailers:

$$\begin{aligned}F'_{hw} &= \pm 0.675 * D \\F_s &\text{ same as a)}\end{aligned}$$

Additionally it is required to verify the resistance to bending of the fifth wheel top plate in the area extending from the guiding flanks for the steering wedge onto the mounting brackets by a static 'bending' test. This will be carried out - with the vertical load simultaneously applied - by means of a bending force working against the flanks where these are guiding the steering wedge; the test moment  $M_p$  will be created by a force  $1.5 * D$  applied on a 500 mm lever arm swivelling about the king pin center. A permanent deformation of up to 0.5 % of the nominal dimensions is permitted.

The dynamic fatigue test shall be carried out with a suitable sliding layer between fifth wheel top plate and trailer skid plate which, with additional lubrication, can assure a sliding coefficient of  $\mu \leq 0.15$  (a grease lubricated sheet of Sustamid 12, 2.0 mm thickness conforms with this requirement).

A static lifting test must be performed on all fifth wheels. The fifth wheel must withstand a lifting force of  $F_A = g * A$  with a permitted maximum permanent convex deformation of 0.2 % of the top plate width.

A lifting force of  $F_A = g * 2.5 * A$  ( $F_A = g * 1.5 * A$  for fifth wheels acc. to DIN 74084) must not cause a separation of the fifth wheel from the king pin. This force is applied by means of a lever bearing on the top plate at one end and being raised at a distance between 1.0 to 1.5 m from the king pin center at its other end (see annex 5).

3.3.2.9 Mounting plates for fifth wheel couplings on trucks

The test procedures as described in section 3.3.2.8 b) for fifth wheel couplings (except bending test) as well as the lifting test must be applied on mounting plates for fifth wheels accordingly.

These tests have to be performed for the maximum assigned installation height of the fifth wheel coupling.

### 3.3.3 Towing devices (on towed vehicles)

General: As a general principle, king pins and ball-type couplings are subject to a fatigue test procedure. For all other towing devices, an endurance test will only be performed if a simplified calculation does not show a satisfactory result or if a calculation is impossible due to a too complicated design of the components. When calculating the D-value, always the maximum weight acc. to § 34 StVZO must be used for  $m_K$  (currently 32 tons). For  $m_A > 8$  tons it is also adequate to calculate with the maximum weight value for  $(m_K + m_A)$  acc. to § 34 StVZO (currently 40 tons).

Static tests are basically performed for ball-type coupling heads and hinged drawbars and can be necessary for thin-walled sections in addition to the calculation.

As for the rest a calculation is sufficient; see annex 4 to get the permissible stress figures which must be used for the design loads.

#### 3.3.3.2 King pins and king pin mounting plates for semitrailers

Fatigue test:

$$F_{hw} = \pm 0.6 * D \text{ (D-value as proposed by manufacturer)}$$

Tests with king pins must not be performed with the fifth wheel test at the same time.

When tests with mounting plates are performed, it may be necessary to apply a vertical load according to 3.3.2.8 a).

A static lifting test must be performed on all king pins and king pin mounting plates. A lifting force of  $F_A = g * 2,5 * A$  ( $F_A = g * 1,5 * A$  for king pins acc. to DIN 74083) must not cause a separation of the king pin, respectively the mounting plate. The force shall be exerted by means of a lever arm which is supported on a bracket on one end and lifted on its other end; thereby the lower collar of the king pin is retained in a fixture by a 180 degree grip (half circumference) (Annex 5).



3.3.3.3 Ball-type trailer couplings

Total weight of trailer  $m_A + S$  and static vertical load  $S$  as proposed by manufacturer

- 1) for  $m_A + S$  up to 3500 kg  
a fatigue test will be performed with a test specimen.

$$F_{hs \text{ res } w} = \pm 0.6 * D$$

$$F_{s \text{ w}} = \pm F_{s1} \text{ but not less than } \pm 0.155 * D$$

The force shall act in a line downwards inclined towards the rear.

- 2) for  $m_A + S$  above 3500 kg  
Fatigue tests as per 3.3.2.3

Additionally, a static lifting test will be performed. For a trailer weight up to  $m_A + S = 2000$  kg the lifting force  $F_A$  shall be same as the total trailer weight. For trailers  $m_A + S > 2000$  kg the force  $F_A$  shall be  $F_A = 20000$  N.

This test shall be performed with a ball diameter 2 % less than the nominal dimension. The ball must not disengage and no permanent deformations are permissible, which may affect proper operation of the coupling.

Remarks: In case that the manufacturer does not propose a static drawbar load (only for trailers with hinged towing device) a fatigue test with the test load

$$F_{hw} = \pm 0.6 * D$$

must be performed. A lifting test is not applicable.

3.3.3.4 Hinged towing devices

a) Common A-frame drawbars shall be calculated acc. to the brochure "Hinweise für das Schweißen von Anhänger-Zuggabeln" ("Hints for welding drawbars"), issued by Deutscher Verband für Schweißtechnik, Düsseldorf 1963. If the calculation results make 90 to 100 % of the buckling strain data given in the brochure, a static load test shall be performed with  
 $F_{h \text{ stat}} = 3 * D$  ;  
after that a maximum permanent deformation (deviation of length) of 0.1 % of the total length is permissible.

b) Cranked and offset towing devices shall be at first calculated ( design load:  $F_{hw} = \pm 0.6 * D$  ); the added bending- and push-/pull stress figures must not exceed the following limits:  
parts made of St 37: 80 N/mm<sup>2</sup>  
of St 44: 87 N/mm<sup>2</sup>  
of St 52: 109 N/mm<sup>2</sup> and  
in welds 54 N/mm<sup>2</sup> (stub weld) resp. 47 N/mm<sup>2</sup> (fillet w.)  
The push-/pull-strain fraction must not exceed 54 % of the permissible buckling strain. For calculation of the push-/pull stress figures, cranked or offset portions of the towing device are neglected and the devices are regarded as straight. When the theoretical stress calculations reveal higher stress values, a fatigue test shall be performed and it's result will then be decisive.

c) For special drawbar designs (as for instance with telescopic towing tube or similar) additional static buckling tests are obligatory as well as a check by calculation of  $F_{qw}$  , repectively fatigue tests.

d) When fatigue tests are required either a resultant load determined from

$$F_{hw} = \pm 0.6 * D \quad \text{and}$$

$$F_{qw} = \pm g * 0.18 * A_v * \frac{R}{L + 1000} \quad (\text{R and L in mm})$$

shall be applied  
or an asynchronous test with  $F_{hw}$  and  $F_{qw}$  shall be performed.

e) For towing devices for trailers with overrun brake the oscillating test load

$$F_{hw} = \pm 0.6 * D$$

may be substituted by the pulsating test load

$$F_{h \text{ sch}} = 0.8 * D$$

3.3.3.5 Rigid towing devices

- a) It will be usually sufficient to check the bending stress by calculation with design loads corresponding with the dynamic vertical drawbar load and longitudinal load. In cases where direct stresses (push or pull) and shearing strains of more than 5 % of the bending stress will be expected, these have to be included when calculating the nominal or reduced stress; the same applies to a lateral force.

Design loads

for $m_A + S$ up to 3500 kg		for $m_A + S$ above 3500 kg
vertical:	$F_{s2}$	$F_{s3}$
horizontal:		$F_{hw} = \pm 0.6 * D$
Brakes	$F_{h sch}$	
with	$0.8 * D$	
without	$1.0 * D$	

The following bending moments shall be calculated and the highest result shall be used with the formula for calculating the nominal stress:

1. $M_{b1}$	$k * F_{s2} * L_1$ resp. $F_{s3} * L_1$	(Subindex i for the location to be checked)
2. $M_{b2}$	$F_h * H_1$	
3. $M_{b3}$	$0.75 * (M_{b1} + M_{b2})$	

$k$  = reduction coefficient for  $L > 2.5$  meters  
 $k = 1.25 - 0.1 * L$  where  $k_{min} = 0.6$  (L in meters)

- b) Additional static tests shall be performed for exceptional thin-walled parts, e.g. supports subject to bending made of open sections with material thickness of less than 3.0 mm. The load for this test shall be 1.5 times the values as per a) and no permanent deformations must occur.

c) In particular cases fatigue tests are required (e.g. structures which are too complicated for calculation).

1) for  $m_A + S$  up to 3500 kg:

1.1) for  $H_i/L_i \geq 0.15$  at the critical location "i"

synchronous fatigue test

$$F_{hs\ res\ sch} = 0.75 * \sqrt{F_{s2}^2 + F_{h^2sch}}$$

The test load shall be applied to the specimen in such direction that the bending moments as calculated acc. to item a) will sum up at the location to be tested! For straight designs or units with downward cranked shape: a force will act along a line directed upwards to the front; for units with upward cranked shape: an inclined pushing force will act along a line directed upwards to the rear.

1.2) for  $H_i/L_i < 0.15$  at the critical location "i"

fatigue test with vertical test load (upwards)

$$F_{s\ sch} = F_{s2}$$

2) for  $m_A + S$  above 3500 kg:

asynchronous fatigue test

$$F_{h\ w} = \pm 0.6 * D$$

$$F_s = F_{s4}$$

d) For strongly cranked towing devices and sections with different stability relative to the upward or transverse ordinate axis the lateral component  $F_q$  must additionally be considered by calculation.

e) In order to verify sufficient lateral rigidity it is necessary that towing devices have the same cross sectional inertia about the upward (y-) axis as it is necessary about the lateral (x-) axis for stability reasons. This requirement may also be regarded as performed, if the section modulus  $W_y$  is at least equal to the required value of  $W_x$ .

3.3.3.6 Calculating drawbar tubes for pole dollies

(see annex 3)

Case acc.to figure	Strain to be calculated	Design load
1	a) tensile and thrust stress (alternating) b) buckling stress by thrust load c) reversed bending stress by lateral load on draw bar	$F_{hw} = \pm 0.6 * D_{empty}$ $F_{hstat} = 1.0 * D_{empty}$ $F_{qw}$ acc. to 3.2.4
2	a) same as 1 a) b) same as 1 b) c) same as 1 c)	$F_{hw} = \pm 0.6 * D$ $F_{hstat} = 1.0 * D$ $F_{qw}$ acc. to 3.2.4
3	a) reversed bending stress	$F_{s3}$ acc. to 3.2.3.c
4	a) same as 3) b) buckling stress by thrust load	$F_{s3}$ acc. to 3.2.3.c $F_{hstat} = 1.0 * D$
5	Reversed bending stress by lateral load on drawbar	$F_{qw}$ acc. to 3.2.4
6	a) same as 5 b) buckling stress by thrust load	$F_{qw}$ acc. to 3.2.4 $F_{hstat} = 1.0 * D$

$$D_{empty} = g * \frac{m_K * m_{A_{empty}}}{m_K + m_{A_{empty}}}$$

$m_{A_{empty}}$  is the empty weight of the pole dolly minus the empty vertical drawbar load

### 3.3.3.7 Calculating serrated drawbar head adjusters

Bending moment  $M_{b\max}$  of towing device, that must be supported by the serration, shall be calculated as per 3.3.3.5.

$$\tau_t = \frac{M_{b\max}}{W_t}$$

$$W_t = \frac{\pi}{16} * \frac{D^4 - d^4}{D}$$

$D, d$  = outside , inside diameter of serration

$$\tau_{t\ sch\ zul} = 120\ N/mm^2 \text{ (pulsating load; for St 52)}$$

$$\tau_{t\ w\ zul} = 80\ N/mm^2 \text{ (alternating load; for St 52)}$$

The serration fixing bolt must be designed for the following preload capacity:

$$F_v = 1.2 * \tan\beta * M_{b\max\ sch} * 4/(D+d) \text{ (pulsating load)}$$

respectively

$$F_v = 1.8 * \tan\beta * M_{b\max\ w} * 4/(D+d) \text{ (alternating load)}$$

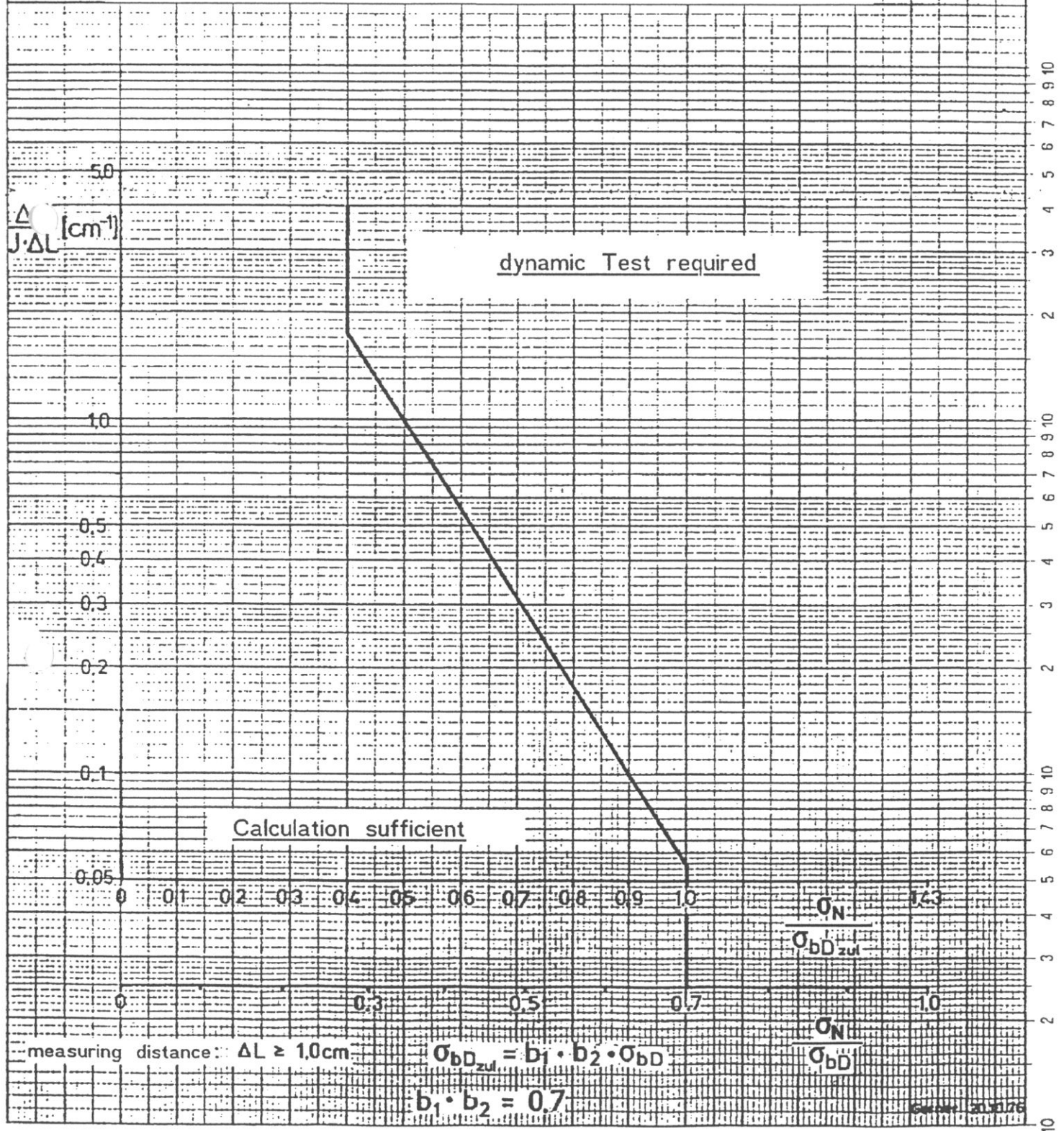
where  $\beta = 1/2$  flank angle of serration tooth

Connection of towing eye stub with drawbar rod: see annex 2)

This graph shows the maximum admissible deviation of the cross sectional inertia per cm of length as a function of the utilisation factor of bending stress.

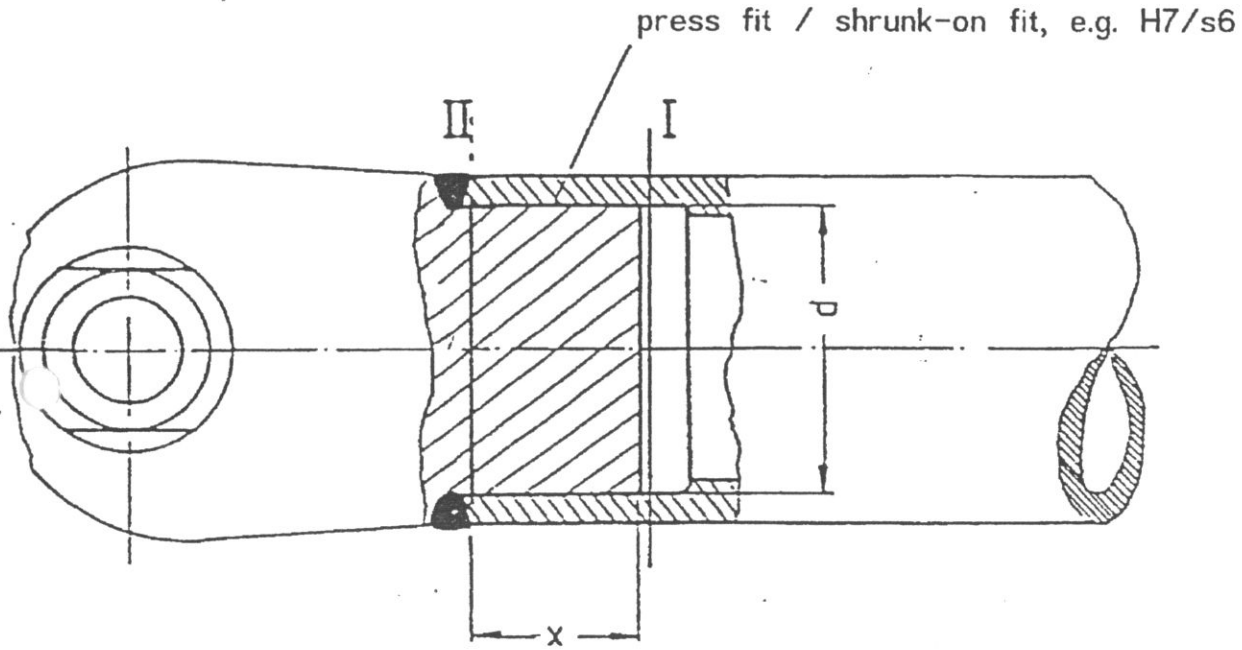
Short attachments without load supporting effect may be neglected if they are preferably located near the neutral zone and are not attached to the supporting profile by means of transverse weld seams.

Load supporting reinforcements attached to the structure must not originate at areas of high stress or at profile edges. Additional notch effects, e.g. by welding craters, transverse seams, must be avoided by appropriate construction practices.



10  
9  
8  
7  
6  
5  
4  
3  
2  
1  
0

welded stud connection



x	$\sigma_{bzul.} \left[ \frac{N}{mm^2} \right]^*$		
	I-I	I-I	II-II stud
0	100**		
0,4d	142	195	209
$\geq 0,8d$	184	290	
	St 35 St 37	St 52	St 52

if  $\sigma_{bvorh.} > \sigma_{bzul.}$ , then fatigue test

Subindex "zul." = permissible  
Subindex "vorh." = required

\* pulsating Load (\*\*\*)

\*\* permissible weld seam stress

intermediate values to be calculated  
by linear interpolation

\*\*\*)

for alternating load (e.g.  $F_{S3}$ ) or for other materials  
the permissible stress data acc. to annex 4 will apply



dolly configuration

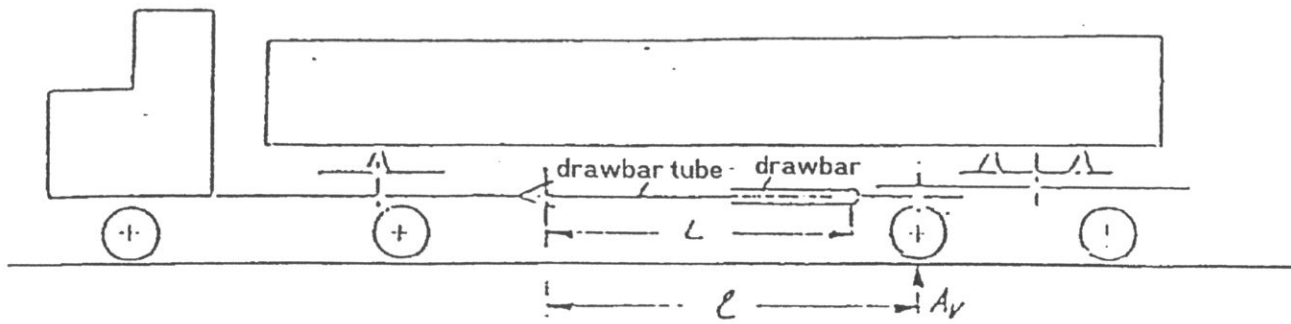


Fig.1: Multi axle dolly - pull load transmission by payload

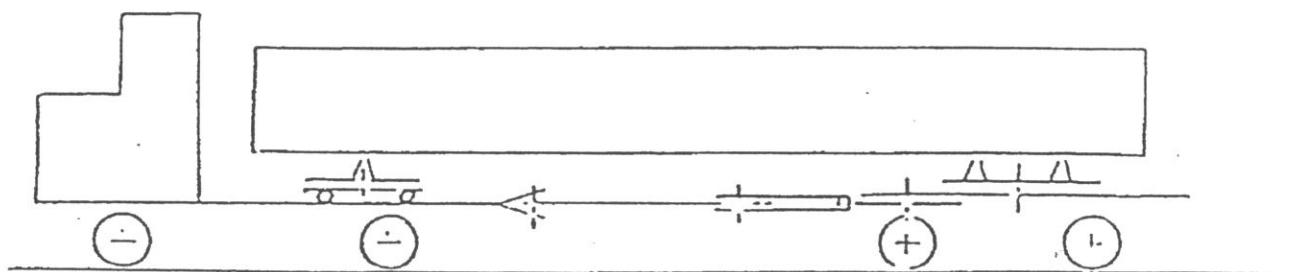


Fig.2: Multi axle dolly - pull load transmission by towing device

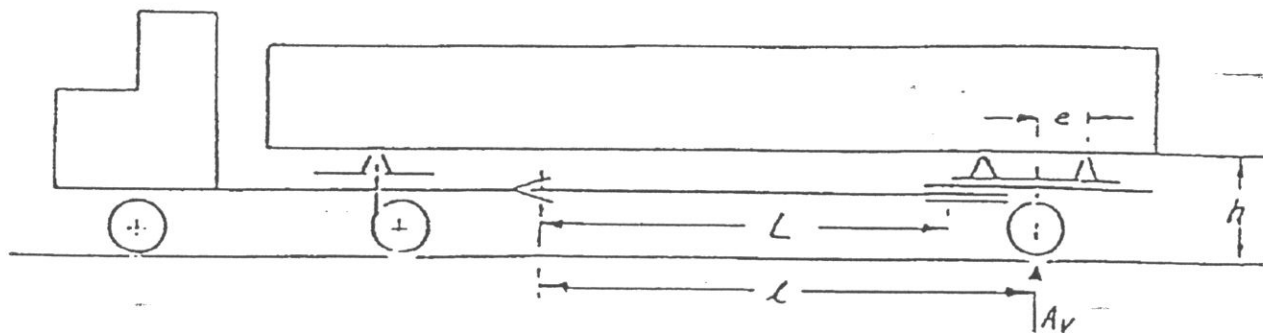


Fig.3: Single axle dolly - pull load transmission by payload

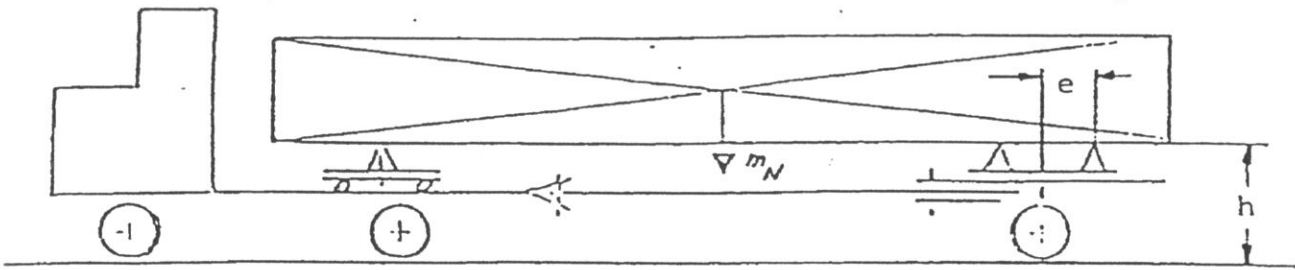


Fig.4: Single axle dolly - pull load transmission by towing device

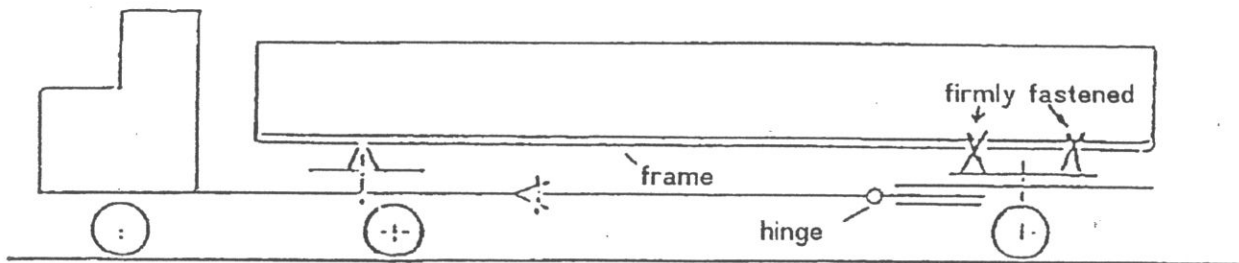


Fig.5: Single axle dolly with load supporting frame or similar - pull load transmission by frame

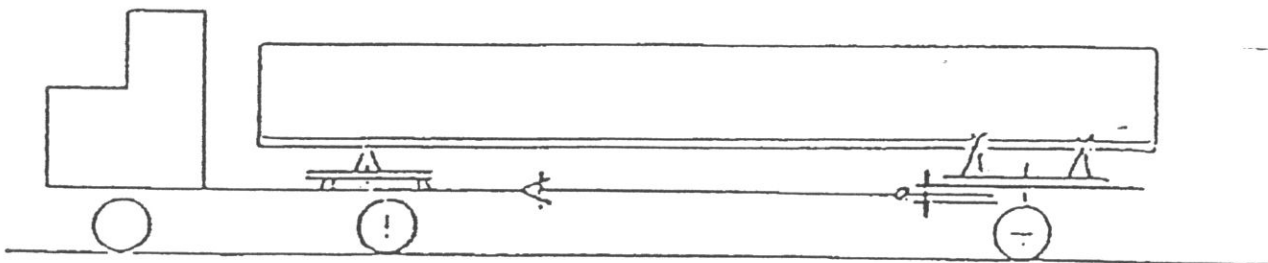


Fig.6: Single axle dolly with load supporting frame or similar - pull load transmission by towing device

Permissible stress values for steel [N/mm<sup>2</sup>]

alternating push-pull load		alternating bending load	
smooth surface, no welds:		smooth surface, no welds:	
else:		else:	
Material (or equivalent):	Material (or equivalent):	Material (or equivalent):	Material (or equivalent):
Fe 360	Fe 510	Fe 360	Fe 510
$\sigma_{zdw\ zUl} = 108$	172	$\sigma_{bw\ zUl} = 122$	192
	other	other	other
	0,45 $\sigma_S$	0,53 $\sigma_S$	0,44 $\sigma_S$
	0,34 $\sigma_B$	0,40 $\sigma_B$	0,30 $\sigma_B$
$\sigma_{zdsch\ zUl} = 198$	301	$\sigma_{bsch\ zUl} = 184$	290
	0,83 $\sigma_S$		0,80 $\sigma_S$
	0,60 $\sigma_B$		0,60 $\sigma_B$
	165		153
	217		209
	90		102
	124		138
	0,38 $\sigma_S$		
	0,25 $\sigma_B$		
	0,66 $\sigma_S$		
	0,45 $\sigma_B$		

permissible shearing stress:

$$\tau_{zUl} = \frac{\sigma_b\ zUl}{\sqrt{3}}$$

reduced stress:

$$\sigma_v = \sqrt{\sigma_b^2 + 3\tau^2}$$

$$\sigma_v\ zUl = \sigma_b\ zUl$$

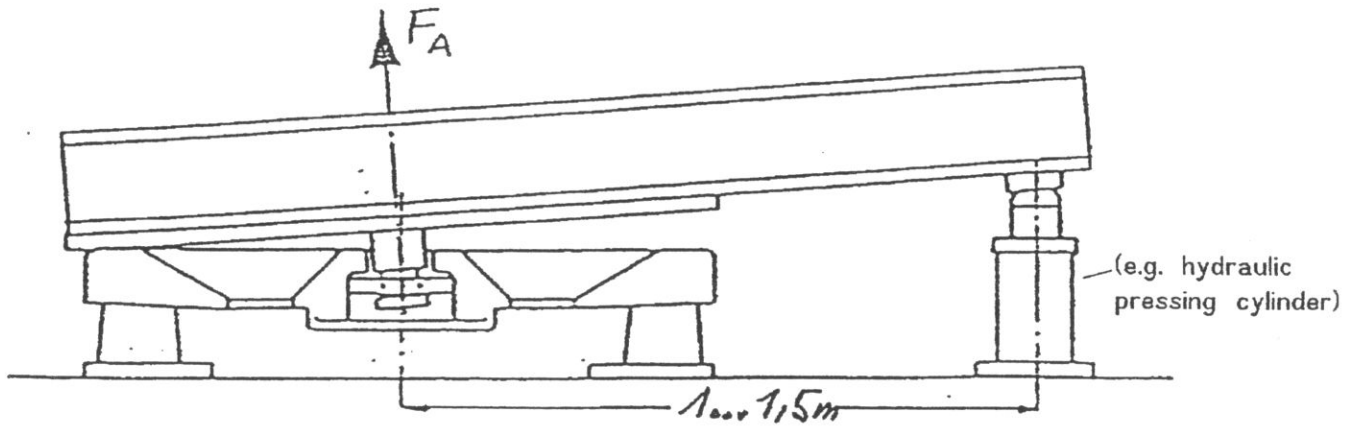
permissible weld stress for all kind of straining, fillet welds: oscillating 47 N/mm<sup>2</sup>; pulsating 90 N/mm<sup>2</sup>  
 butt joints: oscillating 54 N/mm<sup>2</sup>; pulsating 100 N/mm<sup>2</sup>

(Note: suffix "zul" = permissible)

Lifting test for fifth wheels

Configuration of test setup

a) Fifth wheel



b) King pin

