

Sufficient strength values do not give any guarantee of correct operation (e.g. different elongation behaviour of bodies made from aluminium alloys).

Vibration problems on bodies without subframes cannot be ruled out. MAN cannot make any statements about the vibration behaviour of vehicles whose bodies have no subframes since the vibration behaviour depends on the body and its connection to the vehicle. If inadmissible vibration occurs, its cause must be eliminated, which may mean that a subframe has to be retrofitted after all.

5.3 Special bodies

5.3.1 Testing of bodies

MAN, department ESC (for address see „Publisher“ above) can carry out computational testing of the strength and bending stiffness as part of a body check for special bodies. This is on condition that all the required data are provided.

For the calculations, two copies of body documentation that must be suitable for inspection are required.

This documentation must contain the following information in addition to a drawing of the body:

- Loads and their load application points:
 - Forces
 - Dimensions
 - Axle load calculation
- Conditions of use:
 - On-road
 - Off-road, etc.
 - Goods to be carried
- Subframe:
 - Material and cross-sectional data
 - Dimensions
 - Type of section
 - Quality
 - Arrangement of cross members in the subframe
 - Special features of the subframe design
 - Cross-section modifications
 - Additional reinforcements
 - Upsweeps, etc.
- Means of connection:
 - Positioning
 - Type
 - Size
 - Number.

5.3.2 Single-pivot body

The single-pivot body, which is comparable with a fifth-wheel coupling, always requires a subframe. Here, particular attention should be paid to ensuring that the subframe is properly connected to the chassis frame.

Positioning the pivot point for the single-pivot body behind the theoretical rear axle centreline means that the axle load distribution and handling must be checked. Information can be obtained from the ESC Department (for address see „Publisher“ above).

Documents:

- Guidelines for the testing of timber trucks for § 43 StVZO
- Trade association guidelines for timber trucks (ZH 1/588).

5.3.3 Tank and container bodies

5.3.3.1 General

Depending on the type of goods transported, vehicles must be equipped by the companies responsible in accordance with national requirements, guidelines and regulations. In Germany, the hazardous goods officers of the technical monitoring organisations (DEKRA, TÜV) can provide information regarding the transportation of hazardous goods.

5.3.3.2 Body fixtures, mountings

Tank and container bodies require a continuous subframe, yield point $\sigma_{0.2} \geq 350 \text{ N/mm}^2$ (e.g. S355J2G3 = St52-3, see also Table 31: Yield points of subframe materials). The conditions for approving exceptions to this are described in the following section on „Tank and container bodies without subframes“.

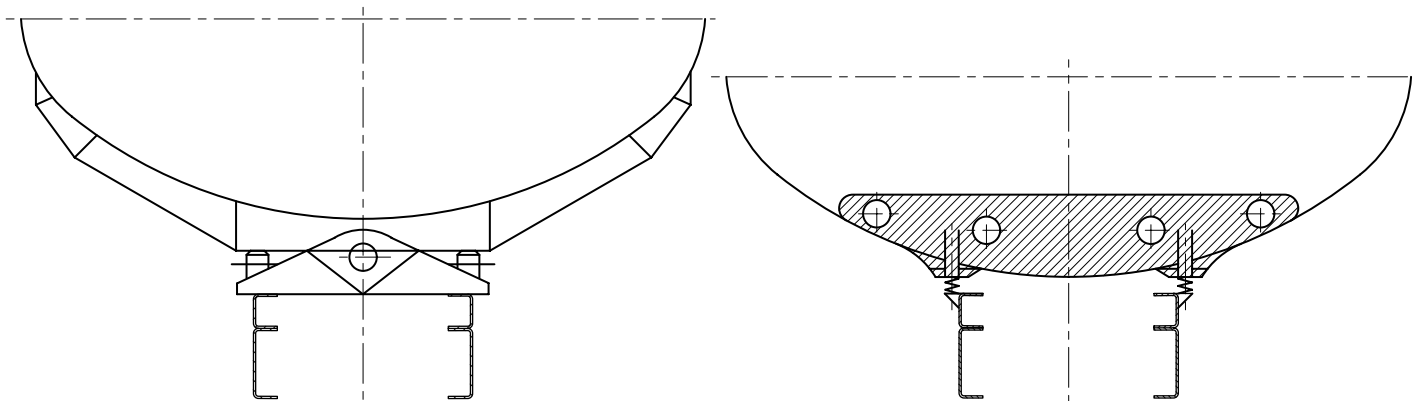
The connection between the body and chassis in the front area must be designed so that it does not excessively hinder the frame's ability to twist.

This can be achieved by having front mountings that are as torsionally compliant as possible, e.g. by having

- Pendulum-type mounting (Fig. 73)
- Flexible mounting (Fig. 74)

Fig. 73: Front mounting as a pendulum mounting ESC-103

Fig. 74: Front mounting as an elastic mounting ESC-104



The front mounting point should be as close as possible to the front axle centreline. (see fig. 75).

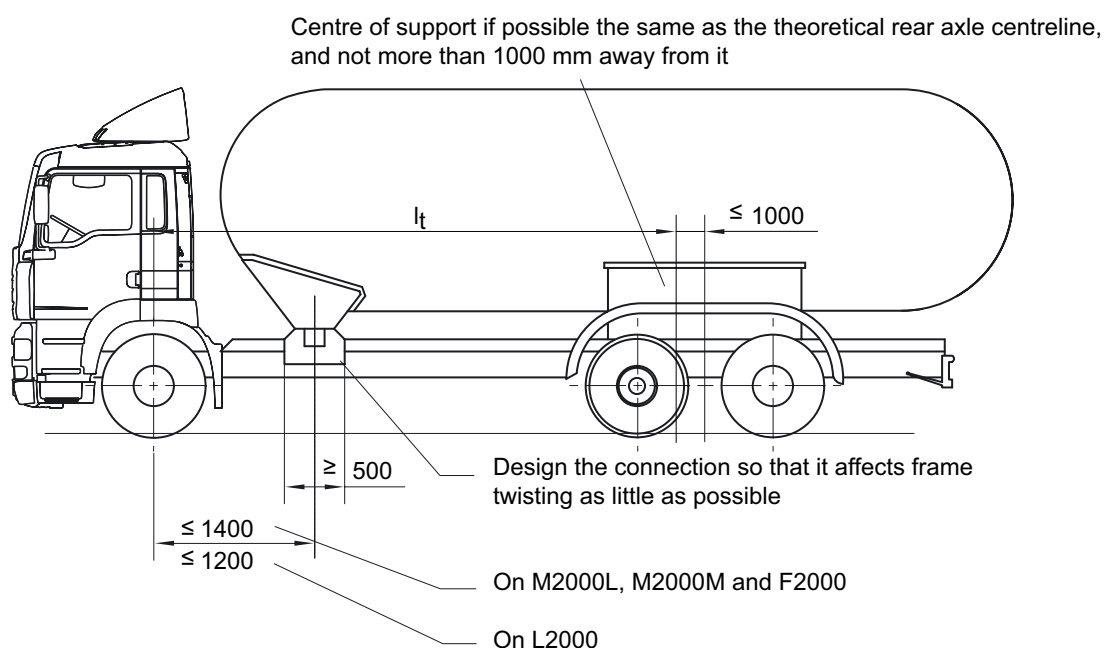
The rear, laterally stiff body support must be fitted in the vicinity of the theoretical rear axle centreline.

At this point the connection to the frame should also be of sufficient size.

The distance between the theoretical rear axle centreline and the centre of the support must be $< 1,000 \text{ mm}$ (see fig. 75).

See the “General” Chapter for ‘Theoretical axle centreline’.

Fig. 75: Layout of tanker and bulk container mountings ESC-004



Once the body has been installed it is important that a test is carried out to confirm whether vibrations or other disadvantageous handling characteristics are evident. Vibration can be influenced by correct subframe design and the correct layout of the tank mountings.

5.3.3.3 Tankers and container bodies without subframes

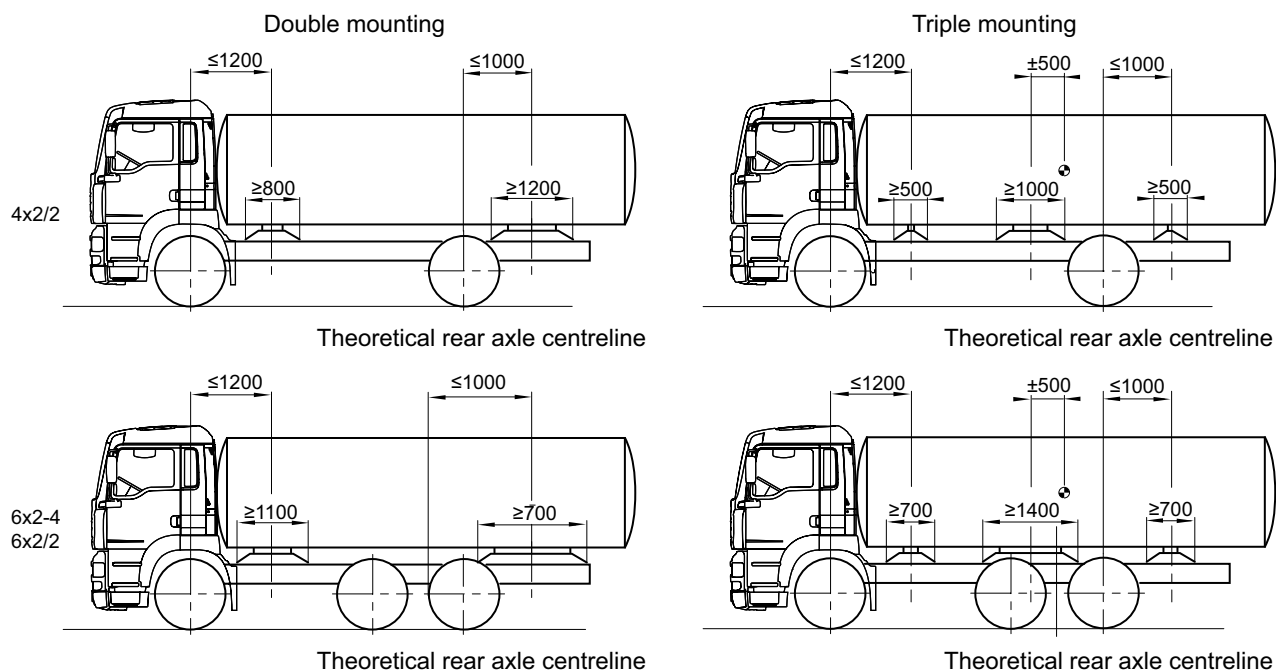
Tanker and container bodies without subframes can be approved if the conditions described here are observed and there are double or triple mountings on each side of the frame.

All supports must be arranged at the specified distances. If the permissible range is exceeded, this may cause the frame to bend excessively, which is not permitted; a continuous subframe would then be required (see above).

Table 33: Chassis without subframes for tanker bodies with double and triple mountings

Vehicle range	Model	Wheel formula	Suspension	Wheelbases [mm]
M2000L	L74	4x2/2	leaf-leaf	3.575 ... 4.250
	L76		leaf-air	"
	L79		full air	"
	L81		leaf-leaf	"
	L84		leaf-air	"
	L86		full air	"
	L87		leaf-leaf	"
	L88		leaf-air	"
	L89		full air	"
M2000M	M38	4x2/2	leaf-leaf	"
	M39		leaf-air	"
	M40		full air	"
F2000	T31	4x2/2	leaf-leaf	3.800 ... 4.500
	T32		leaf-air	"
	T33		full air	"
	T36	6x2/2	leaf-air	4.100 ... 4.600 ... 1.350
	T37	6x2-4	full air	"

Fig. 76: Requirements for tank mountings for designs without subframes ESC-311



5.3.4 Tippers

Tipper bodies require a chassis that is designed for the purpose for which the vehicle will be used. MAN has appropriate chassis in its product range. These are marked with a “K” in the model designation, e.g. 19.364 FLK. Factory-built tipper chassis require no additional work if it is guaranteed that the following points are observed:

- The permissible gross weight
- The permissible axle loads
- The standard tipper body length
- The standard frame overhang
- The standard vehicle overhang
- The maximum tipping angle of 50° to the rear or side.

If tipper bodies are mounted on normal chassis, these chassis must be fitted with the components of a comparable MAN tipper. For example, the leaf springs of semitrailer tractors are not suitable for tippers. An anti-roll bar must be fitted to the rear axle if the standard tipper body lengths of comparable MAN tipper chassis are exceeded.

All tipper bodies require a continuous subframe made of steel with a minimum yield point of $\sigma_{0.2} \geq 350 \text{ N/mm}^2$ (e.g. S355J2G3 = St52-3, for technical data of steel materials for vehicle construction, see Table 31: „Yield points of subframe materials“ in this Chapter).

To improve stability when using vehicles with air suspension, it is important that the air suspension should be lowered for the tipping operation (5-10 mm above the buffer stop). An automatic lowering facility that is activated as soon as the power take-off is switched on can be ordered ex-works. Control via the ECAS remote control will then, as before, enable the vehicle height to be adjusted.

WARNING: Air-sprung chassis from the L2000 range are not approved for tipper bodies (for model allocation, see „General“ Chapter).

The body manufacturer is responsible for the connection between the main frame and the subframe. Tipper rams and tipper mountings must be incorporated into the subframe because the vehicle frame is not suitable for supporting point loads.

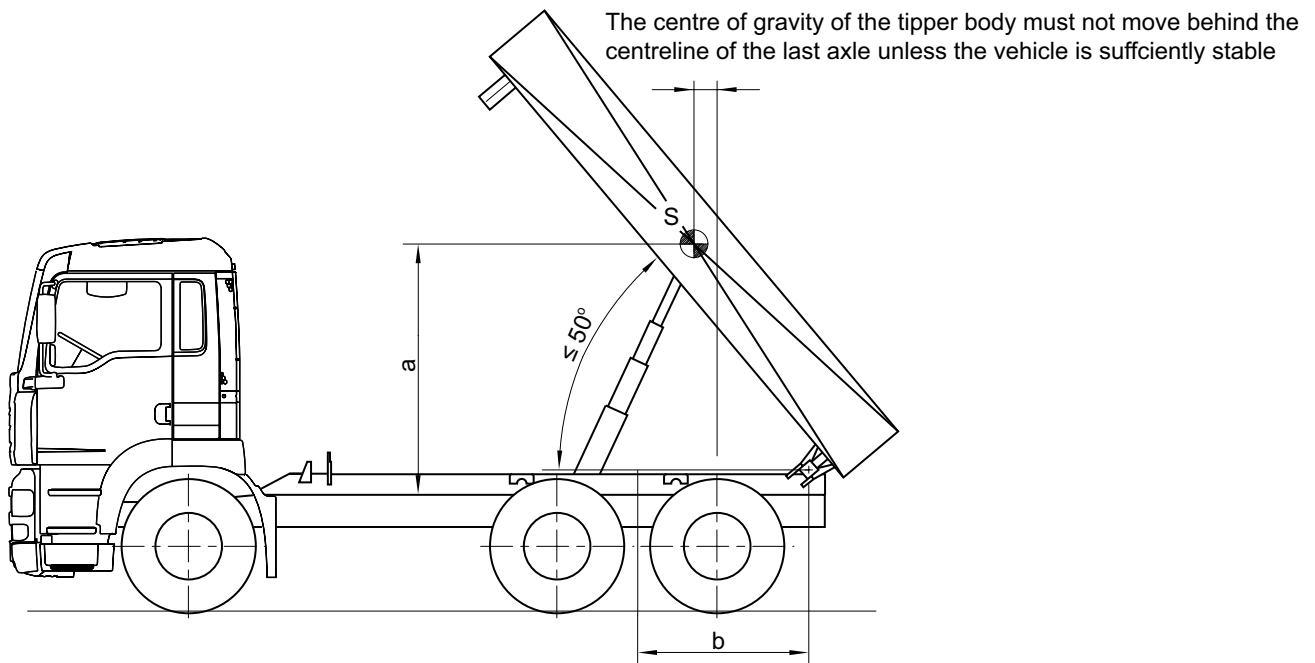
Point loads that arise around the tipper ram during the tipping process are to be taken into account when designing the subframe. The following reference data must be observed:

- Tipping angle to the rear or side $\leq 50^\circ$
- During tipping to the rear, the centre of gravity of the tipper body with payload should not move behind the centreline of the last axle unless stability of the vehicle is guaranteed
- Locate the rear tipper mountings as close to the theoretical rear axle centreline as possible. During the tipping operation the height of the centre of gravity of the tipper body with payload (horizontal line) must not exceed dimension „a“ (see Table 34 and Fig. 77).
- For the rear tipper mountings the distance between the centre of the tipper mountings and the theoretical rear axle centreline must not exceed dimension „b“ (see Table 34 and Fig. 77) (for theoretical rear axle centreline, see „General“ Chapter).

Table 34: Tippers: Maximum dimensions for centre of gravity height and tipping dimensions

Vehicle (for definition of model, see „General“ booklet)	Dimension „a“ [mm]	Dimension „b“ [mm]
L2000	≤ 1.600	≤ 1.000
Two-axle vehicle M2000L, M2000M, F2000, E2000	≤ 1.800	≤ 1.100
Three-axle vehicle F2000, E2000, 6x2, 6x4, 6x6	≤ 2.000	≤ 1.250
Four-axle vehicle F2000, E2000, 8x4, 8x6, 8x8	≤ 2.000	≤ 1.250

Fig. 77: Tippers: Maximum dimensions for centre of gravity height and centre of tipper mountings ESC-105



Because of the said conditions, the length of the platform for three-way and rear tippers is restricted. The length of two-way tippers can be designed similar to that for loading platforms if there is sufficient stability.

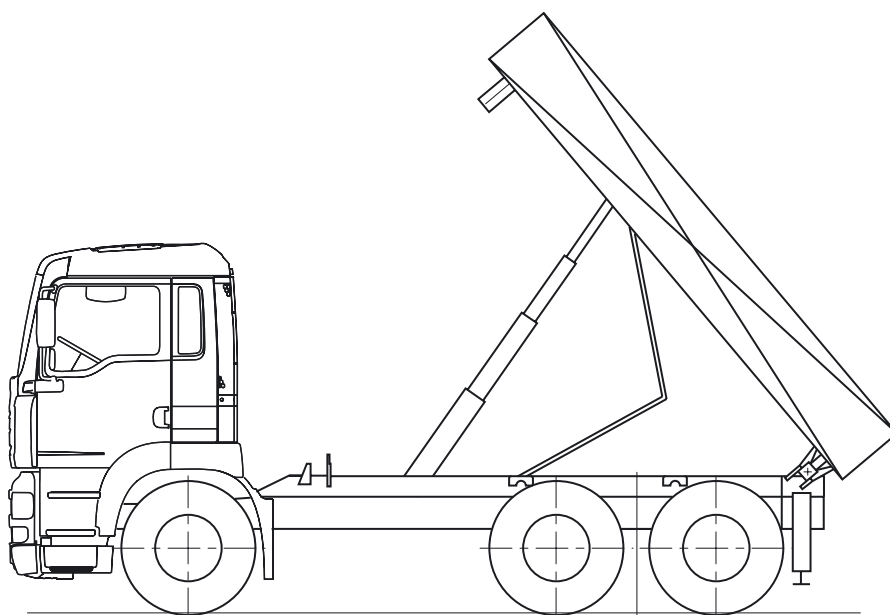
If required for reasons of operational safety, MAN reserves the right to request more far-reaching measures such as the use of hydraulic supports to increase stability or the relocation of specific equipment. However, the body manufacturer is required to recognise the need for such measures himself, since the measures depend mainly on the design of his product.

To improve stationary and operational safety, rear tippers are sometimes required to be fitted with a so-called scissors-action support and/or a support at the end of the frame. See Fig. 78.

Documents:

For tipper bodies §22 and §23 of accident prevention regulations (VBG12).

Fig. 78: Rear tipper with scissors-action support and rear support ESC-106



5.3.5 Set-down, sliding set-down and sliding roll-off skip loaders

For these types of body, the design often means that the subframes cannot follow the contour of the main frame and that special connections to the main frame must be provided. The body manufacturer must ensure that these fixtures are adequately sized and are properly located. Tried and tested fixtures, their design and attachment can be seen in the body installation instructions for manufacturers. The standard MAN platform brackets are not suitable for installing these bodies.

Because of the low substructure heights, the freedom of movement of all moving parts attached to the chassis (e.g. brake cylinders, transmission shift components, axle location components, etc) and the body (e.g. hydraulic cylinders, pipes, tipper frame, etc.) must be particularly carefully checked. If necessary an intermediate frame must be fitted, the suspension travel must be limited, the pendulum movement of the tandem axle must be limited or other similar measures taken.

For rolling, setting down and tipping operations, the same procedure applies (as appropriate) to air sprung vehicles in this category as is applied to air sprung tippers (that is, the vehicle is lowered to 5-10 mm above the buffer stop, see Section 5.3.4).

An automatic lowering facility that is activated when the power take-off is switched on can be ordered ex-works. Control via the ECAS remote control will then, as before, enable the vehicle height to be adjusted (e.g. for pushing containers on to the trailer).

When loading and unloading, supports are required for the end of the vehicle if:

- The rear axle load is more than twice the technically permissible rear axle load. Here, the tyre and rim load capacity must also be taken into account.
- The front axle loses contact with the ground. For safety reasons, lifting of this kind is strictly forbidden.
- The stability of the vehicle is not guaranteed. This can be because of a high centre of gravity height, an inadmissible side tilt when compression occurs on one side, if the vehicle has sunk into soft ground on one side etc.

Rear support by locking the vehicle springs is permitted only if the ESC department at MAN (for address see "Publisher" above) has approved the installation together with the respective load transmissions (for details of documents to be submitted for body testing, see „General“ booklet, Sections „Approval“ and „Submission of documents“).

The required evidence of stability is to be provided by the body manufacturer.

5.3.6 Platform and box bodies

To ensure even load distribution a subframe is normally required. Vehicles in Table 32 (see the Section „Designing the subframe“ earlier in this Chapter) require a continuous subframe.

Exceptions to this are dependent on:

- The length of the support (e.g. tanker body, see Section „Tankers and container bodies without subframes“)
- The distance between cross members (see section „Self-supporting bodies without subframes“).

Point and rear loads (e.g. tail-lift) must not occur on bodies without subframes.

Closed bodies in particular, such as box bodies, are torsionally stiff with respect to the chassis frame. So that the desired twisting of the frame (for example when cornering) is not hindered by the body, the body fixtures should be flexible at the front and rigid at the rear. This is particularly important if the vehicle is designed for off-road purposes. For this application we recommend a front body mount with cup springs (for an example, see Fig. 63 in this Chapter), a three-point mounting or a diamond-shaped mounting layout (see Fig. 79 for mounting principle).

Fig. 79: Mounting options for torsionally rigid bodies compared with flexible chassis with three-point and diamond-shaped mountings ESC-158

