ECONOMIC COMMISSION FOR EUROPE

INLAND TRANSPORT COMMITTEE

World Forum for the Harmonization of Vehicle Regulations (WP.29)

Working Party on General Safety Provisions (GRSG)
(Eightieth session, 2-6 April 2001,
agenda item 4.)

PROPOSAL FOR DRAFT AMENDMENTS TO REGULATION No. 66
(Strength of superstructure)

Transmitted by the Expert from Hungary

Note: The text reproduced below was prepared by the expert from Hungary in
order to incorporate into the Regulation the method for determination of the
centre of gravity. This document is based on a document distributed without a
symbol (informal document No. 11) during the seventy-ninth session of GRSG
(TRANS/WP.29/GRSG/58, para. 30).

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Note: This document is distributed to the Experts on General Safety
Provisions only.

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The list of annexes,

Insert a new annex 7, to read:

Annex 7 – Determination of the position of the centre of gravity of the vehicle.

The text of the Regulation

Insert a new annex 7, to read:

"Annex 7

DETERMINATION OF THE CENTRE OF GRAVITY OF THE VEHICLE

1. The position of the centre of gravity shall be given by three parameters:

1.1. longitudinal distance from the centre line of front axle (l_1)

1.2. transverse distance from the vertical symmetry plane of the vehicle ($\pm e$). This eccentricity (e) is positive, if centre of gravity is closer to the service door side and negative if it is farther.

1.3. vertical distance (height) above the horizontal ground level (h) when the tyres are inflated as specified for the vehicle

2. The position of the centre of gravity shall be determined by measurements:

2.1. the longitudinal (l_1) and transverse (e) parameters with a measurement on flat, horizontal ground (see figure 1)

2.2. there are two options to determine the height of the centre of gravity (h)

2.2.1. lifting method (see figure 2)

2.2.2. tilting method (see figure 3)

        The manufacturer can choose between the two options

3. Because the energy conditions of the rollover test strongly depend on the vehicle's centre of gravity position, its determination should be done very precisely. The following accuracy is required.

dimensions, lees than 2000 mm	$\pm$ 1 mm
above 2000 mm	$\pm$ 0.05 per cent
angles	$\pm$ 1 per cent
load values (wheel loads, lifting load, axle load)	$\pm$ 0.2 per cent

4.   Measurement on flat horizontal ground

4.1.   The wheel loads shall be measured individually in the same time
          (e.g. by load cells):

W_{1L} W_{1R}, W_{2L} W_{2R}, W_{3L} W_{3R}

          Twin tyres should be considered as one wheel.

4.2.   In case of two axle vehicle

$$W_{3L} = W_{3R} = L_{23} = 0$$

4.3.   Calculate axle loads accordingly:

$$A_1 = W_{1L} + W_{1R}$$
$$A_2 = W_{2L} + W_{2R}$$
$$A_3 = W_{3L} + W_{3R}$$

4.4.   Calculate side supporting loads accordingly:

$$S_L = W_{1L} + W_{2L} + W_{3L} \quad \text{(left side)}$$
$$S_R = W_{1R} + W_{2R} + W_{3R} \quad \text{(right side)}$$

4.5.   Calculate unladen kerb mass accordingly:

$$M_k = A_1 + A_2 + A_3 = S_L + S_R$$

5.   Determination of the longitudinal and transverse position of
          centre of gravity. Using the measured and calculated load
          parameters, as well as the given geometrical values of the vehicle
          (see figure 1)

5.1.   Calculate longitudinal position of the centre of gravity
          accordingly:

$$l_1 = L_{23}\left(\frac{A_3}{M_k}\right) + L_{12}\left(1 - \frac{A_1}{M_k}\right)$$

5.2.   Calculate centre of gravity's transverse position accordingly:

$$e = b\left(\frac{1}{2} - \frac{S_L}{M_k}\right)$$

          where b is the average track of the axles, if b_1, b_2 and b_3 is track
          of the first, second and third axle

$$b = \frac{1}{3}\left(b_1 + b_2 + b_3\right)$$

6.   Lifting test to determine centre of gravity's height (see
            figure 2)

6.1.   Lifting shall be done by both sides, both wheels of the second
            axle (e.g. by crane) in vertical direction. The spring system of
            the lifted axle should be sustained and the wheels of the first
            axle should be chocked.

6.2.   The lifting height (*m*) has to result a lifting angle (*b*) between
            15°-20°. To ensure this lifting angle either a ditch should be
            used, or the front axle should be in an elevated position to
            overcome the limitation of the front angle of approach.

6.3.   Reaching the required lifting height the vehicle shall be held
            constantly in this position and the following values have to be
            measured:

6.3.1.   exact lifting height (*m*) measured at the centre of the lifted axle
            wheels

6.3.2.   vertical lifting load (A^*_2)

6.3.3.   vertical supporting axle load at the front axle (A^*_1)

6.4.   Control the measured loads, the sum of them shall be equal to the
            unladen, kerb mass:

$$A^*_1 + A^*_2 = M_k$$

6.5.   Calculate the exact lifting angle accordingly:

$$\boldsymbol{b} = \arcsin\!\left(\frac{m}{L_{12}}\right)$$

6.6.   Calculate the height of the centre of gravity accordingly:

$$h = r + h_1 = r + \left(l_1 - L_{12}\,\frac{A_2^*}{M_k}\right)\frac{1}{\operatorname{tg}\boldsymbol{b}}$$

            where *r* is the static rolling radius of the front wheels when they
            are inflated as specified. The determination of *r* is shown on
            figure 4.

7.   Tilting test to determine the height of the centre of gravity
            (see figure 3.)

7.1.   The vehicle shall be placed parallel to the tilting axis on the
            tilting platform. The wheels should be supported against side

slip. Three side supporting frames with padded heads should be applied to avoid rollover.

7.2.   The distances between the padded heads and the side wall of the vehicle should be equal and in the range of 60-100 mm when the vehicle stands on the horizontal tilting platform.

7.3.   All axles of the vehicle should be fixed, the spring system blocked.

7.4.   The tilting shall be done very slowly, until the unstable position of the vehicle. This position is reached, when:

the wheels on one side do not touch the tilting platform any more, the side supporting load on that side is zero

the side wall of the vehicle touches the padded heads of the side supporting frames
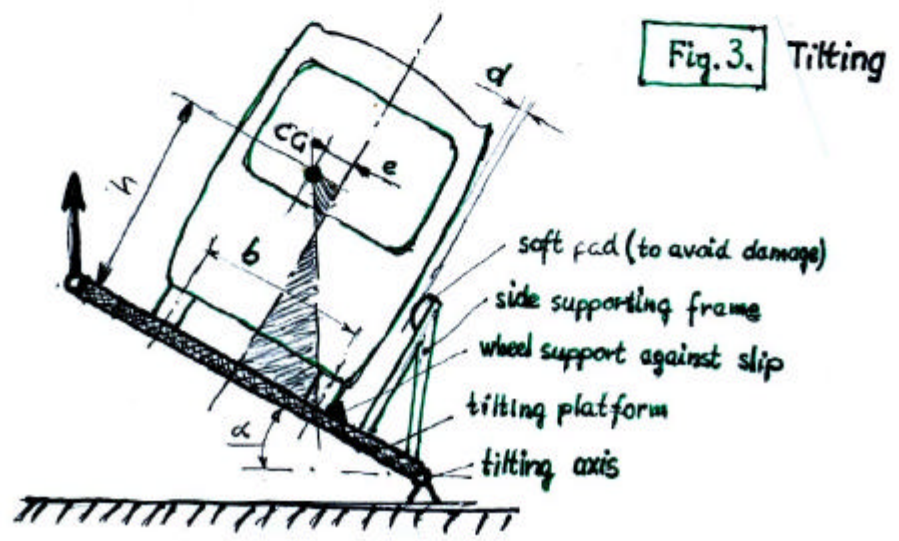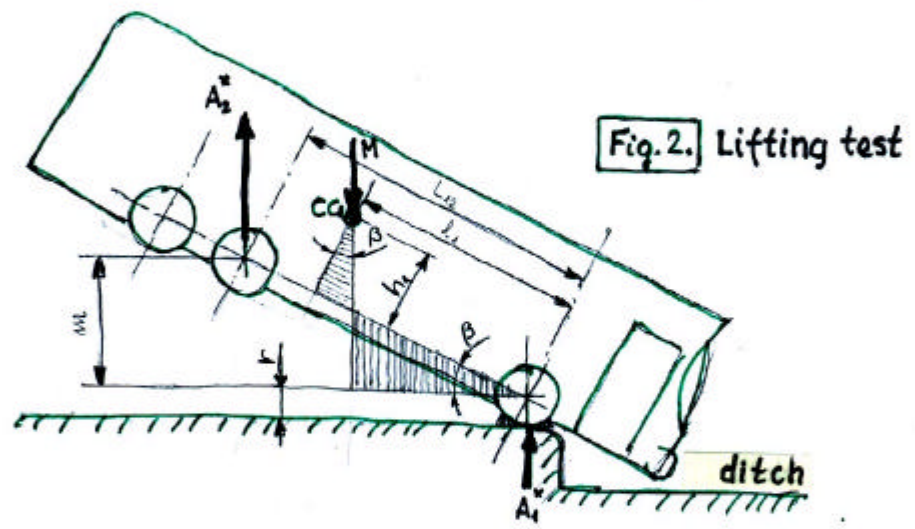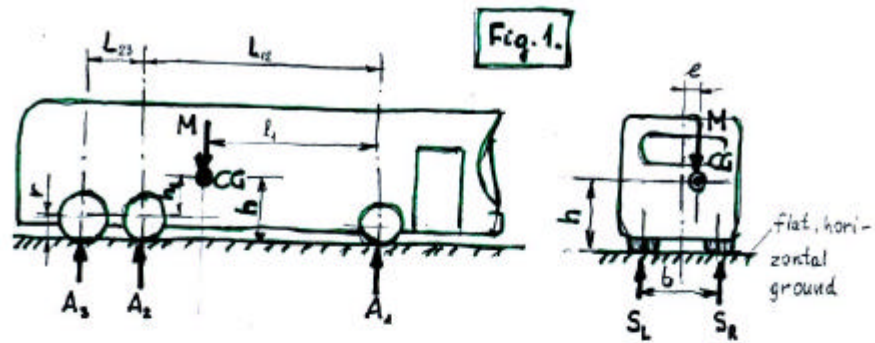
7.5.   Measure precisely the tilting angle (a) of the unstable position. Three measurements have to be carried out independently and the average value of the three tilting angles should be used for the calculation of the height of the centre of gravity.

7.6.   Tilting test shall be made on both directions determining two tilting angles: left side a and right side a

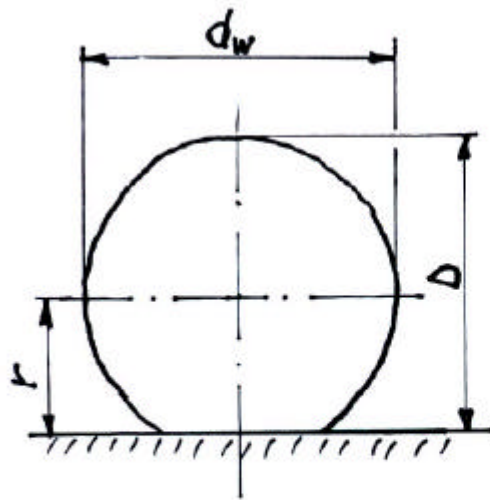7.7.   Calculate heights accordingly to both directions:

$$h_i = \frac{b \pm 2e}{2\,\mathrm{tg}\,a_i}$$

where a and h_i mean the appropriate values of the left and right side tilting test.

7.8.   Calculate the centre of gravity'-s height:

$$h = \frac{h_l + h_r}{2}$$

Fig.1.

Fig.2. Lifting test

ditch

Fig.3. Tilting

soft pad (to avoid damage)
side supporting frame
wheel support against slip
tilting platform
tilting axis

Fig.4.

$$r = D - \frac{d_w}{2}$$

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