UIC/OSJD CODE 505-6

1st edition, April 2006

Translation

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General rules for interoperable rolling stock gauges (without unloading freight or disembarking passengers) in cross-border traffic between UIC and OSJD RUs

Règles générales pour les gabarits des véhicules interopérables (sans décharger ni débarquer) en trafic transfrontalier entre les EF de l'UIC et de l'OSJD

Allgemeine Regeln für Fahrzeugbegrenzungslinien im interoperablen (umlade-/umsteigefreien) grenzüberschreitenden Verkehr zwischen den UIC- und OSShD-EVU

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Reference of the corresponding OSJD leaflet:

500

Application:

With effect from 1. January 2006
All members of the International Union of Railways and the Organisation for the Collaboration between Railways.
This leaflet was elaborated by UIC/OSJD joint group and approved on 08.09.2005 by the study group "Vehicle-Infrastructure interaction".

Record of updates

1st edition, April 2006	Initial version. Unlike OSJD leaflet 500, this leaflet has been structured so as to allow the different methods of calculation to appear in points 3 and 4 and to keep only the explanations of the symbols used in Appendix A.

The person responsible for this leaflet is named in the UIC Code

Contents

Summary

This leaflet:

1. describes acceptance and operating conditions for east-west traffic;
2. defines the UIC kinematic reference profile and the OSJD static reference profile;
3. defines the methods for calculation of vehicle dimensions in relation to the reference profiles of these gauges.

1 - Application

This leaflet is applicable for coaches and wagons and has mandatory status.

The vehicles will be admitted in international traffic on all the UIC and OSJD lines if they meet the requirements of *UIC Leaflet 505-1* regarding the UIC kinematic gauge (see Fig. 1 - page 4) and those of *OSJD Leaflet 500* (see Bibliography - page 34) regarding the OSJD static gauge 03-WM (see Fig. 2 - page 5).

Point 2 - page 4 shows the upper parts of the contours used to determine the widths and the admissible heights of the vehicles. The calculation method for the kinematic gauge is shown in point 3 - page 10 and the calculation method for the static gauge is shown in point 4 - page 28.

The method used to determine the minimum height of the lower parts according to the kinematic gauge is shown in point 3. The lower parts of static gauge is shown in the Fig. 8 and 9 - page 9 and the application rules are shown in point 4.

Free circulation is also granted on the following railways for wagons which conform to the static gauge according to Fig. 3 - page 5 : AZ, BC, GR, KZH, KZD, LDZ, LG, CFM, PKP, RZD, ZSR, UTI, UZ, EVR, HSH, GySEV, BDZ, CFR, CD, JZ, TCDD, DB, ÖBB, CFL, NS, DSB, CFS, IRR, VR, RENFE.

The rolling stock construction gauge must be calculated according to point 4.

NB : Except for JZ : Divica, Sezana, Hrpelie-Kozina, Koper, Kilovce, Llirska, Bistrica, Sapljane, Jurdani, Opatila-Matulji, Rijeka ; MAV : Budapest - Deli pu, Budapest-Kelenföld.

Wagons which respect the OSJD static gauge 1-WM (Fig. 4 - page 6) or the smaller OSJD gauge 0-WM (*OSJD Leaflet 500*) shall be accepted for East-West-railway traffic on the following routes:

Moscow - Terespol – Łuków – Warsaw – Łowicz – Kunowitze – Frankfurt/Oder – Berlin – Schwerin (Magdeburg, Erfurt, Dresden)

Moscow –Tschop – Debrecen – Budapest – Subotica (Koprivnica)

Moscow –Tschop – Koschice – Zwolen – Bratislava – Kuty

Moscow – Ungeny – Bucharest – Sofia

Moscow – Peking

Moscow – Pyongyang

Kaliningrad – Bogatschewo – Tczew – Kostrzyn – Berlin

Vadul Siret – Vikshani – Pashkani – Ploiesti – Bucharest

Budapest – Arad – Bucharest – Constanta

Saint-Petersburg – Resekne – Daugawpils – Vilnius – Warsaw

Tallinn – Riga – Warsaw

Warsaw – Gdansk, Katowice – Warsaw

Moscow – Kiev – Tschop – Kysak – Zilina (for the 0-WM gauge)

The running conditions of vehicles respecting the 1-WM and 0-WM profiles on the lines indicated are to be approved by each network.

It is planned that the lines below will be prepared for the circulation of vehicles conforming to the GC gauge (*UIC Leaflet 506* (see Bibliography - page 34)) and where the profile of the upper parts conforms to the 2-WM gauge (*OSJD Leaflet 500*).

NB : Accepted in accordance with the minutes of the ECE/UN BVA working groups of 16.-18.10.1995 and the conclusions of UIC working group 57/A/6 in 1976.

Moscow – Minsk – Brest – Warsaw – Katowice

Budapest – Galanta – Zilina – Katowice – Lwow – Kiev – Moscow

Katowice – Warsaw – Gdansk

Tallinn – Riga – Vilnius – Warsaw

Saint-Petersburg – Resekne – Daugawpils – Vilnius – Warsaw

Saint-Petersburg – Lushaika – Helsinki

Warsaw – Frankfurt/Oder – Berlin

Berlin – Magdeburg – Hannover – Dortmund – Düsseldorf – Cologne – Aachen

Cologne – Düsseldorf – Münster

Mainz – Frankfurt/Main – Hannover – Amsterdam – Antwerp – Brussels – Cologne

Stockholm – Copenhagen

Paris – Lyon

Paris – Calais – Dover – London

Madrid – Barcelona

Arad – Bucharest – Constanta

Arad – Sofia – Istanbul

Berlin – Prague – Ceska Trebova – Bratislava – Budapest – Arad

Triest – Ljubljana – Zagreb – Budapest – Zilina – Cadca – Jablunkov

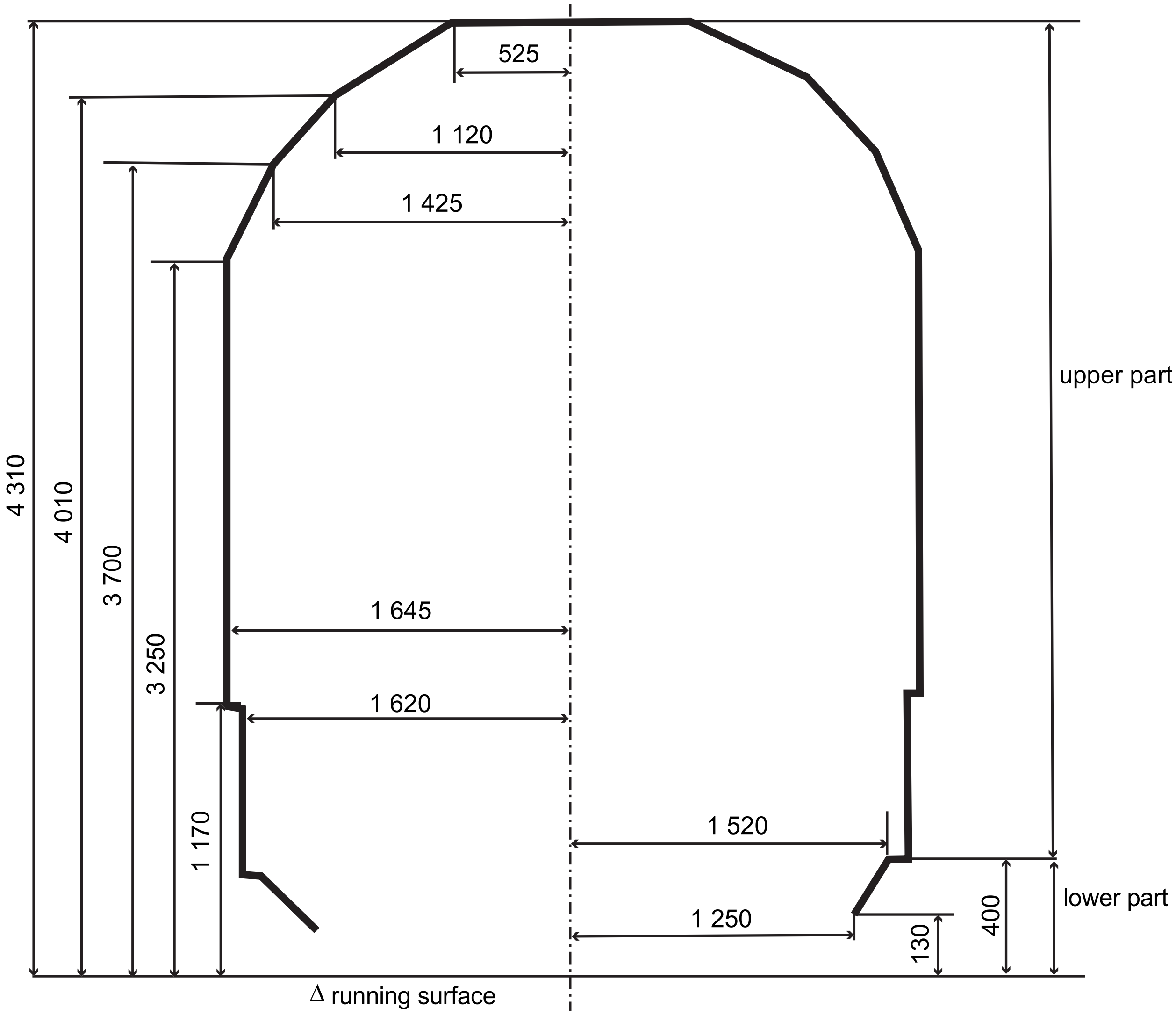
Rieka – Zagreb – Budapest – Bratislava – Warsaw – Gdansk

Drushba – Aktogaj – Mointy – Akmola – Presnogorkowskaja (Zauralje) – Jekaterinburg – Moscow – Riga

Drushba – Aktogaj – Almaty – Arys – Aralsk – Aktjubinsk – Saratow – Charkow – Lwow – Tschop – Kosice – Zwolen – Leopoldow – Zilina – Cadca – Ceska Trebova – Prague – Decin – Dresden – Bonn – Brussels – Paris (London)

2 - Reference profile

2.1 - Reference profile of the UIC kinematic gauge



(dimensions in mm)

Fig. 1 - Reference profile of the UIC kinematic gauge

2.2 - OSJD static reference profiles

2.2.1 - Upper parts

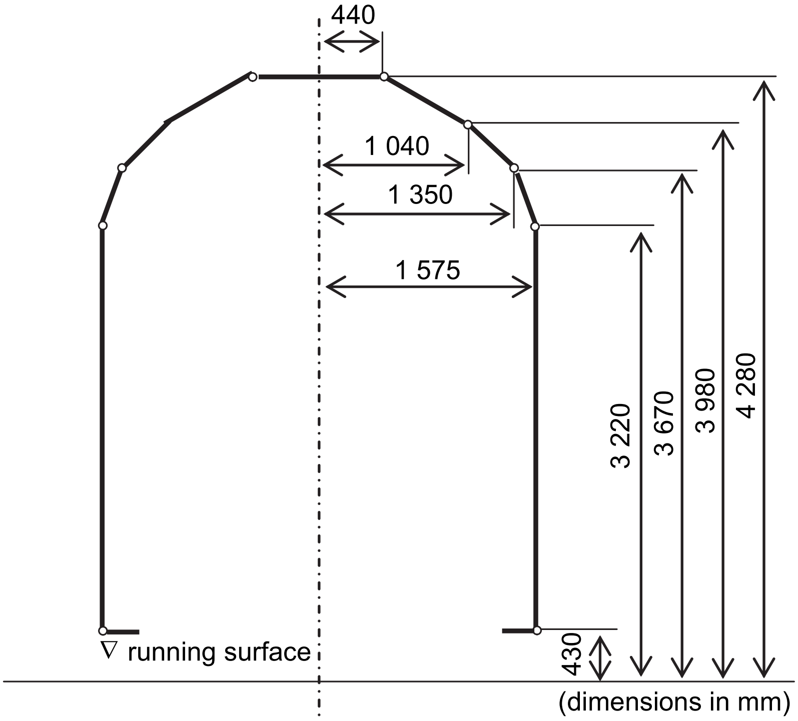


Fig. 2 - Reference profile of the static 03-WM (upper parts)

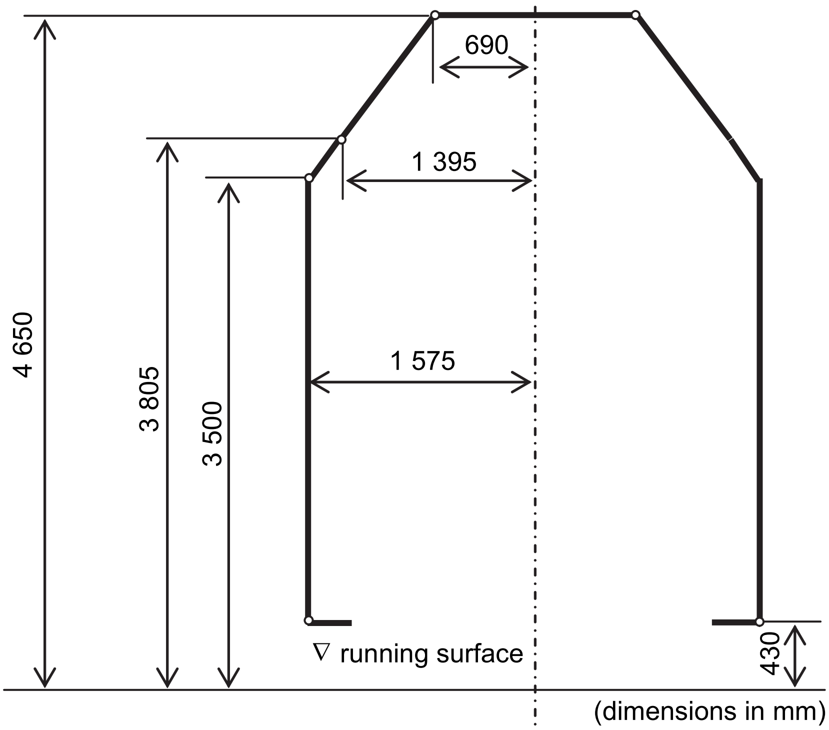


Fig. 3 - Reference profile of the static 02-WM (upper parts)

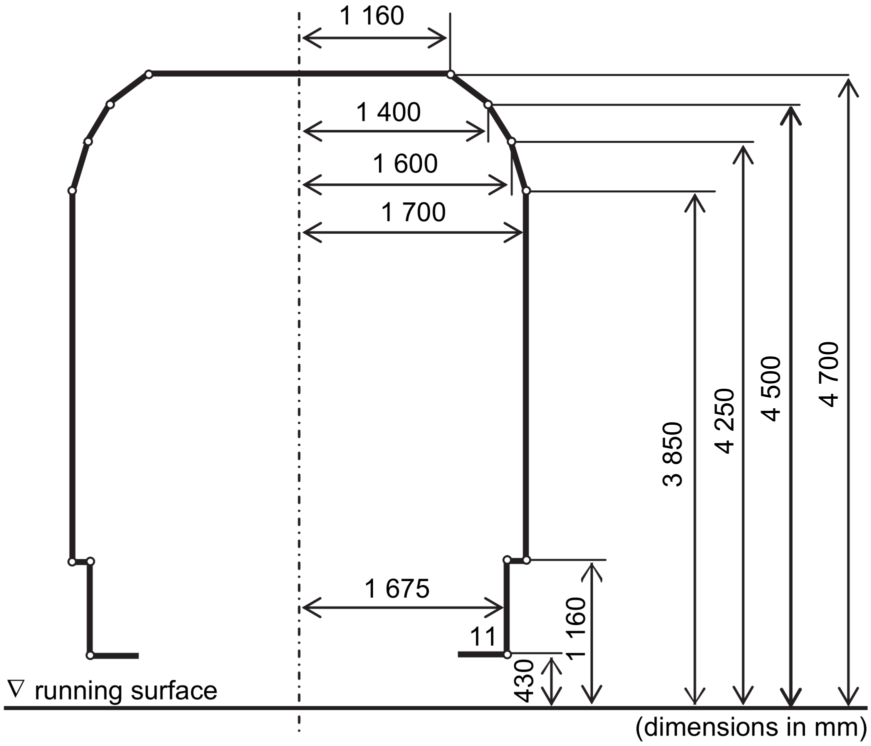


Fig. 4 - Reference profile of the static 1-WM (upper parts)

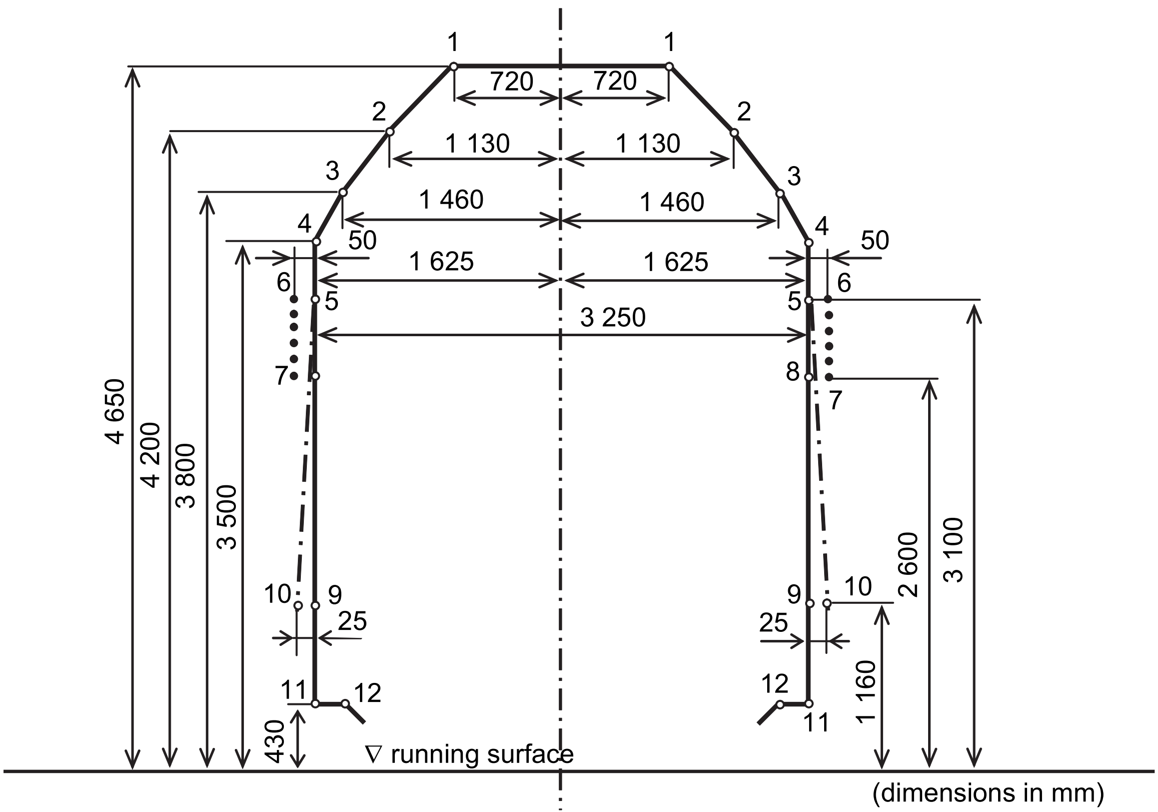


Fig. 5 - Reference profile of the static 0-WM (upper parts)

········· only for signals on the vehicles

— · — only for existing vehicles

2.2.2 - Lower part

Certain gauge restrictions are to observed close to wheelsets when vehicles are placed on an under-floor wheel lathe for wheel reprofiling.

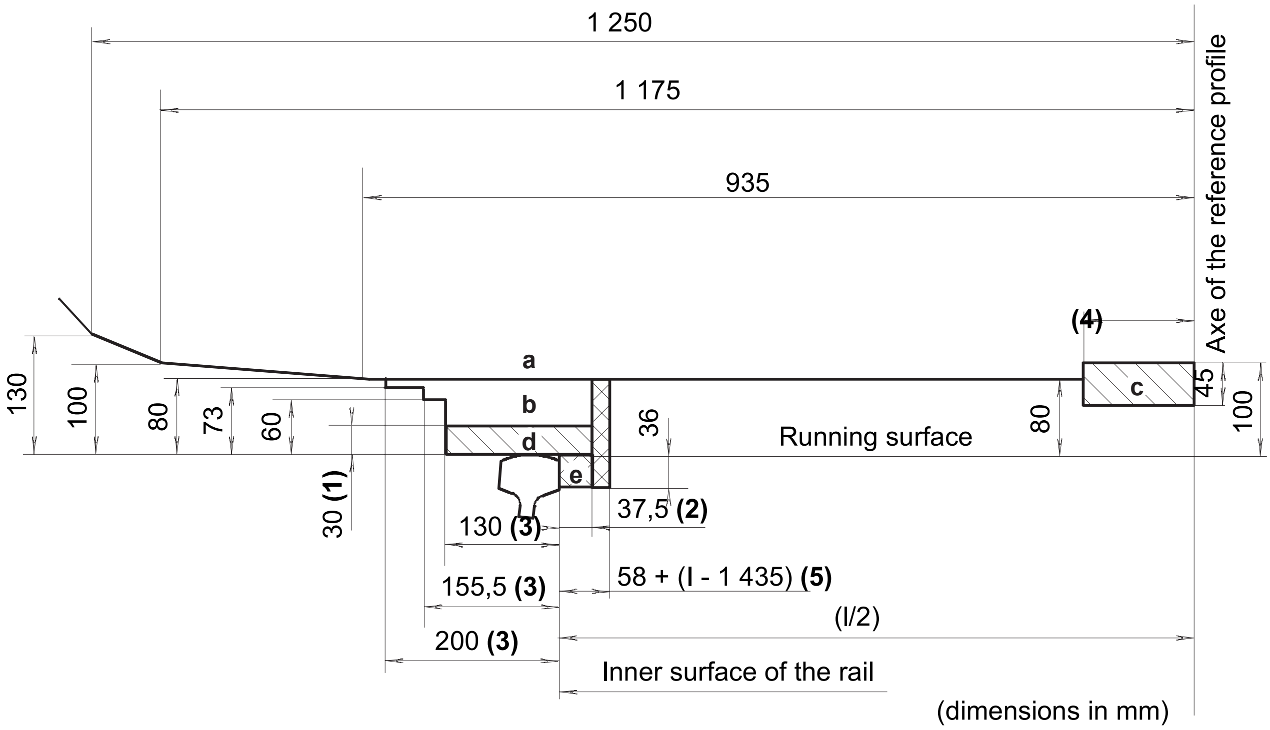


Fig. 6 - Part below 130 mm for vehicles not able to negotiate rail brakes and other activated shunting and stopping devices

a zone for equipment located away from wheels

b zone for equipment in immediate proximity of wheels

c zone for contact ramp brushes

d zone for wheels and other parts coming into contact with the rails

e zone occupied exclusively by the wheels

(1) Limit not to be exceeded by parts located outside the axle ends (guard irons, sanders, etc.) for running over detonators. This limit may however be disregarded for parts located between the wheels, provided these parts remain within the wheel track.

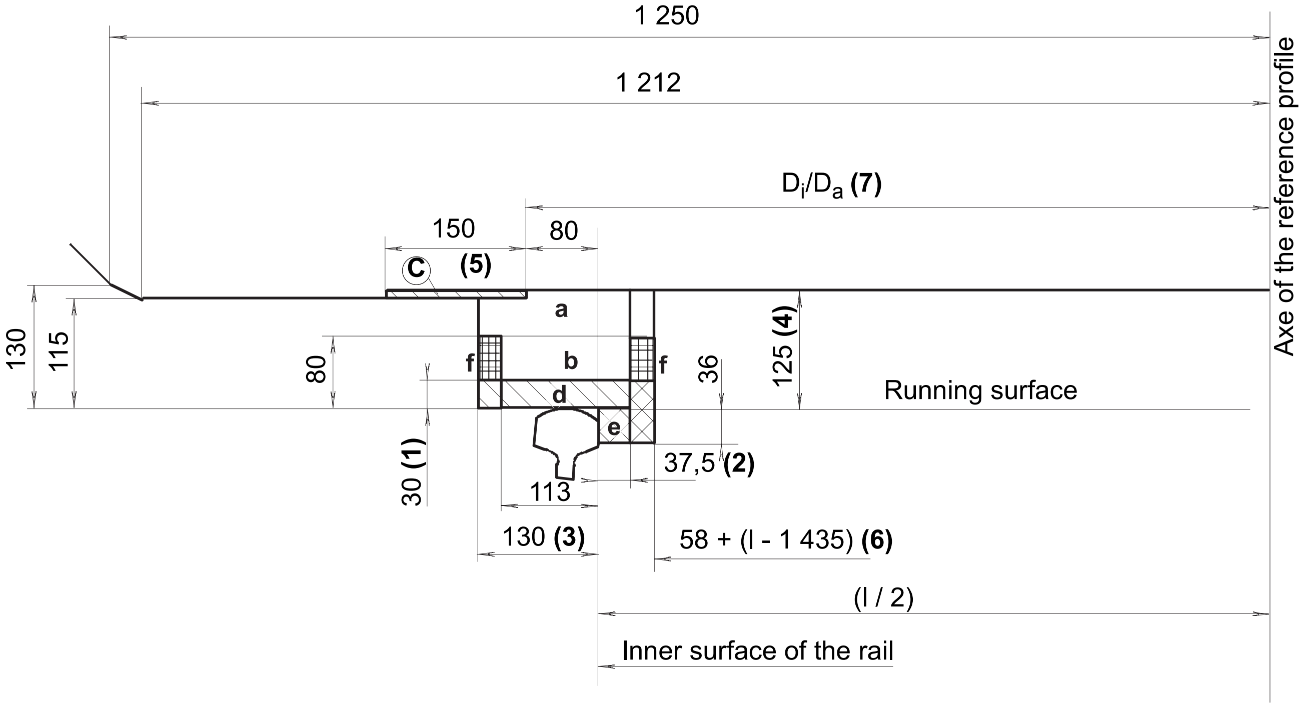
(2) Maximum theoretical width of the flange profile in the case of check-rails (*UIC Leaflet 505-5* - see Bibliography - page 34).

(3) Effective limit position of the outside surface of the wheel and of the parts associated with this wheel. Lower parts: see *UIC Leaflet 505-5*.

(4) When the vehicle is in any position whatsoever on a curve of radius R = 250 m (minimum radius for contact ramp installation) and a track width of 1 465 mm, no part of the vehicle likely to descend to less than 100 mm from the running surface, except for the contact brush, should be less than 125 mm from the track centre. For parts located inside the bogies, this dimension is 150 mm.

(5) Effective limit position of the internal surface of the wheel when the axle is against the opposite rail. This dimension varies with gauge widening.

NB : All vehicles must be able to pass over convex or concave transition curves of radius ≥ 500 m, without any part other than the wheel flange descending below the running surface.



(dimensions in mm)

Fig. 7 - Part below 130 mm for vehicles able to negotiate rail brakes and other activated shunting and stopping devices

a zone for equipment located away from wheels

b zone for equipment in immediate proximity of wheels

c zone for ejection of standardised drag shoes (see *UIC Leaflet 505-5*).

d zone for wheels and other equipment coming into contact with the rails

e zone occupied exclusively by the wheels

f zone for rail brakes in released position

(1) Limit for parts located outside the axle ends (guard-irons, sanders, etc) not to be exceeded for running over detonators.

(2) Maximum fictional width of the flange profiles in the case of check rails.

(3) Effective limit position of the wheel external surface and of the parts associated with the wheel (Lower part : see *UIC Leaflet 505-5*).

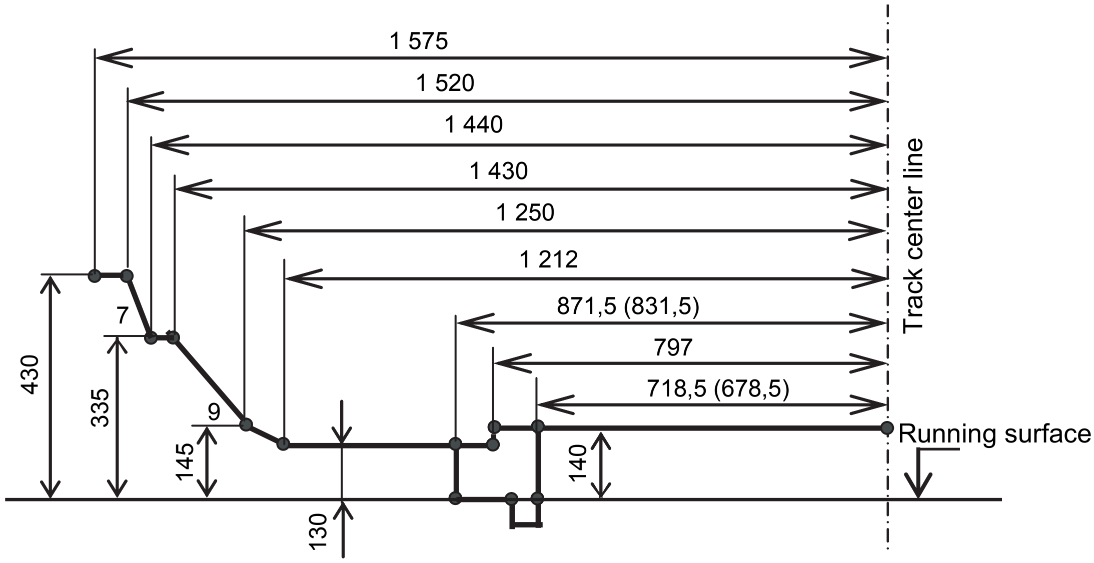
(4) This dimension also shows the maximum height of standard drag shoes used for scotching or slowing down the rolling stock.

(5) No rolling stock equipment should penetrate into this area.

(6) Effective limit position of the wheel internal surface when the axle is against the opposite rail. This dimension varies with gauge widening.

(7) See *UIC Leaflet 505-1, point 5.3:* Use of shunting devices in curved track sections.

The lower part of the static reference profile for wagons and coaches for acceptance on all railways including those equipped with rail brakes and other gravity hump devices in all operational modes.



The given dimensions are to be reduced by 15 mm for non-suspended parts

Fig. 8 - For the 03-WM reference profile

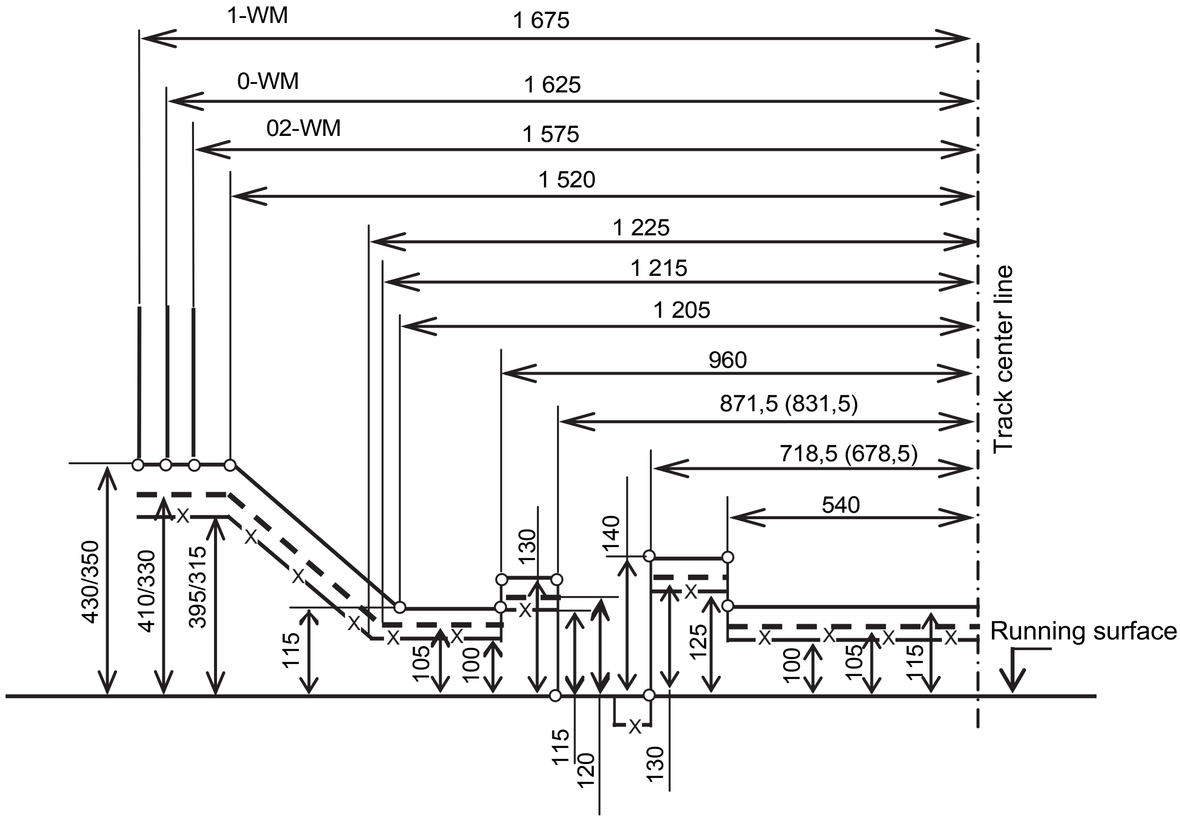


Fig. 9 - For the 1-WM, 02-WM, 0-WM reference profile

————	For the suspended parts of the wagon body
– – – –	For the suspended parts of the bogies
—x—x—	For non-suspended parts

NB : In order to accept vehicles with a gauge width of 1 520 mm on 1 435 mm gauge tracks, the bogies must respect the lower part of the reference profile in accordance with Fig. 7.

3 - Calculation method for the dimensions of vehicles according to the kinematic gauge described in *UIC Leaflet 505-1*

In order to obtain the admissible width of the wagons, the width of the reference profile by the considered height must be reduced of the value E_i or E_a calculated according to the following rules.

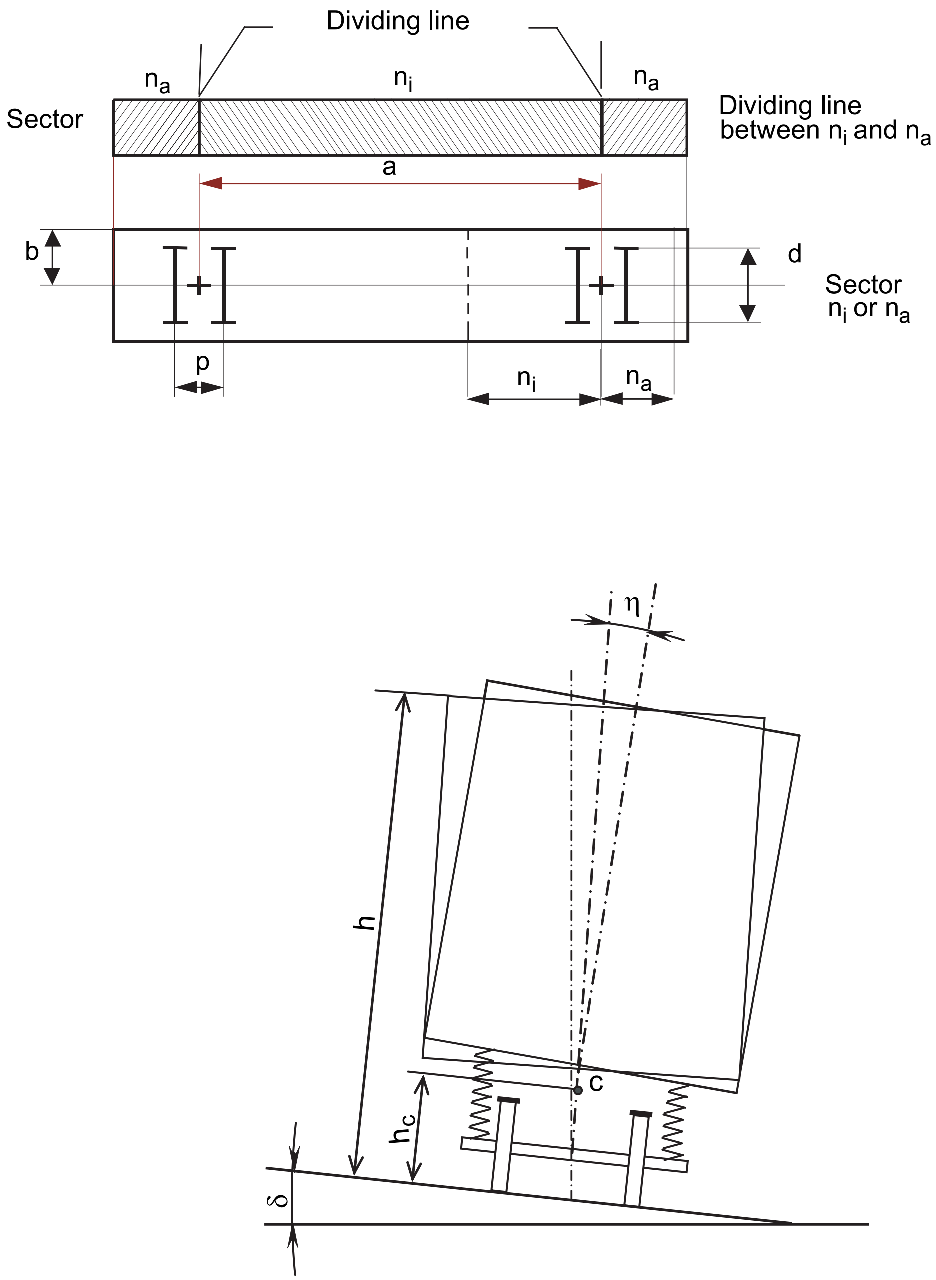


Fig. 10 - General illustration of the parameters of the vehicles

NB : Symbols used in the calculation of the kinematic gauge are listed in Appendix A.

Calculation formulas of the reduction value E_i and E_a to determine the vehicles dimensions according to the kinematic gauge (dimension s in m).

3.1 - Coaches

3.1.1 - Coaches for which the w play is independent of track position radius or varies linearly depending on the curvature.

3.1.1.1 - Calculation of the internal reductions E_i for the sections between bogie pivots ($n = n_i$).

When:

$$an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) \leq 250(1{,}465 - d)\Big|_{0 \quad (**)}^{-2{,}5 \quad (*)}$$

position on straight track preponderant:

$$E_i = \frac{1{,}465 - d}{2} + q + w_\infty + z - 0{,}015 \qquad \textbf{(1)}$$

When:

$$an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) > 250(1{,}465 - d)\Big|_{0 \quad (**)}^{-2{,}5 \quad (*)}$$

position on curve preponderant:

$$E_i = \frac{an - n^2 + \frac{p^2}{4}}{500} + q + w_{i(250)} + z + [x_i]_{>0} - \Big|_{0{,}015 \quad (**)}^{0{,}010 \quad (*)} \qquad \textbf{(2)}$$

with:

$$x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 100\right) + w_{i(150)} - w_{i(250)} \qquad \textbf{(3)}$$

Here and in the following formulas:

(*) This value applies to equipment located not more than 400 mm above the running surface and to parts which, as a result of wear and vertical movements, may descend below this level, as defined in point 3.3.1 - page 16

(**) This value applies to equipment located more than 400 mm above the running surface, with the exception of the parts covered by footnote (*) above

3.1.1.2 - Calculation of the external reduction E_a for the sections beyond bogie pivots ($n = n_a$).

When:

$$an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{a(250)})\frac{n+a}{a}\right] \leq 250(1{,}465 - d)\frac{n}{a} + \begin{vmatrix} 5 & (*) \\ 7{,}5 & (**) \end{vmatrix}$$

position on straight track preponderant:

$$E_a = \left(\frac{1{,}465 - d}{2} + q + w_\infty\right)\frac{2n + a}{a} + z - 0{,}015 \qquad \textbf{(4)}$$

When:

$$an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{a(250)})\frac{n+a}{a}\right] > 250(1{,}465 - d)\frac{n}{a} + \begin{vmatrix} 5 & (*) \\ 7{,}5 & (**) \end{vmatrix}$$

position on curve preponderant:

$$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \frac{1{,}465 - d}{2} \times \frac{n+a}{a} + q\frac{2n+a}{a} + w_{i(250)}\frac{n}{a} + w_{a(250)}\frac{n+a}{a} + z + [x_a]_{>0} - \begin{vmatrix} 0{,}025 & (*) \\ 0{,}030 & (**) \end{vmatrix} \qquad \textbf{(5)}$$

with:

$$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - 120\right) + (w_{i(150)} - w_{i(250)})\frac{n}{a} + (w_{a(150)} - w_{a(250)})\frac{n+a}{a} \qquad \textbf{(6)}$$

3.1.2 - Coaches for which the w play varies non-linearly in relation to the curvature

On straight track, the reductions are calculated using formulas **(1)** and **(4)**. In curves, the maximum reduction has to be calculated by comparison of the reduction in different radius R.

3.1.2.1 - Calculation of the internal reductions E_i for the sections between bogie pivots ($n = n_i$).

When $\infty > R \geq 250$:

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - \left| \begin{matrix} 5 & (*) \\ 7{,}5 & (**) \end{matrix} \right.}{2R} + w_{i(R)} \right] + q + z \qquad \textbf{(7)}$$

When $250 > R \geq 150$:

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - 100}{2R} + w_{i(R)} \right] + q + z + \left| \begin{matrix} 0{,}190 & (*) \\ 0{,}185 & (**) \end{matrix} \right. \qquad \textbf{(8)}$$

3.1.2.2 - Calculation of the external reductions E_a for the sections beyond bogie pivots ($n = n_a$).

When $\infty > R \geq 250$:

$$E_a = \left[\frac{an + n^2 + \frac{p^2}{4} - \left| \begin{matrix} 5 & (*) \\ 7{,}5 & (**) \end{matrix} \right.}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a} \right] + \frac{1{,}465 - d}{2} \times \frac{n+a}{a} + q\frac{2n+a}{a} + z - 0{,}015 \qquad \textbf{(9)}$$

When $250 > R \geq 150$:

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - 120}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a} \right] + \frac{1{,}465 - d}{2} \times \frac{n+a}{a} + q\frac{2n+a}{a} + z + \left| \begin{matrix} 0{,}215 & (*) \\ 0{,}210 & (**) \end{matrix} \right. \qquad \textbf{(10)}$$

3.1.3 - Calculation of reductions for bogies and their associated parts

The reduction formulas applicable are those given in point 3.2.1 - page 14.

3.2 - Wagons

3.2.1 - For wagons with independent axles and the bogie themselves and their associated parts (w = 0)

For 2-axle wagons, and only for those parts located below 1,17 m above the running surface, term z in formulas **(11)** to **(20)** may be reduced by 0,005 m when (z-0,005) > 0. It shall be considered null when (z-0,005) ≤ 0.

3.2.1.1 - Calculation of the internal reductions E_i for the sections between bogie pivots ($n = n_i$).

When:

$$an - n^2 \leq \begin{vmatrix} 5 & (*) \\ 7{,}5 & (**) \end{vmatrix}$$

position on straight track preponderant:

$$E_i = \frac{1{,}465 - d}{2} + q + z - 0{,}015 \qquad \textbf{(11)}$$

When:

$$an - n^2 > \begin{vmatrix} 5 & (*) \\ 7{,}5 & (**) \end{vmatrix}$$

position on curve preponderant:

$$E_i = \frac{an - n^2}{500} + \frac{1{,}465 - d}{2} + q + z - \begin{vmatrix} 0{,}025 & (*) \\ 0{,}030 & (**) \end{vmatrix} \qquad \textbf{(12)}$$

3.2.1.2 - Calculation of the external reductions E_a for the sections beyond bogie pivots ($n = n_a$).

When:

$$an - n^2 \leq \begin{vmatrix} 5 & (*) \\ 7{,}5 & (**) \end{vmatrix}$$

position on straight track preponderant:

$$E_a = \left(\frac{1{,}465 - d}{2} + q\right)\frac{2n + a}{a} + z - 0{,}015 \qquad \textbf{(13)}$$

When:

$$an + n^2 > \left| \begin{matrix} 5 & (*) \\ 7{,}5 & (**) \end{matrix} \right.$$

position on curve preponderant:

$$E_a = \frac{an + n^2}{500} + \left(\frac{1{,}465 - d}{2} + q\right)\frac{2n + a}{a} + z - \left| \begin{matrix} 0{,}025 & (*) \\ \\ 0{,}030 & (**) \end{matrix} \right. \qquad \textbf{(14)}$$

3.2.2 - For bogie wagons whose play is considered to be constant, except for the bogies themselves and their associated parts

3.2.2.1 - Calculation of the internal reductions E_i for the sections between bogie pivots ($n = n_i$).

When:

$$an - n^2 + \frac{p^2}{4} \leq 250(1{,}465 - d) - \left| \begin{matrix} 2{,}5 & (*) \\ \\ 0 & (**) \end{matrix} \right.$$

position on straight track preponderant:

$$E_i = \frac{1{,}465 - d}{2} + q + w + z - 0{,}015 \qquad \textbf{(15)}$$

When:

$$an - n^2 + \frac{p^2}{4} > 250(1{,}465 - d) - \left| \begin{matrix} 2{,}5 & (*) \\ \\ 0 & (**) \end{matrix} \right.$$

position on curve preponderant:

$$E_i = \frac{an - n^2 + \frac{p^2}{4}}{500} + q + w + z + [x_i]_{>o} - \left| \begin{matrix} 0{,}010 & (*) \\ \\ 0{,}015 & (**) \end{matrix} \right. \qquad \textbf{(16)}$$

with:

$$x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 100\right) \qquad \textbf{(17)}$$

3.2.2.2 - Calculation of the external reductions E_a for the sections beyond bogie pivots ($n = n_a$).

When:

$$an + n^2 - \frac{p^2}{4} \leq 250(1{,}465 - d)\frac{n}{a} + \begin{vmatrix} 5 & (*) \\ 7{,}5 & (**) \end{vmatrix}$$

position on straight track preponderant:

$$E_a = \left(\frac{1{,}465 - d}{2} + q + w\right)\frac{2n + a}{a} + z - 0{,}015 \qquad \textbf{(18)}$$

When:

$$an + n^2 - \frac{p^2}{4} > 250(1{,}465 - d)\frac{n}{a} + \begin{vmatrix} 5 & (*) \\ 7{,}5 & (**) \end{vmatrix}$$

position on curve preponderant:

$$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \frac{1{,}465 - d}{2} \text{ x } \frac{n + a}{a} + (q + w)\frac{2n + a}{a} + z + [x_a]_{>o} - \begin{vmatrix} 0{,}025 & (*) \\ 0{,}030 & (**) \end{vmatrix} \qquad \textbf{(19)}$$

with:

$$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - 120\right) \qquad \textbf{(20)}$$

3.3 - Vertical displacements

3.3.1 - Minimum height of lower parts

3.3.1.1 - The minimal height of the lower parts are fixed by taking into account the vertical wear, the deflection of the suspension and the vertical dimension of lower contour taken on Fig. 6 - page 7 and 7 - page 8 must be increased accordingly.

The distances D_i et D_a (see Fig. 7) are determined according to the following formulas:

$$D_i = 0{,}840 + \frac{an - n^2 + \frac{p^2}{4}}{300}$$

$$D_a = 0{,}840 + \frac{an + n^2 - \frac{p^2}{4}}{300}$$

3.3.1.2 - Rules of determination of the vertical displacements for the calculation of the minimal and maximal heights of the vehicle

1. Research of the minimal height above the rail level

   When researching the minimal height of the parts located in the transition zone at 1 170 mm and lower, the deflections set out in tables 1 and 2 will be taken into account.

Table 1 : Deflections independent of the load state and the suspension state

Wheels	Maximum wear for all types of vehicles
Various parts	Maximum wear Examples: transoms, brake rigging, etc, for all vehicles and for each special assembly
Axle boxes	Wear ignored
Bogie frame	Manufacturing tolerances giving rise to deflection in relation to the nominal dimensions: ignored
Body structures	Manufacturing tolerances giving rise to deflection in relation to the nominal dimensions: ignored for all vehicles including all conventional and special wagons

Table 2 : Deflection dependent on the load state of the vehicles and on the state of their suspension

Axles	Deflection ignored
Bogie frame	Deflection ignored
Body	- Transverse deflection ignored - Twist ignored - For all vehicles, except wagons for which the longitudinal sag must be taken into account under the effect of a maximum load increased by 30%, in order to take dynamic stresses into consideration

Table 3 : Types of springs

Steel spring	- Deflection under static load, - Additional deflection under dynamic stress, - deflection due to flexibility tolerances
Rubber spring	same deflections as for steel springs
Pneumatic spring	total deflection with cushions deflated (including back-up suspension when it exists)

Table 4 : Suspension deflection conditions

Equal and simultaneous deflections on the suspensions (zones A, B, C and D are concerned) (see Fig. 16 - page 23)

Coaches (empty in running order)	30 mm overall deflection
Coaches and vans	Deflection with a 30% overload on the sprung weight (maximum load) or total deflection.
"Conventional" wagons	Total deflection (bottoming).
Special wagons	Deflection under the effect of a 30% overload on the sprung weight or total deflection.

2. Normal values for the e_i or e_a vertical reductions to be taken into account for empty coaches, empty or loaded vans and wagons.

   These vehicles, when they can be gravity shunted, must be capable of passing over activated rail brakes and other shunting or stopping devices located on non-vertically curved track and reaching the 115 and 125 mm dimensions above the running surface, up to 3 m from the end of convex transition curves of radius $R_V \geq 250$ m (dimension d) (see Fig. 11 - page 18).

   They must also be able to pass over such devices located inside or near concave transition curves of radius $R_V \geq 300$ m.

   In applying these conditions, the lower dimensions of these vehicles, taking into account vertical movements, assessed as stated in tables 2 and 3, must in relation to the running centre be at least equal to 115 or 125 mm increased by the following e_i ou e_a quantities.

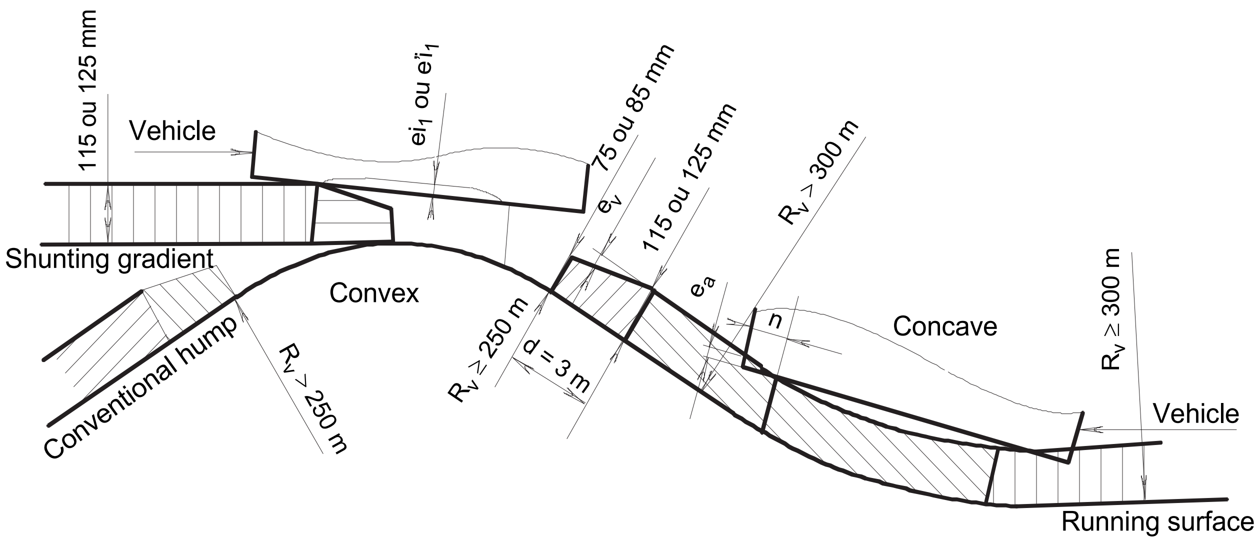


Fig. 11 - Normal values for vertical reductions of the lower parts for passing over vertical transition curves and marshalling yard humps

e_i or e_a : vertical reduction at the lower part of the rolling stock equipment in relation to the 115 and 125 mm dimensions.

e_v : lowering of the rail brakes in relation to the 115 or 125 mm dimensions.

a. For sections between the end axles or bogie pivots:

$$e_{i1} = \frac{n}{a}\frac{(a-n-3)^2}{500} \quad \text{when } a \le 17{,}8 \text{ m and } n < \frac{a-3}{3}$$

$$e_{i1} = \frac{(a-3)^3}{3\,375a} \quad \text{when } a \le 17{,}8 \text{ m and } n \ge \frac{a-3}{3}$$

$$e_{i1} = \left[\frac{27}{4}\frac{n}{a-3}\right]\left[1-\frac{n}{a-3}\right]^2\left[\frac{a^2}{3\,375}-0{,}04\right] \quad \text{when } a > 17{,}8 \text{ m and } n < \frac{a-3}{3}$$

$$e_{i1} = \frac{a^2}{3\,375}-0{,}04 \quad \text{when } a > 17{,}8 \text{ m and } n \ge \frac{a-3}{3}$$

N.B.: This formula for $n \ge \frac{a-3}{3}$ gives reductions greater than or equal to those resulting from the formula for or $n < \frac{a-3}{3}$.

When empty coaches and empty or loaded wagons and vans can be gravity shunted, they must also be able to pass over convex transition curves of radius ≥ 250 m, without any part other than the wheel flange descending below the running surface.

This condition, which concerns the central part of the vehicles, is in addition to those resulting from the e_i formulas for long vehicles.

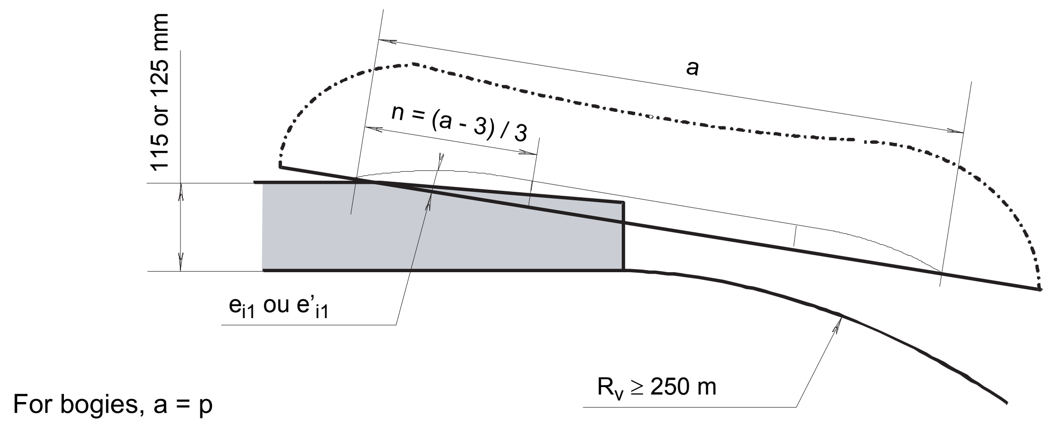


Fig. 12 - Normal values for lower parts reduction on convex transition curves for sections between bogie pivots

b. For sections located beyond the end axles or bogie pivots.

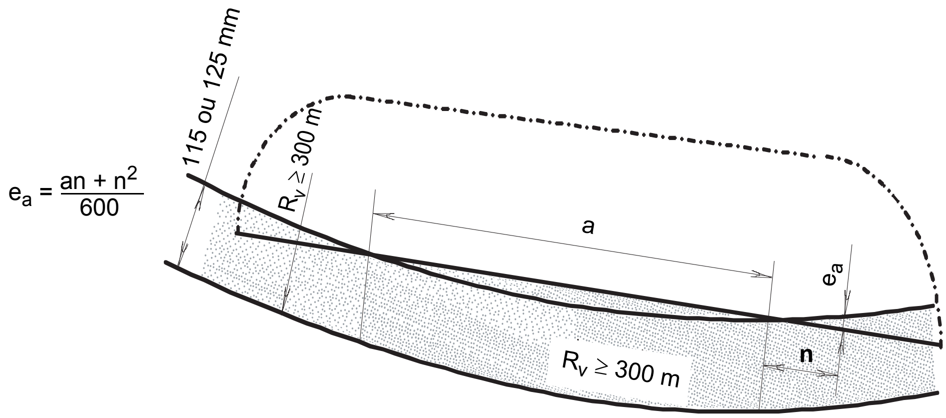


Fig. 13 - Lower parts on concave transition curves for sections located beyond bogie pivots

3. Reduced values for the e_i increase (sections between the end axles or bogie pivots) to be considered for certain vehicles for passing over gradient transition curves including shunting humps.

   These reduced values are only tolerated for certain types of wagon, insofar as they require a larger space than that determined using the normal values given in table 6 - page 29. These are, for example, the recess wagons used in rail/road combined traffic, and other identical or similar designs.

   Use of these reduced values may require special precautions to be taken in certain marshalling yards with hump retarders at the base of a shunting gradient.

   For these vehicles, the value of dimension d becomes 5 m.

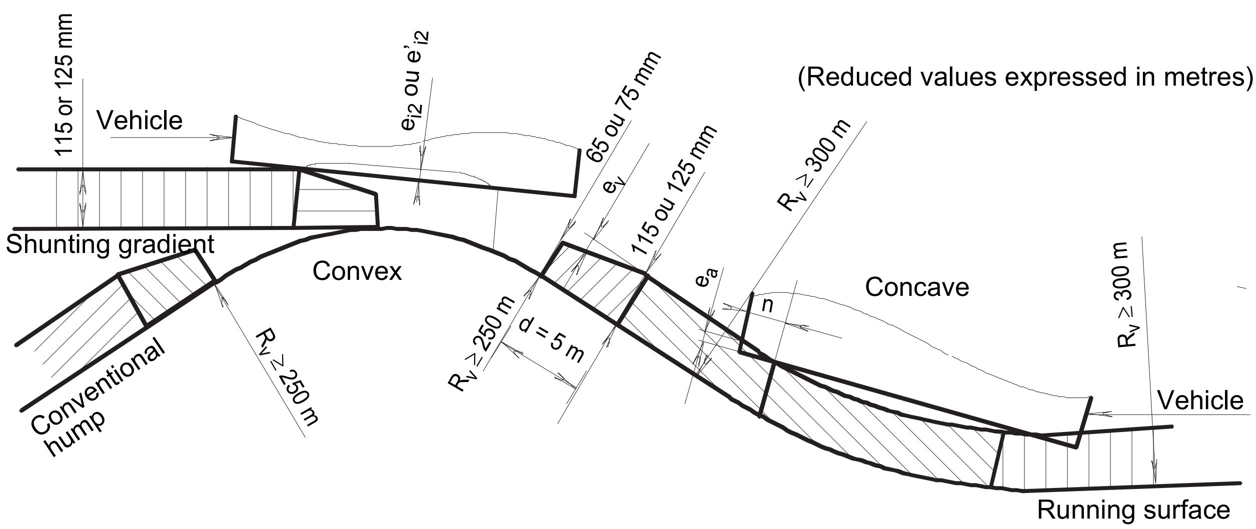


Fig. 14 - Reduced lower parts for passing over vertical transition curves and marshalling yard humps

$$e_{i2} = \frac{n}{a}\frac{(a-n-5)^2}{500} \qquad \text{when } a \leq 15{,}8 \text{ m and } n < \frac{a-5}{3}$$

$$e_{i2} = \frac{(a-5)^3}{3\,375a} \qquad \text{when } a \leq 15{,}8 \text{ m and } n \geq \frac{a-5}{3}$$

$$e'_{i2} = \left[\frac{27}{4}\frac{n}{a-5}\right]\left[1-\frac{n}{a-5}\right]^2\left[\frac{a^2}{3\,375}-0{,}05\right] \qquad \text{when } a > 15{,}8 \text{ m and } n < \frac{a-5}{3}$$

$$e'_{i2} = \frac{a^2}{3\,375} - 0{,}05 \qquad \text{when } a > 15{,}8 \text{ m and } n \geq \frac{a-5}{3}$$

NB: This formula for $n \geq \frac{a-5}{3}$ gives reductions greater than or equal to those obtained using the formula for $n < \frac{a-5}{3}$.

When they can be gravity shunted, the wagons must also be able to pass over convex transition curves with a radius ≥ 250 m, without any part other than the wheel flange descending below the running surface. This condition, which concerns the central part of the wagons, is in addition to those resulting from the e_i formulas for long wagons.

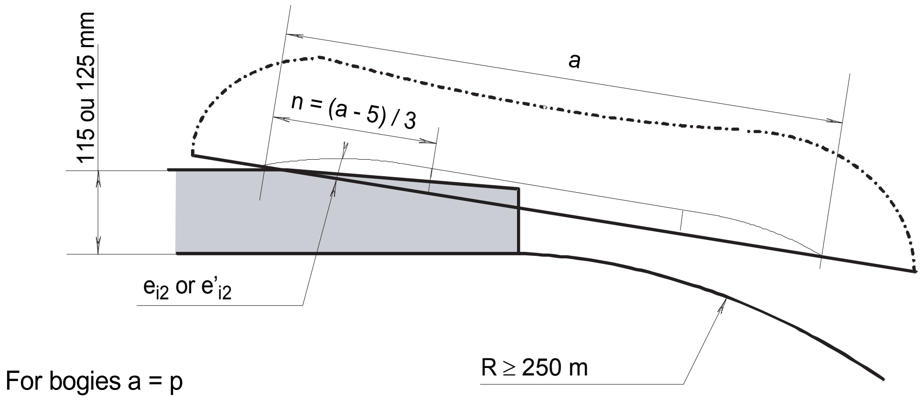
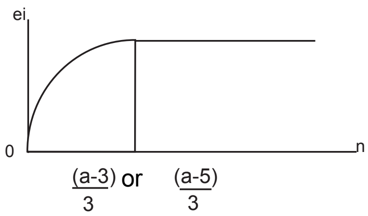
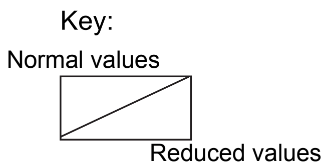


Fig. 15 - Reduced lower parts on convex transition curves for sections between bogie pivots

Table 5 : Values e_i and e'_i (in mm, a and n in m)

a \ n	> 6	5,5	5	4,5	4	3,5	3	2,5	2	1,5	1	0,5	0
20	79 / 69	78 / 69	78 / 69	76 / 68	73 / 66	69 / 63	63 / 59	57 / 54	49 / 46	39 / 37	28 / 27	15 / 14	0 / 0
19,5	73 / 63	73 / 63	72 / 63	71 / 62	68 / 61	65 / 59	60 / 55	54 / 50	46 / 43	37 / 35	26 / 25	14 / 14	0 / 0
19	67 / 57	67 / 57	67 / 57	66 / 57	64 / 56	60 / 54	56 / 51	50 / 46	43 / 40	35 / 33	25 / 24	13 / 13	0 / 0
18,5	61 / 51	61 / 51	61 / 51	61 / 51	59 / 51	56 / 49	52 / 47	47 / 43	41 / 37	33 / 30	23 / 22	13 / 12	0 / 0
18	56 / 46	56 / 46	56 / 46	56 / 46	54 / 46	52 / 45	48 / 42	44 / 39	38 / 34	31 / 28	22 / 20	12 / 11	0 / 0
17,5	52 / 41	52 / 41	52 / 41	51 / 41	50 / 41	48 / 40	45 / 38	41 / 35	36 / 31	29 / 26	21 / 19	11 / 10	0 / 0
17	48 / 36	48 / 36	48 / 36	48 / 36	47 / 36	45 / 35	43 / 34	39 / 31	34 / 28	28 / 23	20 / 17	11 / 9	0 / 0
16,5	44 / 31	44 / 31	44 / 31	44 / 31	44 / 31	42 / 30	40 / 30	37 / 28	32 / 25	26 / 20	19 / 15	10 / 8	0 / 0
16	41 / 26	41 / 26	41 / 26	41 / 26	41 / 26	40 / 26	38 / 25	34 / 24	30 / 21	25 / 18	18 / 13	10 / 7	0 / 0
15,5	37 / 22	37 / 22	37 / 22	37 / 22	37 / 22	37 / 22	35 / 22	32 / 21	28 / 19	23 / 16	17 / 12	9 / 6	0 / 0
15	34 / 20	34 / 20	34 / 20	34 / 20	34 / 20	34 / 20	32 / 20	30 / 19	27 / 17	22 / 14	16 / 11	9 / 6	0 / 0
14,5	31 / 18	31 / 18	31 / 18	31 / 18	31 / 18	31 / 18	30 / 17	28 / 17	25 / 16	21 / 13	15 / 10	8 / 6	0 / 0
14	28 / 15	28 / 15	28 / 15	28 / 15	28 / 15	28 / 15	27 / 15	26 / 15	23 / 14	19 / 12	14 / 9	8 / 5	0 / 0
13,5	25 / 13	25 / 13	25 / 13	25 / 13	25 / 13	25 / 13	25 / 13	24 / 13	21 / 13	18 / 11	13 / 8	7 / 5	0 / 0
13	23 / 12	23 / 12	23 / 12	23 / 12	23 / 12	23 / 12	23 / 12	22 / 12	20 / 11	17 / 10	12 / 8	7 / 4	0 / 0
12,5	20 / 10	20 / 10	20 / 10	20 / 10	20 / 10	20 / 10	20 / 10	20 / 10	18 / 10	15 / 9	12 / 7	7 / 4	0 / 0
12	18 / 8	18 / 8	18 / 8	18 / 8	18 / 8	18 / 8	18 / 8	18 / 8	16 / 8	14 / 8	11 / 6	6 / 4	0 / 0
11,5		16 / 7	16 / 7	16 / 7	16 / 7	16 / 7	16 / 7	16 / 7	15 / 7	13 / 7	10 / 5	6 / 3	0 / 0
11		14 / 6	14 / 6	14 / 6	14 / 6	14 / 6	14 / 6	14 / 6	13 / 6	12 / 6	9 / 5	5 / 3	0 / 0
10,5			12 / 5	12 / 5	12 / 5	12 / 5	12 / 5	12 / 5	12 / 5	10 / 5	8 / 4	5 / 2	0 / 0
10			10 / 4	10 / 4	10 / 4	10 / 4	10 / 4	10 / 4	10 / 4	9 / 4	7 / 3	4 / 2	0 / 0
9,5				9 / 3	9 / 3	9 / 3	9 / 3	9 / 3	9 / 3	8 / 3	6 / 3	4 / 2	0 / 0
9				7 / 2	7 / 2	7 / 2	7 / 2	7 / 2	7 / 2	7 / 2	6 / 2	3 / 1	0 / 0
8,5					6 / 1	6 / 1	6 / 1	6 / 1	6 / 1	6 / 1	5 / 1	3 / 1	0 / 0
8					5 / 1	5 / 1	5 / 1	5 / 1	5 / 1	5 / 1	4 / 1	3 / 1	0 / 0
7,5						4 / 1	4 / 1	4 / 1	4 / 1	4 / 1	3 / 1	2 / 1	0 / 0
7						3 / 0	3 / 0	3 / 0	3 / 0	3 / 0	3 / 0	2 / 0	0 / 0
6,5							2 / 0	2 / 0	2 / 0	2 / 0	2 / 0	1 / 0	0 / 0
6										1 / 0	1 / 0	1 / 0	0 / 0
5,5										1 / 0	1 / 0	1 / 0	0 / 0
5										0 / 0	0 / 0	0 / 0	0 / 0
4,5										0 / 0	0 / 0	0 / 0	0 / 0





Vehicles not allowed on shunting humps in reason of their length

When empty coaches or wagons suitable for international traffic and empty or loaded vans are not allowed over marshalling yard humps on account of their length, they must nonetheless respect the profile in Fig 7 - page 8 when placed on a non-vertically curved track, so as to allow for the use of shunting or stopping devices.

All vehicles

All vehicles must be able to pass over convex or concave transition curves of radius $R_V \geq 500$ m, without any part other than the wheel flange descending below the running surface.

This may concern mainline vehicles whose:

- wheelbase is greater than 17,8 m,
- overhang is greater than 3,4 m.

Special cases

Vertical transition curves for vehicles fitted with the automatic coupler, see *UIC Leaflet 522* (see Bibliography - page 34).

Angle of inclination for vehicles used on ferries, see:

- *UIC Leaflet 507* for wagons;
- *UIC Leaflet 569* for coaches and vans (see Bibliography - page 34).

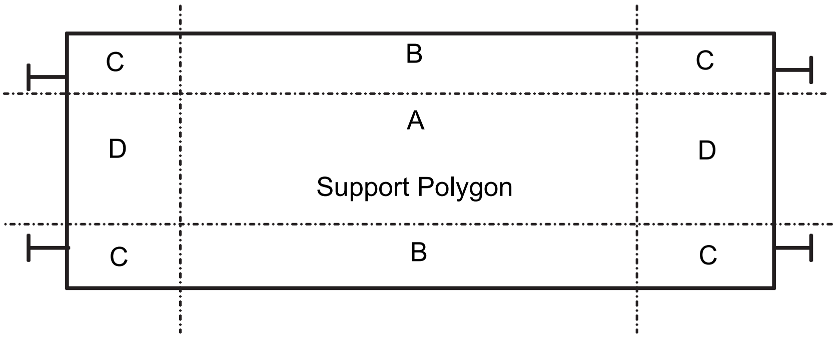


Fig. 16 - Deflection of the vehicle bodies (the division shown in the diagram shall be considered)

For all vehicles and wagons in particular, it may be necessary to take account of additional vertical movements f_z due to inclination of the vehicle body (roll, pitching) following, for example, an off-centre load or deflation of pneumatic suspension.

The following simplified formulas should be used for these additional depressions:

Lateral: zones concerned B and C

$$\frac{f_{max}}{2b_2} = \frac{f_z}{b - b_2} \quad f_z = \frac{f_{max}(b - b_2)}{2b_2}$$

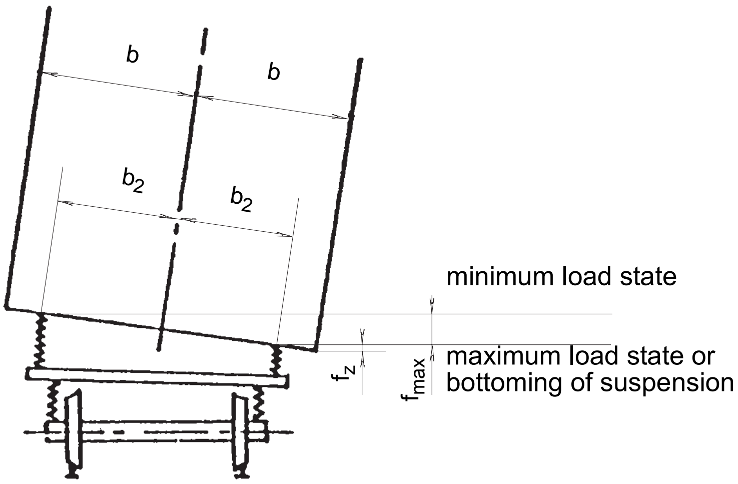


Fig. 17 - Deflection in phase on the 2 bogies and on the same rail

Longitudinal : zones concerned C and D

$$\frac{f_{max}}{a} = \frac{f_z}{n_a} \quad f_z = \frac{f_{max}\, n_a}{a}$$

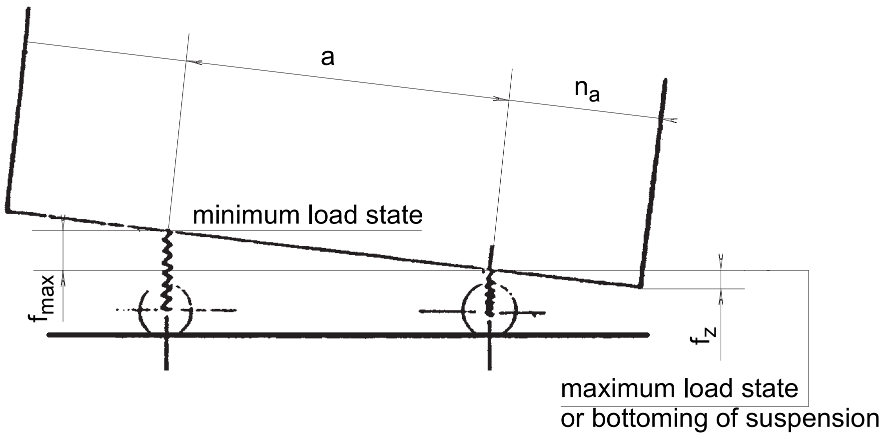
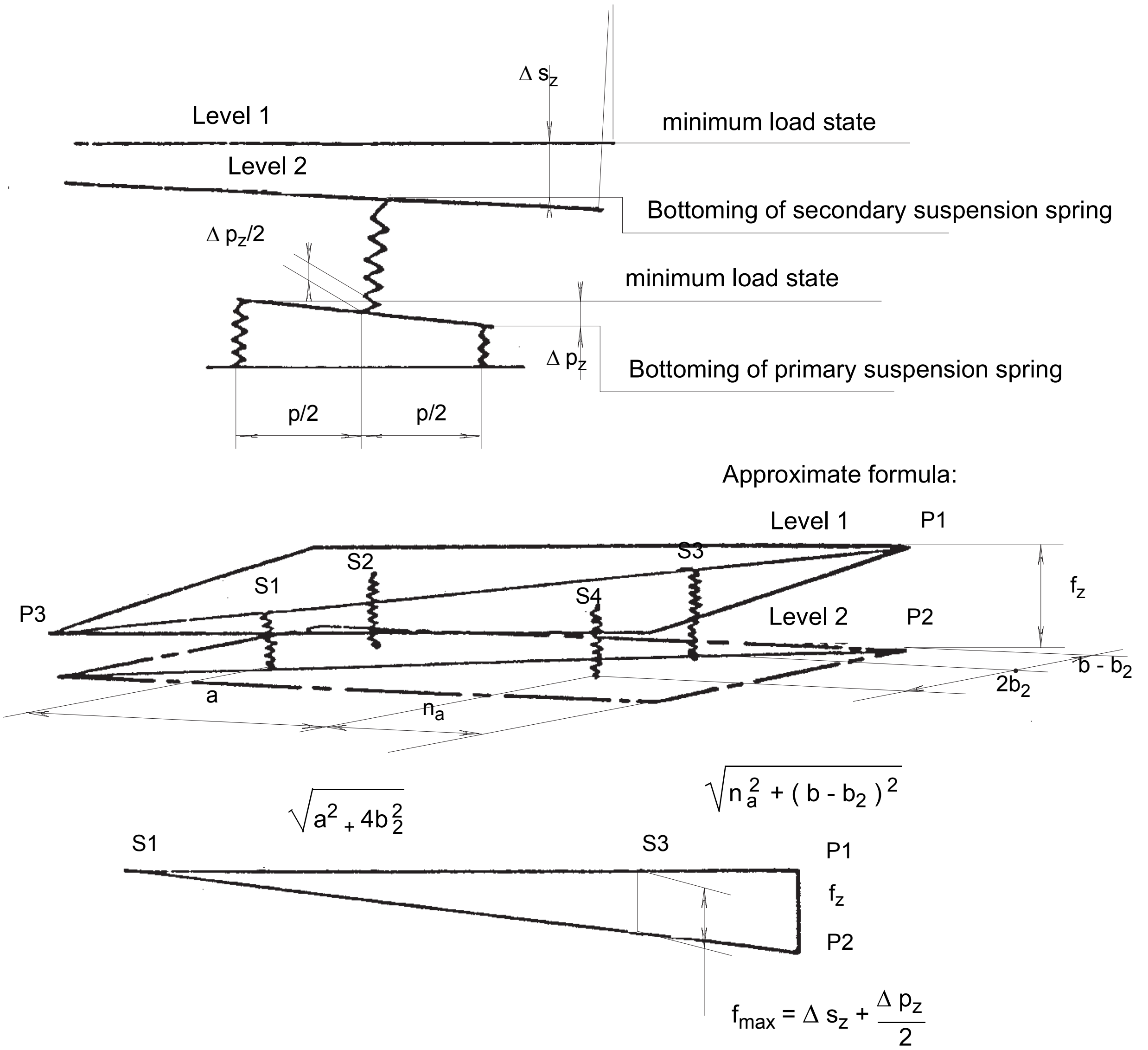


Fig. 18 - Deflection on single bogie or axle



$$f_z = (\Delta sz + \Delta pz/2)\left(1 + \frac{\sqrt{n_a^2 + (b - b_2)^2}}{\sqrt{a^2 + 4b_2^2}}\right)$$

Fig. 19 - Deflection of a primary suspension spring and a secondary suspension spring or deflated pneumatic suspension (calculation principle zone C) - Deflection in an initial approach

3.3.2 - Maximum heights of the upper parts of the vehicles

The value of vertical movements to be taken into consideration, as regards the upper parts of rolling stock where ($h \geq 3\ 250$ mm), is determined with account being taken of the upward dynamic movements for empty rolling stock in running order without wear.

In this part, the vehicles come close to the reference profile under the influence of:

1. upward oscillations;

2. the vertical component of the quasi-static inclination;

3. transverse movements.

Consequently, the vertical dimensions of the reference profile must be reduced by the values generated by these movements ξ ; if they can be calculated, or otherwise by a fixed value of 15 mm per suspension stage. Nevertheless, it must be noted that when the vehicle is subject to quasi-static inclination, the side opposite the inclination rises but at the same time moves away from the reference profile in such a way that no interference is to be feared. Conversely, on the side of the inclination, the vehicle lowers, thus compensating part of the upward movements.

As an approximation, for cant excess or deficiency of 50 mm, this vertical reduction $\Delta V(h)$ of the reference profile for nominal heights greater than h = 3,25 m is expressed as:

$$\Delta V(h) = \xi - \left\{ \frac{\left[\frac{1}{2} LCR(h) - E_{i\ or\ a}\right] s}{30} \right\}$$

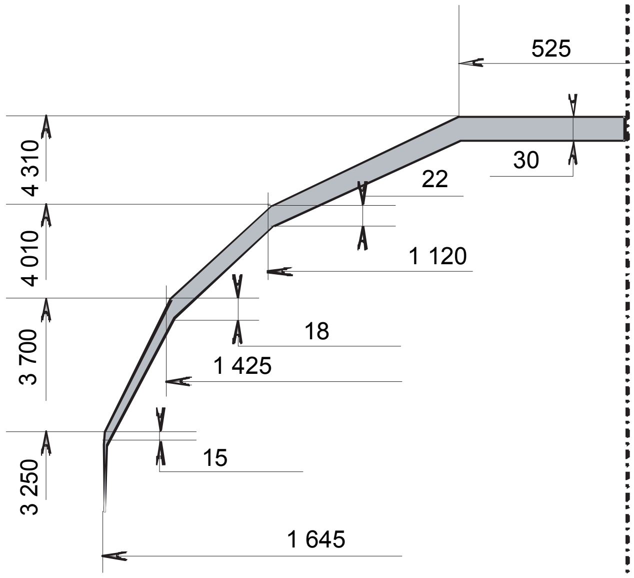
Where:

½ LCR(h)	:	represents the half-width of the reference profile,
E_i or E_a	:	the transverse reductions,
s	:	the vehicle's coefficient of flexibility,
ξ	:	the vehicle resilience (fixed or calculated term).

Example: for a vehicle with a reduction E_i or E_a of 217 mm based on h = 3,25 m, the following is obtained:

Vehicle with 2 suspension stages

s = 0,3; ξ = 30 mm



Vehicle with 1 suspension stage

s = 0,1; ξ = 15 mm

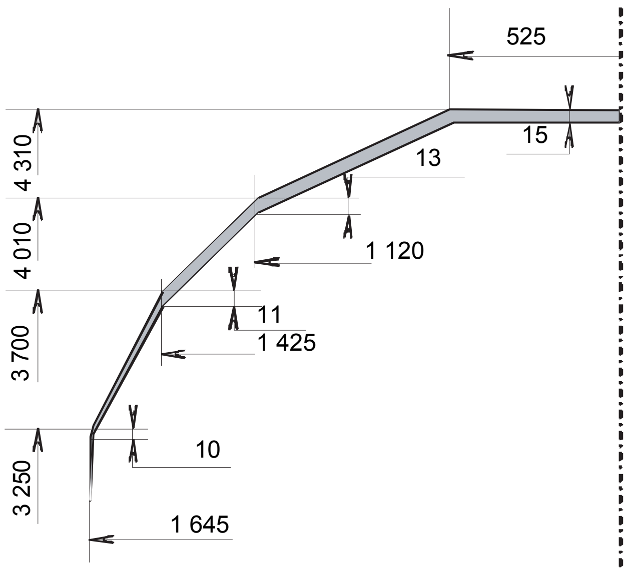


Fig. 20 - Reductions for cut-away sides on the upper part of the reference profile

4 - Calculation method for the dimensions of vehicles according to the OSJD static gauges

4.1 - Definitions

The symmetry axis of the reference contour is the orthogonal axe to the running surface, at equal distance from the rails, when the vehicle is centered in the track.

The half widths are determined from this symmetry axis and the heights from the running surface.

4.2 - Maximum half widths

The maximum admissible half widths of the vehicles are obtained by reducing the half widths of the respective reference contour with the values E_0, E_i or E_a which are calculated according to the following formulas:

Reduction value E_0 (n = 0) :

$$E_0 = 30 + q + w + (k_1 - k_3) - k \qquad \text{[mm]} \qquad \textbf{(21)}$$

Reduction value E_i ($n = n_i$) :

$$E_i = 30 + q + w + k_2(a - n)n + (k_1 - k_3) - k + \alpha \qquad \text{[mm]} \qquad \textbf{(22)}$$

Reduction value E_a ($n = n_a$) :

$$E_a = (30 + q + w)\frac{2n + a}{a} + k_2(a + n)n - (k_1 - k_3) - k + \beta \qquad \text{[mm]} \qquad \textbf{(23)}$$

NB: 30 = approached value.
For the exact calculation $\frac{l - d}{2} = 0{,}5\ (1\ 546 - d)$ must be used.

The values of k, k_1, k_2 and k_3 are taken from Table 6 - page 29.

4.3 - Values k, k_1, k_2 and k_3 for the static gauges

Table 6 : Values k, k_1, k_2 and k_3 for the static gauges

Coefficients	03-WM, 02-WM et 0-WM		1-WM	
	For heights ≥ 430 mm	**For heights < 430 mm**	**For heights ≥ 430 mm**	**For heights < 430 mm**
k, mm	75	25	0	25
k_1, mm	0,5 p^2	0,5 p^2	0,625 p^2	0,5 p^2
k_2, mm	2,0	2,0	2,5	2,0
k_3, mm	0	0	180	0

(p : in metres)

NB : For the points of the reference contour 1-WM, where the height ≥ 430 mm in the formulas **(21)** to **(23)**, the value ($k_1 - k_3$) is only taken into account if it is positive. If the value is negative, it is considered null.
α and β are additional reductions for very long vehicles.

The values α and β are determined with a curve radius of 150 m according to the following formulas:

1. For all the heights of the gauges 03-WM, 02-WM, 0-WM and also for the heights < 430 mm of gauge 1-WM:

$\alpha = 0$	when $(an - n^2 + 0,25\ p^2) \leq 100$
$\alpha = 1,333\ (an - n^2 + 0,25\ p^2 - 100)$	when $(an - n^2 + 0,25\ p^2) > 100$
$\beta = 0$	when $(an + n^2 - 0,25\ p^2) \leq 120$
$\beta = 1,333\ (an - n^2 - 0,25\ p^2 - 120)$	when $(an + n^2 - 0,25\ p^2) > 120$

2. For the heights ≥ 430 mm of gauge 1-WM :

$\alpha = 0$	when $(an - n^2 + 0,25\ p^2) \leq 72$
$\alpha = 0,833\ (an - n^2 + 0,25\ p^2 - 72)$	when $(an - n^2 + 0,25\ p^2) > 72$
$\beta = 0$	when $(an + n^2 - 0,25\ p^2) \leq 72$
$\beta = 0,833\ (an + n^2 - 0,25\ p^2 - 72)$	when $(an + n^2 - 0,25\ p^2) > 72$

For conventional wagons, the values α and β are null.

4.4 - Determination of the admissible vertical dimensions

The heights of the upper part of the static reference contour also correspond to the maximum admissible height for unloaded vehicles.

The minimal admissible heights for lower parts of vehicles are determined by adding the possible deflection to the vertical dimensions of the reference contour represented in Fig. 7 - page 8 and 9 - page 9. The deflections correspond to the maximum wear of the running gear, the bruising of the suspensions and bending of various parts.

This concerns conventional wagons for which the maximum vertical dynamic oscillations are not superior to 30 mm for heights ≥ 430 mm and to 15 mm for heights < 430 mm.

The maximum admissible vertical dimensions are determined based on new wheels with the maximum diameter and the minimum admissible vertical dimensions are determined based on the wheels at limit of wear.

The vertical dimensions of wagons are determined by taking into account the behaviour on gravity humps which have a vertical convex radius of 250 m.

4.5 - Lateral displacements and deflections

For new vehicles, all potential movements relating to construction characteristics of suspensions and running gear must be taken into account.

For vehicles which are analogous to existing vehicles in terms of construction or conditions of use, the values of the lateral displacements and deflections set out in Table 7 may be used.

Table 7 : Displacement value

Description of displacement	Vehicles without bogies	Vehicles with bogies	
		single suspension	double suspension
Possible lateral play q + w - of the body - of the bogie - of the axle box	 15-30 - 0	 5-25 5-20 0	 25-40 5 0
Possible deflections - of the body - of the bogie - of the axle box	 120-130 - 25-65	 55-90 55-60 25-60	 90-95 70-75 45-50

Appendix A - Symbols used in the calculation of the kinematic gauge

Symbol	Definition
a	Distance between the end axles of vehicles not fitted with bogies or between the pivots of bogie vehicles.
b_G	Half distance between the transoms.
d	The outer distance between the wheel flanges measured at a point 10 mm below the running treads, with the flanges worn to the permissible limit, the absolute limit being 1 410 mm. This limit may vary according to the maintenance criteria for the vehicle under consideration. This value is equal to 1 410 mm for every reference profile except for the upper part of reference profile 1-WM where this value is equal to 1 489 mm.
e_a	External vertical reduction at the lower part of vehicles (see Fig. 13 - page 20).
e_i	Internal vertical reduction at the lower part of vehicles (see Fig. 12 - page 19).
E_a	Reduction value for the reference profile half-width dimensions for the sections beyond the end axles of vehicles not mounted on bogies or the pivots of vehicles mounted on bogies.
E_i	Reduction value for the reference profile half-width dimensions for the sections located between the end axles of vehicles not mounted on bogies or between the pivots of vehicles mounted on bogies.
h	Height in relation to the running surface.
h_c	Height of the roll centre of the transverse cross-section of the vehicle in relation to the running surface.
ℓ	Track width of 1 435 mm in function of the tolerances maintenance. The value maximum of 1 465 mm is applies for all the gauges except the gauge 1-WM for whom the maximum value is 1 546 mm.
n	Distance of the section considered to the adjacent end axle or to the nearest pivot.
n_a	For the sections located outside the axles or bogie pivots.
n_i	For the sections located between the axles or bogie pivots.
η_0	Angle of vehicle asymmetry due to construction tolerances, to suspension adjustment and to uneven load distributions (in degrees).
p	Bogie wheel base.
q	Lateral play between axle and bogie frame or between axle and vehicle body in the case of axle vehicles.
R	Level curve radius.

s	Vehicle flexibility coefficient (Whenever a stationary vehicle is placed on a canted track whose running surface lies at an angle δ to the horizontal, its body leans on its suspensions and forms an angle η with the perpendicular to the rail level. The vehicle flexibility coefficient s is defined by the ratio: $s = \frac{\eta}{\delta}$).
w	Lateral play between bogie and vehicle body.
$w_{a,R}$	Lateral play between the bogie and vehicle body on the outside of an R radius curve.
$w_{i,R}$	Lateral play between the bogie and vehicle body on the inside of an R radius curve.
w_∞	Lateral play between the bogie and the vehicle body on straight track.
x_a	Additional reduction for extra-long vehicles for the sections beyond the bogie pivots. This term terminates the domain of application between the radiuses of curve of 250 and 150 m. x_a only applies if $$an_a + n_a^2 - \frac{p^2}{4} > 120 \text{ (exceptional case)}$$
x_i	Additional reduction for extra-long vehicles between the bogie pivots. This term terminates the domain of application between the radiuses of curve of 250 and 150 m. x_i only applies if $$\frac{a^2 + p^2}{4} > 100$$ an approximate value for a of 20 m.
z	Deviation in relation to the median position due to quasi-static inclination and to dissymetry. Term concerning the inclination due to the suspension (lateral movement due to the flexibility of the suspension, under the influence of cant excess or deficiency of 0.05 m). $$\frac{s}{30}(h - h_c)$$ Term concerning the asymmetry, (lateral movement due to that part of the asymmetry exceeding 1°). $$\tan[\eta_0 - 1°]_{>0}\lvert h - h_c\rvert$$ This sum may be increased by: $$\left[\frac{s}{10}\lvert h - h_c\rvert - 0{,}04[h - 0{,}5]_{>0}\right]_{>0}$$ Term integrating cant excess or deficiency of 0,2 m.

	For sprung parts located at height h, the above terms give, in the formulas, a value of: $$z = \left[\frac{s}{30} + \tan[\eta_0 - 1^\circ]_{>0}\right]\lvert h - h_c\rvert + \left[\frac{s}{10}\lvert h - h_c\rvert - 0{,}04[h - 0{,}5]_{>0}\right]_{>0}$$ Term z taking account of transom play greater than 5 mm becomes: $$z = \left\{\frac{s}{30} + \tan\left[\eta_0 + \left(\arctan\frac{(J - 0{,}005)_{>0}}{b_G}\right)(1 + s) - 1^\circ\right]_{>0}\right\}\lvert h - h_c\rvert + + \left[\frac{s}{10}\lvert h - h_c\rvert - 0{,}04[h - 0{,}5]_{>0}\right]_{>0}$$ Special case: when: $h > h_c$ and 0,5 m $s \leq 0{,}4$ $\eta_0 \leq 1^\circ$ $$z = \frac{s}{30}(h - h_c)$$ when: $h < 0{,}5$ m $\eta_0 \leq 1^\circ$ and for any value of h_c and s $$z = \frac{4s}{30}\lvert h_c - h\rvert$$ when: $h = h_c$ $z = 0$ For unsprung parts, z = 0.

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UIC Leaflet 505-5: Basic conditions common to Leaflets 505-1 and 505-4 - Notes on the preparation and provisions of these leaflets, 2nd edition of 1.1.77 and 4 Amendments

UIC Leaflet 506: Rules governing application of the enlarged GA, GB and GC gauges, 1st edition of 1.1.87 and 4 Amendments

UIC Leaflet 507: Wagons - Conditions governing wagons conveyed on ferries, 1st edition of 1.7.89 - Reprint dated 1.7.97

UIC Leaflet 522: Technical conditions to be fulfilled by the automatic coupler of the UIC and OSJD Member Railways, 4th edition of 1.1.90

UIC Leaflet 569: Regulations to be observed in the construction of coaches and vans suitable for conveyance by train ferry, 2nd edition of 1.7.79 and 2 Amendments

2. Miscellaneous

Organization for the collaboration between Railways (OSJD)
OSJD Leaflet 500-4: Kinematic rolling stock construction gauges based on the static gauges 1-WM and 2-WM of members of OSJD,

OSJD Leaflet 500: Rolling stock construction gauges and obstacle gauges, 4th edition of 22.11.96

Warning

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