
**Commercial road vehicles — Coupling
equipment between vehicles in
multiple vehicle combinations —
Strength requirements**

*Véhicules routiers utilitaires — Équipement de couplage entre
véhicules dans des combinaisons de véhicules multiples — Exigences
de résistance*





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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 15, *Interchangeability of components of commercial vehicles and buses*.

Introduction

This International Standard specifies general requirements and definitions to secure the safe operation of mechanical couplings between individual vehicles in a multiple-vehicle combination.

The expanded application of multiple-vehicle combinations brings new perspectives and needs into the area of trailer couplings. This has made evident the need for a consolidated method to handle the dimensioning of mechanical couplings applied in multiple-vehicle combinations. This International Standard is meant to facilitate the interaction between International Standards and relevant regulations.

The drivers for the introduction of this International Standard are

- the development of the European modular system making multiple-vehicle combinations (road trains) more of a global application, and
- the lack of rules for the dimensions of couplings used together with converter dolly. Those applications are already very common on the roads today.

The limited number of types of multiple-vehicle combinations addressed in this International Standard is the result of a voting process among the nations. Other types may be added in later editions as experience is gained.

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Commercial road vehicles — Coupling equipment between vehicles in multiple vehicle combinations — Strength requirements

1 Scope

This International Standard defines different multiple-vehicle combinations (vehicle combinations with more than one coupling point) and the formulae to calculate the requirement of performance for the coupling equipment used in those vehicle combinations. Vehicle categories concerned are N2, N3, O3, and O4.

NOTE For these vehicle combinations, the formulae in this International Standard override the formulae in References [6], [7], [8], and [9] that apply to vehicle combinations with one coupling point only. However, the capability of the coupling equipment is still determined through tests as defined in References [6], [7], [8], and [9].

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1

centre-axle trailer (CAT)

trailer where the axle(s) is(are) positioned close to the centre of gravity of the trailer such that (when uniformly loaded) only a small static vertical load, not exceeding 10 % of the load corresponding to the maximum design total mass of the trailer or 1 000 daN (whichever is less), is transmitted to the towing vehicle

2.2

converter dolly

towed vehicle with one axle group or single axle and a fifth wheel coupling, designed to be combined with a semi-trailer

Note 1 to entry: In cases where the drawbar of the converter dolly is hinged, the combination of a converter dolly and a semi-trailer is equivalent to a full trailer.

Note 2 to entry: The drawbar of a converter dolly may be rigid or hinged. A hinged drawbar is free to pivot around an axle that is perpendicular to the vertical plane.

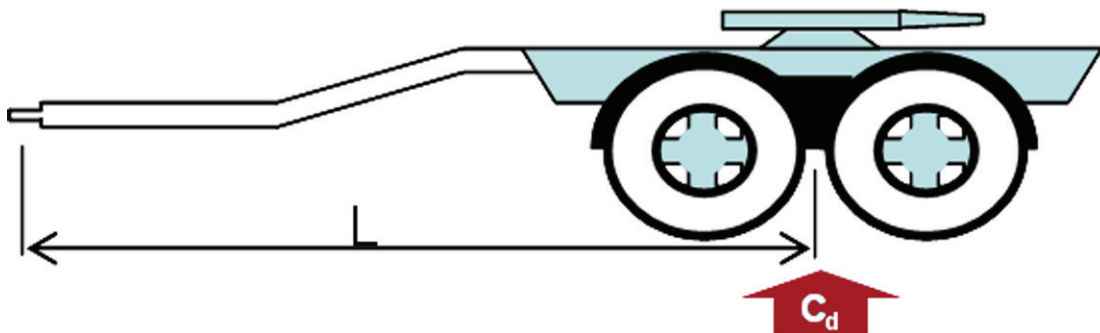


Figure 1 — Converter dolly

2.3

drawbar trailer

trailer having at least two axles, of which at least one is a steered axle, equipped with a towing device (drawbar) which can move vertically (in relation to the trailer) and that transmits less than 100 daN as a static vertical load to the towing vehicle

2.4

semi-trailer

trailer which is designed and constructed to be by means of a kingpin coupled to a tractor unit or to a converter dolly and that impose a substantial vertical load on the towing vehicle

2.5

A-trailer

semi-trailer in a multiple-vehicle combination that is towed on a converter dolly

2.6

link-trailer (or B-trailer)

semi-trailer with a fifth wheel mounted at the rear such that a semi-trailer could be towed by the link-trailer

2.7

tractor

motor vehicle built to tow a semi-trailer

2.8

truck

motor vehicle built to tow a full trailer or a centre-axle trailer

3 Symbols¹⁾

3.1

S

mass imposed vertically on the coupling under static conditions by the CAT loaded to its maximum design total mass

3.2

T

technically permissible maximum total mass, in tonnes, of the towing vehicle including, as applicable, the vertical static load, *S*, of a CAT or the vertical static load, *U*, imposed by a semi-trailer

3.3

R

technically permissible maximum total mass, in tonnes, of the full trailer (with drawbar free to move in the vertical plane) or of the semi-trailer

3.4

C

mass, in tonnes, transmitted to the ground by the axle(s) of the CAT loaded to its maximum total design mass

3.5

***U* (*U_T*, *U_d*, *U_b*)**

mass, in tonnes, imposed vertically on the fifth wheel of a tractor (*U_T*), a converter dolly (*U_d*), or a B-trailer (*U_b*) by the semi-trailer loaded to its maximum total design mass

Note 1 to entry: The total mass of a semi-trailer (*R*) is divided into two parts for the calculation: the front part (*U_x*) and the rear part (*R_b*) giving the bogey mass.

3.6

W_d

tare mass, in tonnes, of a converter dolly

3.7

g

acceleration due to gravity (assumed as 9,81 m/s²)

1) The symbols defined below are in line with those used in UNECE R55.

3.8***a***

equivalent vertical acceleration in the coupling point, dependent on the kind of suspension on the rear axle(s) of the towing vehicle including a constant factor

3.8.1***a*₁**

1,8 m/s² for vehicles with air suspension or equivalent

3.8.2***a*₂**

2,4 m/s² for vehicles with other suspension

3.9***X* (*X*_{*i*})**

length, in metres, of the loading area of the centre-axle trailer

3.10***L* (*L*_{*i*})**

theoretical drawbar length, in metres, i.e. the distance between the centre of the drawbar eye and the centre of the axle assembly of the centre-axle trailer

3.11***t*_{*i*}**

distance, in meter, from the centre of axles of a centre-axle trailer to its rear coupling point

3.12***R*_{*b*}**

mass, in tonnes, transmitted to the ground by the axle(s) of the semi-trailer loaded to its maximum total design mass

3.13***C*_{*d*}**

mass, in tonnes, transmitted to the ground by the axle(s) of the converter dolly including *U_d*

3.14***D* (*D*_{*c*})**

D-value is a comparative value determined by calculating for the longitudinal forces occurring between a towing vehicle and a trailer

Note 1 to entry: *D*, expressed in kilonewtons.

Note 2 to entry: For applications where a drawbar coupling is subject to vertical forces, the related *D*-value is designated *D_c*. Defined by the formulae given in the tables of [5.2.2](#).

3.15***V***

V-value is a comparative value determined by calculating for the vertical forces occurring between a towing vehicle and a centre-axle trailer

Note 1 to entry: Defined by the formulae given in the tables of [5.2.2](#).

3.16***A* and *B***

parameters used in the calculations.

Note 1 to entry: “*A*” is the total mass forward of the coupling point.

Note 2 to entry: “*B*” is the total mass behind the coupling point.

Note 3 to entry: Their detailed definitions as sum of masses are given in the tables of [5.2.2](#).

4 ISO vehicle combinations definition

4.1 ISO vehicle combination 1

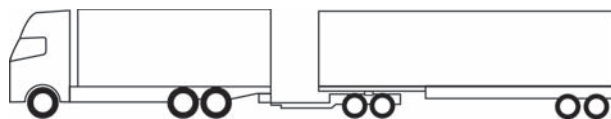


Figure 2 — truck + dolly + A-semi

4.2 ISO vehicle combination 2



Figure 3 — tractor + A-semi + centre-axle trailer

4.3 ISO vehicle combination 3

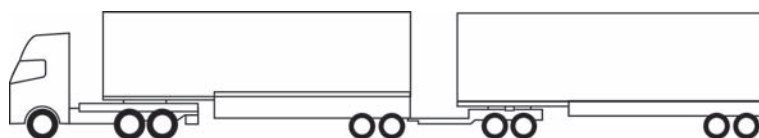


Figure 4 — tractor + A-semi + dolly + A-semi

4.4 ISO vehicle combination 4

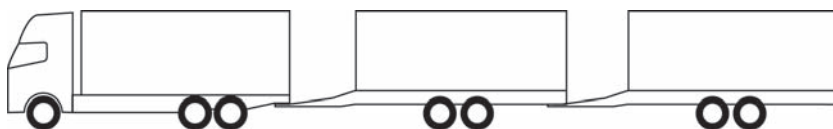


Figure 5 — truck + centre-axle trailer + centre-axle trailer

4.5 ISO vehicle combination 5

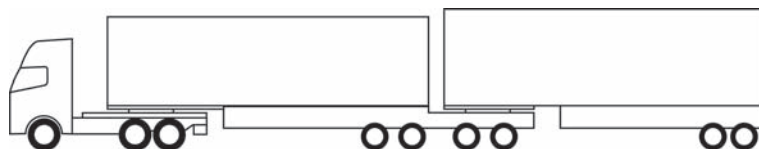


Figure 6 — tractor + link-trailer + A-semi (B-train)

5 General requirements

5.1 Vehicle combination handling

A prerequisite for the coupling performance requirements of this International Standard is that the overall design of the vehicle combinations are such that handling and ride stability can be guaranteed.

5.2 Determination of minimum coupling equipment performance capability required for a specific vehicle combination

The minimum required performance capability in terms of D -values and V -values is determined by calculation in accordance with the formulae provided in the tables in 5.2.2.

The minimum performance capability required at each coupling point shall be calculated individually. The highest performance capability value determined for each type of coupling shall apply throughout the whole vehicle combination.

The calculated D -value and V -value requirements for CAT shall be evaluated against the D_c and V -value performance capability of the coupling equipment applied.

5.2.1 Determination of (calculated) D -value performance requirement

The formulae given in the tables of 5.2.2 are applicable to determine the performance capability requirement for

- a) all types of coupling equipment:
 - drawbar couplings, drawbar eyes;
 - fifth wheels, and king pins;
- b) all types of towing and towed vehicles:
 - rigid truck, tractor, converter dolly, CAT, semi-trailer, link-trailer, and full trailers.

5.2.2 D -value and V -value formulae per ISO vehicle combination

$$\frac{X_i^2}{L_i^2} \geq 1 \quad (1)$$

Where the result is a value less than 1,0, the value shall be at least 1.

5.2.2.1 ISO Combination 1: truck + dolly + A-semi

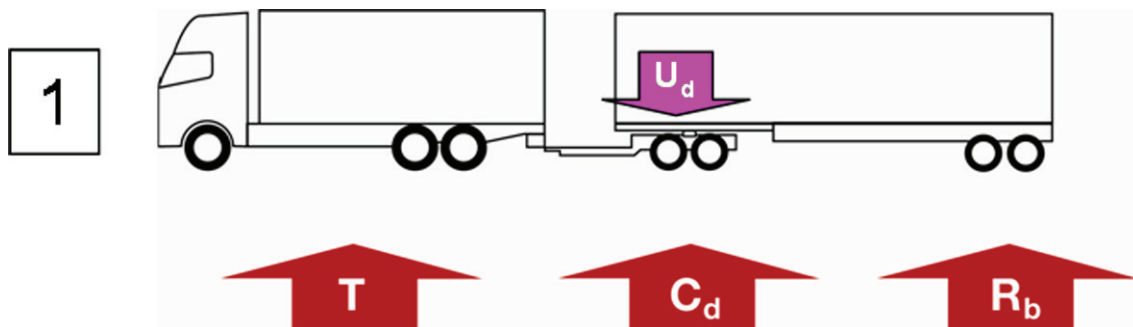


Figure 7 — ISO combination 1

Dolly tare mass = W_d Dolly drawbar length = L ; $U_d = C_d - W_d$; $S_{max} = 1\,000$ kg

Step 1: Evaluate parameter *A* and *B*

Step 2: Calculate *D* and *V* using *A* and *B*

Couplings	<i>A</i> =	<i>B</i> =		<i>D</i> ^b	<i>V</i> ^a
Drawbar coupling	<i>T</i>	<i>C_d</i> + <i>R_b</i>	<i>A</i> ; <i>B</i> =>	$D = g \frac{AB}{A+B}$	$V = \text{Max}(\frac{54}{L}; 5 \frac{C_d}{L})$
Fifth wheel dolly	<i>T</i> + <i>W_d</i>	<i>U_d</i> + <i>R_b</i>	<i>A</i> ; <i>B</i> =>	$D = 0,5g \frac{A(B+0,08A)}{A+B-U_d}$	N/A

^a Applicable to dollies with a rigid drawbar.
^b For dollies with a rigid drawbar, the *D_c*-rating shall exceed this calculated *D*-value.

5.2.2.2 ISO combination 2: tractor + A-semi + centre-axle trailer

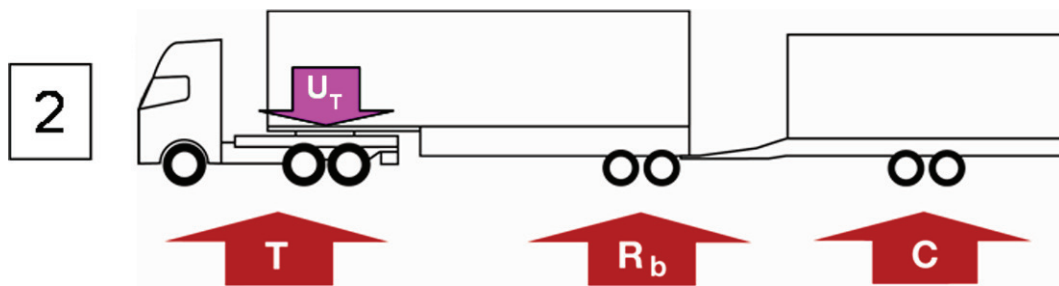


Figure 8 — ISO combination 2

CAT coupling support load = *S_{max}* = 1 000 kg; CAT drawbar length = *L*; CAT loaded length = *X*

Step 1: Evaluate parameter *A* and *B*

Step 2: Calculate *D* and *V* using *A* and *B*

Couplings	<i>A</i> =	<i>B</i> =		<i>D</i> ^a	<i>V</i>
Drawbar coupling	<i>T</i> + <i>R_b</i>	<i>C</i>	<i>A</i> ; <i>B</i> =>	$D = 0,65g \frac{AB}{A+B}$	$V = a \frac{X^2}{L^2} C$
Fifth wheel tractor	<i>T</i>	<i>U_T</i> + <i>R_b</i> + <i>C</i>	<i>A</i> ; <i>B</i> =>	$D = 0,5g \frac{B(A+0,08B)}{A+B-U_T}$	N/A

^a The *D_c*-rating of the drawbar coupling equipment shall exceed this calculated *D*-value.

5.2.2.3 ISO combination 3: tractor + A-semi + dolly + A-semi

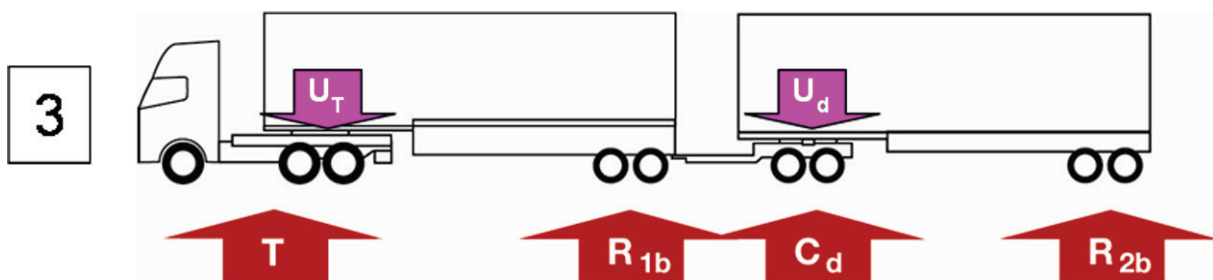


Figure 9 — ISO combination 3

Dolly tare mass = *W_d* Dolly drawbar length = *L*; *U_d* = *C_d* · *W_d*; *S_{max}* = 1 000 kg

Step 1: Evaluate parameter *A* and *B*

Step 2: Calculate *D* and *V* using *A* and *B*

Couplings	<i>A</i> =	<i>B</i> =		<i>D</i> ^b	<i>V</i> ^a
Drawbar coupling	<i>T</i> + <i>R</i> _{1b}	<i>C</i> _d + <i>R</i> _{2b}	<i>A</i> ; <i>B</i> =>	$D = 0,65g \frac{AB}{A+B}$	$V = \text{Max}\left(\frac{54}{L}; 5 \frac{C_d}{L}\right)$
Fifth wheel dolly	<i>T</i> + <i>R</i> _{1b} + <i>W</i> _d	<i>U</i> _d + <i>R</i> _{2b}		$D_1 = 0,5g \frac{A(B+0,08A)}{A+B-U_d}$	N/A
Fifth wheel tractor	<i>T</i>	<i>U</i> _T + <i>R</i> _{1b} + <i>C</i> _d + <i>R</i> _{2b}	<i>A</i> ; <i>B</i> =>	$D_2 = 0,5g \frac{B(A+0,08B)}{A+B-U_T}$	N/A
Required fifth wheel coupling				<i>Max</i> (<i>D</i> ₁ ; <i>D</i> ₂)	N/A

^a Applicable to dollies with a rigid drawbar.
^b For dollies with a rigid drawbar, the *D_c*-rating shall exceed this calculated *D*-value.

5.2.2.4 ISO combination 4: truck + centre-axle trailer+ centre-axle trailer

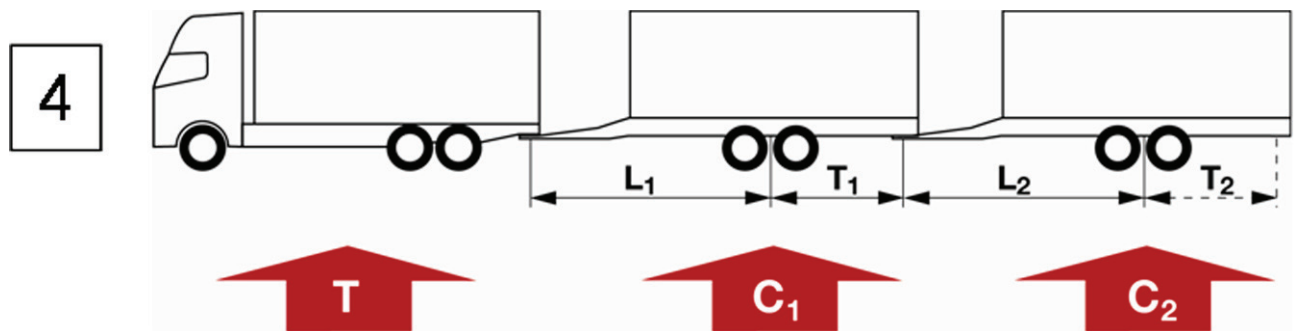


Figure 10 — ISO combination 4

CAT coupling support load = *S*_{max} = 1 000 kg; CAT drawbar length = *L*; CAT loaded length = *X*

Step 1: Evaluate parameter *A* and *B*

Step 2: Calculate *D* and *V* using *A* and *B*

Couplings	<i>A</i> =	<i>B</i> =		<i>D</i> ^a	<i>V</i>
First drawbar coupling	<i>T</i>	<i>C</i> ₁ + <i>C</i> ₂	<i>A</i> ; <i>B</i> =>	$D_1 = 0,9g \frac{AB}{A+B}$	$V_1 = \sqrt{\left(\frac{X_1^2}{a \frac{L_1}{2}} C_1\right)^2 + \left(\frac{t_1}{L_1} V_2\right)^2}$
Second drawbar coupling	<i>T</i> + <i>C</i> ₁	<i>C</i> ₂		$\left[D_2 = 0,65g \frac{AB}{A+B} \right]$	$V_2 = a \frac{X_2^2}{L_2^2} C_2$
Required drawbar coupling				<i>D</i> ₁	<i>V</i> ₁

^a The *D_c*-rating of the drawbar coupling equipment shall exceed this calculated *D*-value.

5.2.2.5 ISO combination 5: tractor + link-trailer + A-semi (B-train)

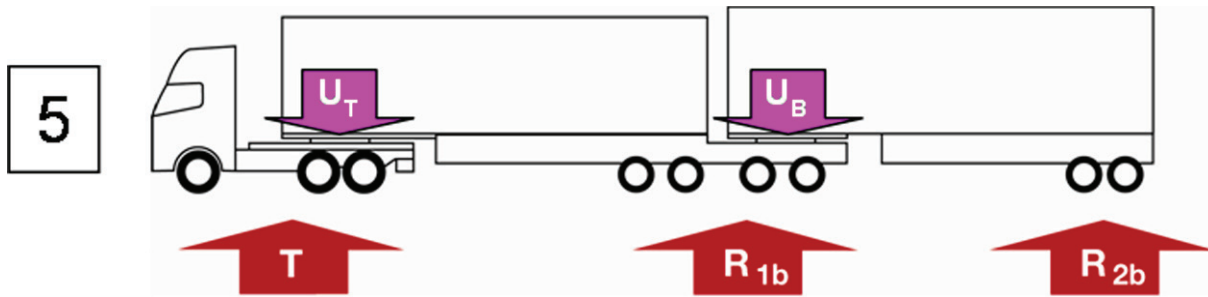


Figure 11 — ISO combination 5

Step 1: Evaluate parameter *A* and *B*

Step 2: Calculate *D* and *V* using *A* and *B*

Couplings	<i>A</i> =	<i>B</i> =		<i>D</i>	<i>V</i>
Fifth wheel B-train	<i>T</i>	$U_T + R_{1b} + R_{2b}$	<i>A</i> ; <i>B</i> =>	$D = 0,5g \frac{B(A + 0,08B)}{A + B - U_T}$	N/A

6 Worked numerical examples

6.1 ISO combination 1: truck + dolly + A-semi (numerical example)

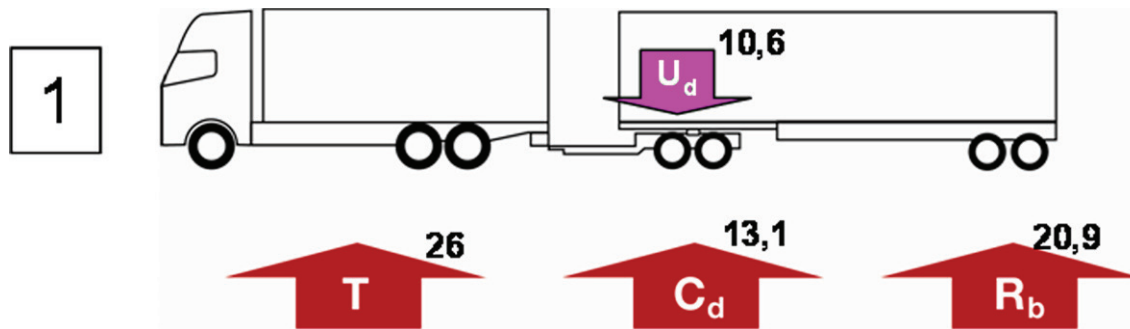


Figure 12 — Example, ISO combination 1

$W_d = 2,5$ tonnes; $L = 3$ m; $U_d = 10,6$ tonnes; $S_{max} = 1\ 000$ kg

Couplings	<i>A</i>	<i>B</i>		<i>D</i> ^a	<i>V</i>
Drawbar coupling	26	34		145	22
Fifth wheel dolly	28,5	31,5		96	N/A

^a For dollies with a rigid drawbar, the *D_C*-rating shall exceed this calculated *D*-value.

6.2 ISO combination 2: tractor + A-semi + centre-axle trailer (numerical example)

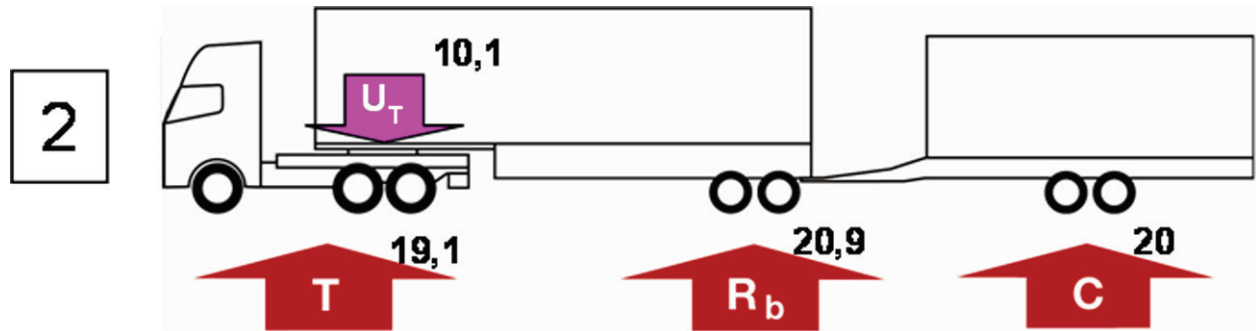


Figure 13 — Example, ISO combination 2

$S_{max} = 1\ 000\text{ kg}$; $L = 5,5\text{ m}$; $X = 7\text{ m}$; $a = 1,8\text{ m/s}^2$

Couplings	A	B		D^a	V
Drawbar coupling	40	20		86	59
Fifth wheel tractor	19,1	51		97	N/A

^a The D_c -rating of the drawbar coupling equipment shall exceed this calculated D -value.

6.3 ISO combination 3: tractor + A-semi + dolly + A-semi (numerical example)

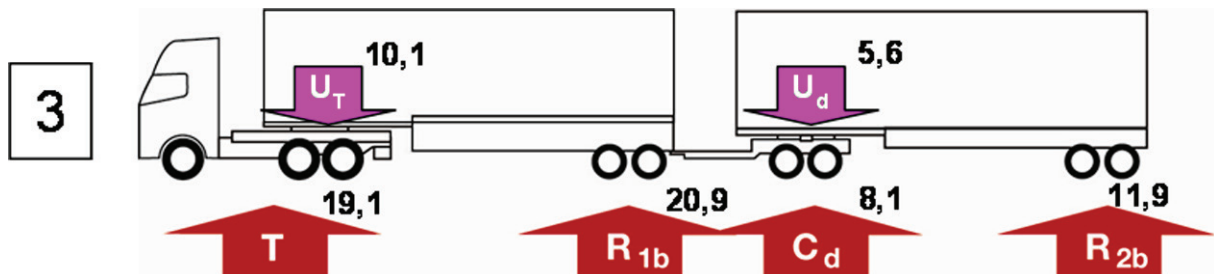


Figure 14 — Example, ISO combination 3

$W_d = 2,5\text{ tonnes}$; $L = 3\text{ m}$; $U_d = 5,6\text{ tonnes}$; $S_{max} = 1\ 000\text{ kg}$

Couplings	A	B		D^a	V
Drawbar coupling	40	20		86	18
Fifth wheel dolly	42,5	17,5		81	N/A
Fifth wheel tractor	19,1	51		97	N/A
Required fifth wheel coupling				97	N/A

^a For dollies with a rigid drawbar, the D_c -rating shall exceed this calculated D -value.

6.4 ISO combination 4: truck + centre-axle trailer + centre-axle trailer (numerical example)

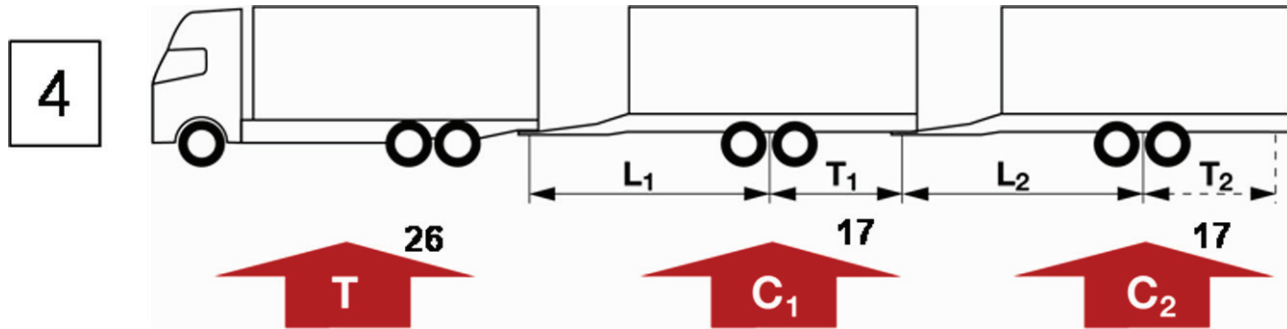


Figure 15 — Example, ISO combination 4

$S_{max} = 1\ 000\text{ kg}$; $L = 5,5\text{ m}$; $X = 7\text{ m}$; $t_1 = 1,8\text{ m}$; $a = 1,8\text{ m/s}^2$

Couplings	A	B		D^a	V
First drawbar coupling	26	34		131	50
Second drawbar coupling	43	17		78	50
Required drawbar coupling				131	50

^a The D_C -rating of the drawbar coupling equipment shall exceed this calculated D -value.

6.5 ISO combination 5: tractor + link-trailer + A-semi (B-train) (numerical example)

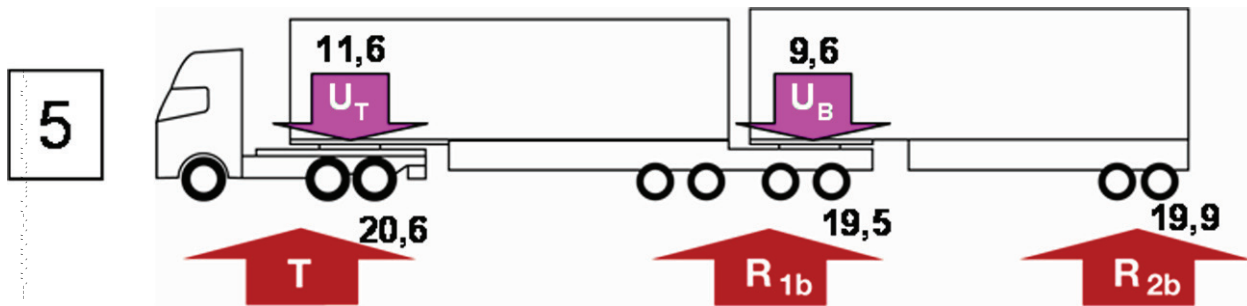


Figure 16— Example, ISO combination 5

Couplings	A	B		D	V
Fifth wheel B-train	20,6	51		103	N/A

Bibliography

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