

Correlations - for information only, no guarantee of information correctness

Quote from German ZTVE- STB 94, Research Institute for Road and Traffic (2005 addition)

3.4.7.2 Requirements for deflection modulus

The information provided below is based on the 10% minimum quantile.

When constructing roads of Construction Classes SV and I to IV on frost-protected substrate or substructure, the following deflection modulus of at least

$$E_{v2} = 120 \text{ MN/m}^2 \text{ or alternatively } E_{vd} = 65 \text{ MN/m}^2$$

and for Construction Classes V and VI a deflection modulus of at least

$$E_{v2} = 100 \text{ MN/m}^2 \text{ or alternatively } E_{vd} = 50 \text{ MN/m}^2$$

$E_{v2} = 100 \text{ MN/m}^2$ or alternatively $E_{vd} = 50 \text{ MN/m}^2$ is necessary.

The deflection modulus E_{v2} is to be verified in accordance with a static plate load test in accordance with DIN 18134 and the deflection module E_{vd} with a dynamic plate load test in accordance with TPBF Part B8.3.

Once these requirements have been able to be fulfilled by compaction of the layers to be constructed above the formation, it is sufficient to achieve a deflection modulus of at least

$$E_{v2} = 100 \text{ MN/m}^2 \text{ or alternatively } E_{vd} = 50 \text{ MN/m}^2$$

and for Construction Classes V and VI a deflection modulus of at least

$$E_{v2} = 80 \text{ MN/m}^2 \text{ or alternatively } E_{vd} = 40 \text{ MN/m}^2$$

in the case of Construction Classes SV and I to IV through the use of separate verification.

In the case of frost-sensitive substrate or substructure, a deflection modulus of at least

$$E_{v2} = 45 \text{ MN/m}^2 \text{ or alternatively } E_{vd} = 25 \text{ MN/m}^2$$

$E_{v2} = 100 \text{ MN/m}^2$ or alternatively $E_{vd} = 50 \text{ MN/m}^2$ is necessary.

is required on the formation. If the specifications do not specify whether the static or dynamic deflection modulus must be verified for cases stated in this section, verification should always take place using the static deflection modulus.

As an alternative, calibration of the dynamic deflection modulus on the static deflection modulus in accordance with TPBF Part E4 can take place, and then the dynamic deflection modulus can be used as a requirement.

If the required deflection modulus cannot be achieved on the formation through compaction, either

- (1) *the substrate or substructure must be improved or consolidated, or*
- (2) *the thickness of the loose base courses must be increased.*

These measures must be stated in the specifications.

Section 14.2.5:

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Table 8: Guide value for correlation of static deflection modulus E_{v2} or dynamic deflection modulus E_{vd} to compaction ratio D_{pr} for course-grained soils groups

Soils group	Static deflection modulus E_{v2} in MN/m^2	Dynamic deflection modulus E_{vd} in MN/m^2	Compaction ratio D_{pr} in %
GW, GI	≥ 120	≥ 65	≥ 103
	≥ 100	≥ 50	≥ 100
	≥ 80	≥ 40	≥ 98
	≥ 70	≥ 30	≥ 97
GE, SE, SW, SI	≥ 80	≥ 50	≥ 100
	≥ 70	≥ 40	≥ 98
	≥ 60	≥ 35	≥ 97

Quote from Directive 836: "Earthworks Design, Construction and Maintenance" (Ril 836)" Deutsche Bahn AG (German Rail), (20.12.1999 a)

836.0501
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Ril 836 - "Earthworks Design, Construction and Maintenance"
Principles

Fig. 2 Normal requirements for the construction of rail tracks on soil bodies

1	Route type		Formation		Capping layer					Soil formation		Standard cross-section			
	Route category ¹⁾	Superstructure	E _{v2} [MN/m ²]	E _{vd} ²⁾ [MN/m ²]	Grain mixture	D _{pr} (-)	Standard thickness [cm]			E _{v2} [MN/m ²]	E _{vd} ²⁾ [MN/m ²]	in accordance with Appendix 1, Fig.			
							Frost effect area					Embankment	Cutting		
2	3	4	5	6	7	I	II	III	8	9	10	11	12	13	14
New construction	P 300	Ballast top layer	120	50	kg1/2	1,00	70	70	70	80	40/35	a 1.1	a 1.3		
		Solid track	120	50	kg2	1,00	³⁾ 40	³⁾ 40	³⁾ 40	60	35/30	a 1.2	a 1.4		
	P 230 M 230	Ballast top layer	120	50	kg1/2	1,00	50	60	70	60	40/35	a 1.9	a 1.7		
		Solid track	120	50	kg2	1,00	³⁾ 40	³⁾ 40	³⁾ 40	60	35/30	a 1.6	a 1.8		
	P 160, M 160 G 120, R 120	Ballast top layer	100	45	kg1/2	1,00	40	50	60	45	35/30	a 1.9	a 1.10		
R 80, G 50 other tracks	Ballast top layer	80	40	(KG 1/2) ⁴⁾	1,00	30	40	50	45	30/25	A 1.11	A 1.12			
Strengthening ⁵⁾ /Maintenance	P 230 M 230	Ballast top layer	80	40	kg1/2	1,00	30	40	50	45	30/25	A 1.13	A 1.13		
		Solid track	100	45	kg2	1,00	³⁾ 40	³⁾ 40	³⁾ 40	45	30/25	A 1.14	A 1.14		
	P 160, M 160 G 120, R 120	Ballast top layer	50	35	kg1/2	1,00	20	25	30	30	25/20	A 1.15	A 1.15		
	R 80, G 50 other tracks	Ballast top layer	40	30	(KG 1/2) ⁴⁾	0,97	20	20	20	20	25/20	A 1.16	A 1.16		

1) Route categories in accordance with module 413.0202

- P 300 High-speed transport routes 300 km/h
- P 230 Passenger transport routes (ABS)230 km/h
- M230 Mixed transport routes (ABS)230 km/h
- P 160 Passenger transport routes (I+II)160 km/h
- M160 Mixed transport routes 160 km/h
- G 120 Goods transport routes 120 km/h
- R 120 Regional transport routes 120 km/h
- R 80 Regional transport routes 80 km/h
- G 50 Goods transport routes 50 km/h

2) Dynamic deflection modulus: Application conditions see Section 6; para. 5

- on soil formation: 1. Value for coarse-grained soils
- 2. Value for mixed and fine-grained soils

- 3) This thickness assumes a hydraulically-bonded based course underneath the solid track of at least 30 cm thickness
- 4) Also coarse-grained soils GW, GI, SW and SI; see Modul 836.0503, Section 3
- 5) If the route is being overhauled for high-speed transport, new construction criteria apply

Quote from Construction Material and Soil Engineering Institute, Wetzlar

Backfilling of trenches

Verification of compaction with
light drop weight tester
in accordance with TP BF-StB Part 8.3

Indicators for the allocation of

Compaction ratio D_{pr}
Dynamic deflection modulus E_{vd}

	Required compaction at various depths (ZTVT-StB 95*) (ZTVE-StB 94)	Based on guide values for allocation to D_{pr} (ZTVE-StB 94 Tab. 8)	1) Proposal for allocation of E_{vd} to E_{v2} (in acc. w. FGSV AA Prüftechnik, Oct. 96 edition)
Soils group	Compaction ratio D_{pr}	Deflection modulus E_{v2}	Deflection modulus E_{v2}
DIN 18 196	%	MN/m ²	MN/m ²
GW, GI (e.g. stony soil or mineral aggregate 0/32)	≥ 103	≥ 120	≥ 60
	≥ 100	≥ 100	≥ 50
	≥ 98	≥ 80	≥ 40
	≥ 97	≥ 70	≥ 35
GE, SE, SW, SI	≥ 100	≥ 80	≥ 40
	≥ 98	≥ 70	≥ 35
	≥ 97	≥ 60	≥ 32
mixed and fine-grained soils	≥ 100	≥ 45	≥ 25
	≥ 97	≥ 30	≥ 15
	≥ 95	≥ 20	≥ 10

1) These indicator values can be used as guide values for the verification of the compaction achieved in acc. w ZTVE-StB 94, para. 14.2.5 as agreed between client and contractor.