

FERRMED FREIGHT LOCOMOTIVE CONCEPT

by

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FERRMED

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Promotion du Grand Axe Ferroviaire de marchandises
Scandinavie-Rhin-Rhône-Méditerranée Occidentale A.S.B.L

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Technical parameters required to haul “FERRMED trains”: 1.500m and 3.600 – 5.000 tons

- Maximum admissible train gross weight with current European locomotives
- Starting tractive effort required to haul “FERRMED trains”
- Power required to haul “FERRMED trains” at defined speed
- Conclusions

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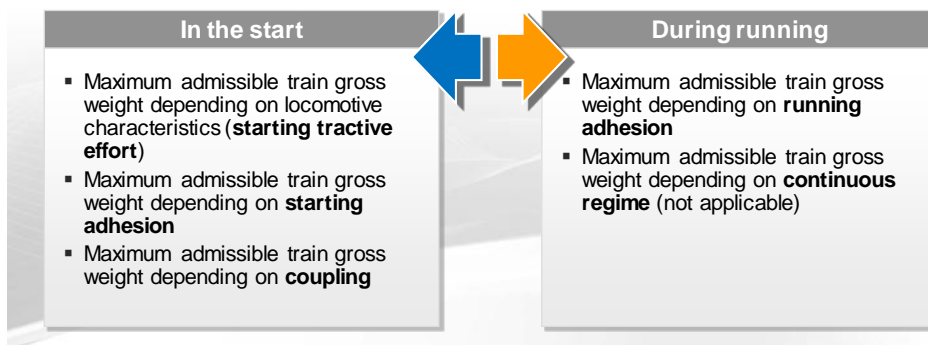


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Maximum admissible train gross weight

It is calculated as the minimum of following value:



Maximum train gross weight that can be started - depending on the starting tractive effort

Locomotive type	Loco weight	Starting tractive effort	Slopes	Maximum train gross weight*	Slopes	Maximum train gross weight *	Slopes	Maximum train gross weight *
USA: GE ES44AC	188 t	880 kN	4 ‰	11.036 t	12 ‰	5.424 t	18 ‰	3.894 t
Europe: Co-Co	125 t	400 kN	4 ‰	4.977 t	12 ‰	2.426 t	18 ‰	1.730 t
Europe: Bo-Bo	85 t	300 kN	4 ‰	3.741 t	12 ‰	1.828 t	18 ‰	1.306 t

$$*Q \leq [(F_s / 9,8 * 1000) / (r_s + i)] - L \quad F_s: \text{starting tractive effort, } i: \text{slope, } r_s: \text{starting resistance of the train}$$

- American locomotives, with a higher starting tractive effort than European ones, can start more than 5.000t in slopes of 12‰.
- Starting tractive efforts of European locomotives are enough to haul "FERRMED trains" in low slopes but not in high slopes where maximum load is less than 2.000t or even lower depending on the slopes.





Maximum train gross weight that can be started - depending on the starting adhesion

Locomotive type	Loco weight	Starting tractive effort	Number of axles	Slopes	Max. train gross weight*	Slopes	Max. train gross weight*
USA: GE ES44AC	188 t	880 kN	6	4 ‰	7.567 t	12 ‰	3.690 t
Europe: Co-Co	125 t	400 kN	6	4 ‰	5.031 t	12 ‰	2.453 t
Europe: Bo-Bo	85 t	300 kN	4	4 ‰	3.421 t	12 ‰	1.668 t

$$* Q \leq [(F\mu_0 * 1000) / (rs + i)] - L \quad F\mu_0 = \mu_0 * La; \mu_0 = 33\%, La: \text{adherent weight}$$

- The adhesion can be increased:
 - increasing the adherent weight (weight of motorized axles):
 - Greater number of axles, or,
 - Higher axle-load
 - Increasing the starting adhesion μ_0
- To start FERRMED trains in slopes of 12mm/m in Europe (22,5 t/axle), 12 motorized axles are required to increased the adherent weight, that is, 2 Co-Co locomotives or 3 Bo-Bo locomotives in multiple traction.



Maximum train gross weight that can be started - depending on the coupling

Coupling type	Slope	Max. train gross weight
UIC coupling of 135 t	4 ‰	7.147 t
UIC coupling of 85 t	4 ‰	4.500 t
UIC coupling of 135 t	12 ‰	3.574 t
UIC coupling of 85 t	12 ‰	2.250 t



- With current European UIC couplings of 85 t is not possible to haul "FERRMED trains" of 5.000 t without breaking the hook.
- With European reinforced UIC coupling of 135 t, the maximum train gross weight that can be started in slopes of 12mm/m is 3.574 t.
- Some automatic couplings can duplicate the load of the European ones.
- Solution: to implement automatic coupling in the locomotives and wagons used in "FERRMED trains"
- Automatic coupling has other advantages respect screw ones like more safety, more speed in train formation, possibility of transmit electrical signals...





Starting tractive effort required to haul “FERRMED Trains”

Load	Slope	Starting tractive effort in Co-Co locomotive	Starting tractive effort in Bo-Bo locomotive
3.600 t	0‰	146 kN	144,5 kN
	4‰	292 kN	289 kN
	12‰	584 kN	578 kN
	18‰	803 kN	794,5 kN
5.000 t	0‰	201 kN	199 kN
	4‰	402 kN	399 kN
	12‰	804 kN	797 kN
	18‰	1.105 kN	1.096 kN

- In low slopes, the current European locomotives can haul FERRMED trains
- But, not in higher slopes.
- In 12 mm/m the required starting tractive effort of the locomotives is 600kN -800kN
- More than 1 locomotive is required.



Power required to haul “FERRMED Trains” at defined speed

Load	Slope	Speed	Power at wheel rim
3.600 t	0‰	40 km/h	1.178 kW
		60 km/h	2.075 kW
		100 km/h	5.093 kW
		120 km/h	7.215 kW
	4‰	40 km/h	2.800 kW
		60 km/h	4.509 kW
		100 km/h	9.149 kW
		120 km/h	12.324 kW
	12‰	40 km/h	6.045 kW
		60 km/h	9.379 kW
		100 km/h	17.261 kW
		120 km/h	22.058 kW
	18‰	40 km/h	8.479 kW
		60 km/h	13.027 kW
		100 km/h	23.346 kW
		120 km/h	29.360 kW

- Power does not influence the maximum load that can be hauled but powerful locomotives allow higher speed and better acceleration
- Required power increases with the slopes and with the speed
- To run “FERRMED trains” with an acceptable speed, more than one locomotive is required.
- Power of the train between 7.000 kW and 10.000 kW → power or individual locomotives: 3.500 kW – 5.000k
- With 2 locomotives, “FERRMED trains” can achieve speeds over 100km/h in low slopes but not in high slopes.
- Because energy efficiency reasons, it is necessary a commitment between speed, load and time schedule.





Power required to haul “FERRMED Trains” at defined speed

- Both type of traction, diesel or electrical, solve already now the power requirements to haul “FERRMED trains”.

Diesel locomotives

- Some modern current European Diesel locomotives achieve 3.500 kW and 400kN and incorporate last innovations to reduce emissions and noise.
- They give more flexibility in the operations and interoperability.

Electrical locomotives

- New European multi-tension electrical locomotives solve interoperability problems.
- They have more power than diesel ones (up to 6.000kW) achieving higher speed but have lower starting tractive effort (300kN)



Conclusions of the technical parameters:

- The maximum train gross weight depends on:
 - Starting tractive effort
 - Adhesion and adherent weight of the locomotive
 - Coupling resistance
 - Slopes
- With current European infrastructure conditions (max. 22,5 t/axle) “FERRMED trains” require to be hauled :
 - Automatic couplings with higher resistance
 - 2 or more locomotive in multiple traction
 - 12 motorized axles
 - Starting tractive effort : 600 kN - 800kN
- Power required to run “FERRMED trains” in an acceptable speed: 8.000 kW – 10.000kW → Power of individual locomotives: 3.500kW - 5.000kW
- Most of the technological requirements to haul “FERRMED trains” are already implemented in current locomotives, diesel and electrical.





ENVIRONMENTAL ISSUES OF THE “LOCOMOTIVE FERRMED”

- Energy efficiency
- Exhaust emissions reduction
- Noise reduction
- Recycling materials



Exhaust Emissions

Current locomotives fulfill Stage IIIA of the European Directive NMRR 97/68/EC, revised by the new Directive 2004/26/EC. (mandatory since 2009)

European Project CleanER-D, coordinated by UNIFE. The goal is to develop the first European locomotive that fulfill Stage IIIB. Stage IIIB is similar to normative EURO V of road vehicles. Following tables shows the big effort made by the rail industry to have cleaner locomotives.

Innovations: DPF, SCR...

