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Investigation on the resilient modulus of soil mixture at various water contents and coarse grain contents under train moving loads

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Context and objective

1

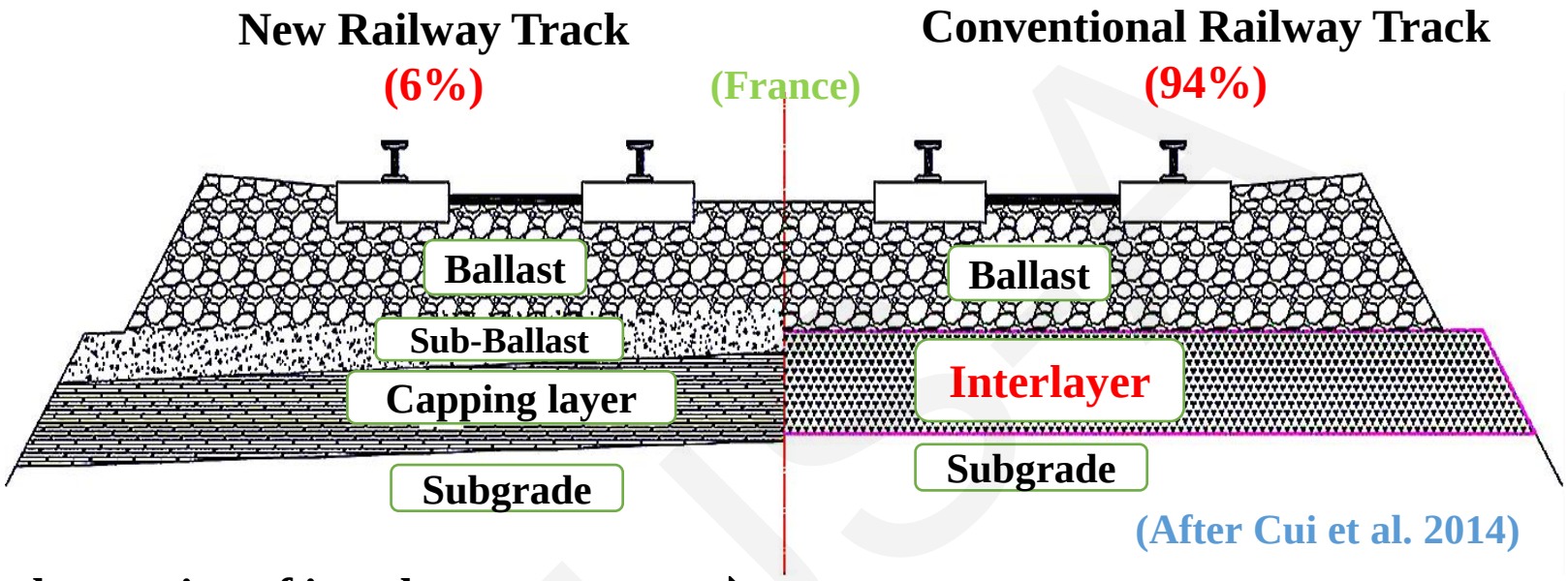
French railway network in late XIX century

French railway network at present

Current situation: old lines : 94%; TGV lines: 6%

➡ This shows the importance of old lines in French railway network

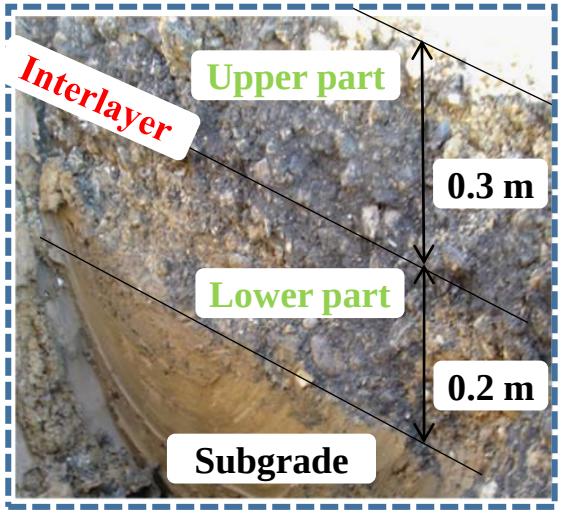
Context and objective



(After Cui et al. 2014)

Field observation of interlayer:
high ρ_d (2.4 Mg /m^3) and bearing capacity

⇨ **French railway company (SNCF - track renewal program):**
keep the interlayer in railway substructure



(Trinh et al. 2012)

Upper part Ballast grains: skeleton Fines: filling voids	1) Mechanical behavior 2) Hydraulic behavior **(Trinh 2011; Duong 2013; Calon 2016; Lamas-Lopez 2016)**
Lower part Fines: dominant Ballast grains: floating in fines	1) **Effect of coarse grain content f_v on the** mechanical behaviour 2) **Effect of coefficient of uniformity C_u** on the mechanical behaviour **(Wang et al. 2018a, 2018b; Qi et al. 2020)**

Reconstituted fine/coarse soil mixture

✓ Reconstituted fines ⇨ Subgrade fines

(< 2 mm)

Commercial Soils	Proportion (%)
HN34	3.3
HN31	3.3
HN0.4-0.8	6.7
HN0.6-1.6	6.7
HN1-2.5	13.3
Sand C4	16.7
Sand C10	20.0
Speswhite	23.3
Bentonite	6.7

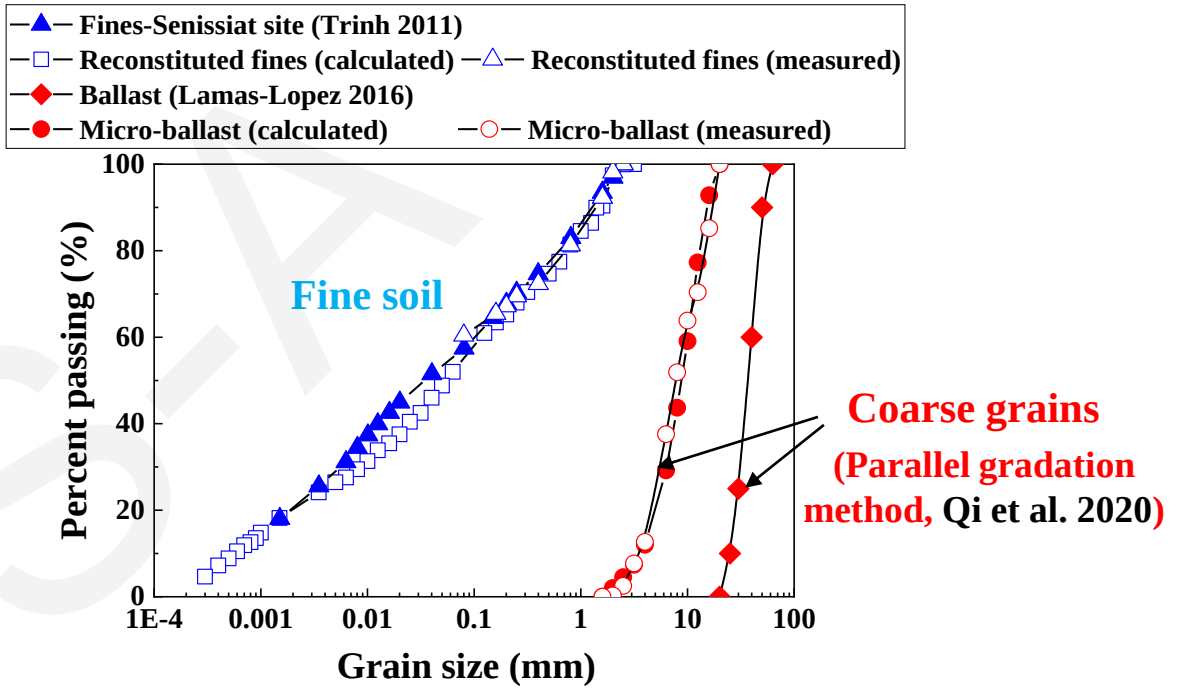
Fine soil mixer

✓ Micro-ballast ⇨ Ballast

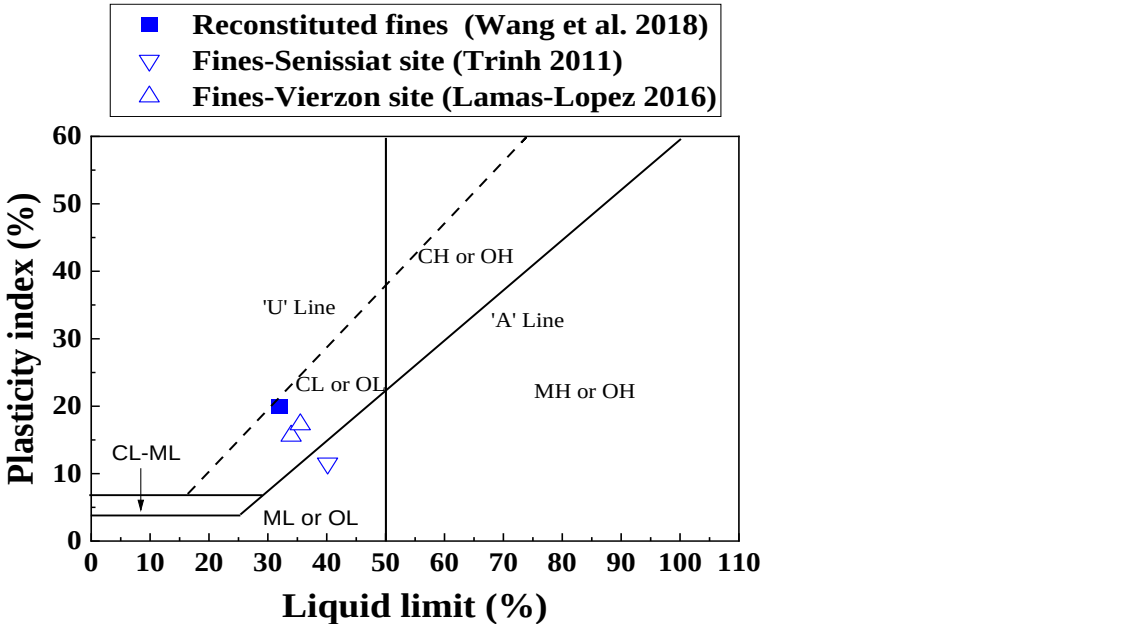
(2 mm< *d* < 20 mm) (20 mm< *d* < 63 mm)

Soils	Proportion (%)
G 10-20	34.0
G 4-10	58.0
HN 2-4	8.0

* f_v : volumetric ratio of micro-ballast to the mixture



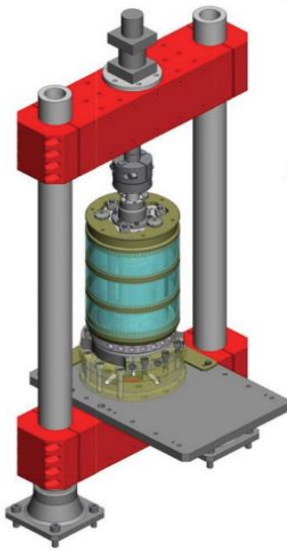
Coarse grains (Parallel gradation method, Qi et al. 2020)



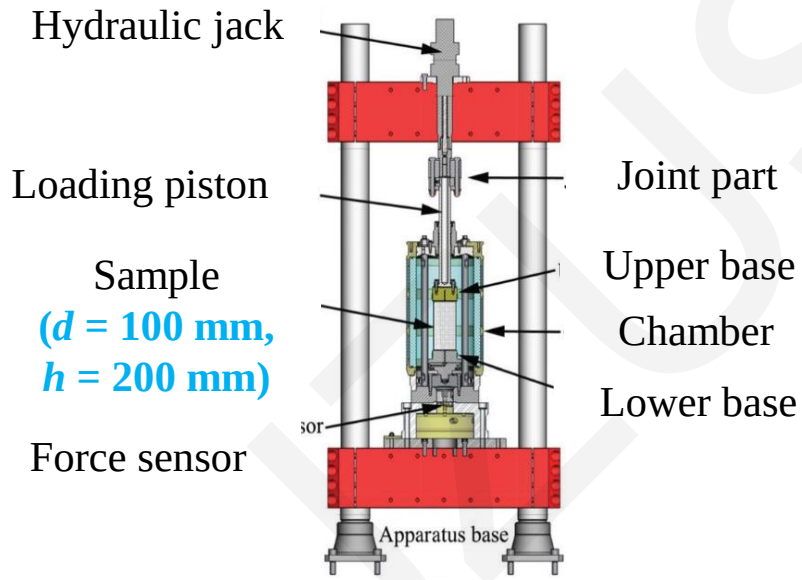
Experimental techniques

Cyclic triaxial test

50 kN hydraulic actuator



(a) 3D view



(b) Profile view

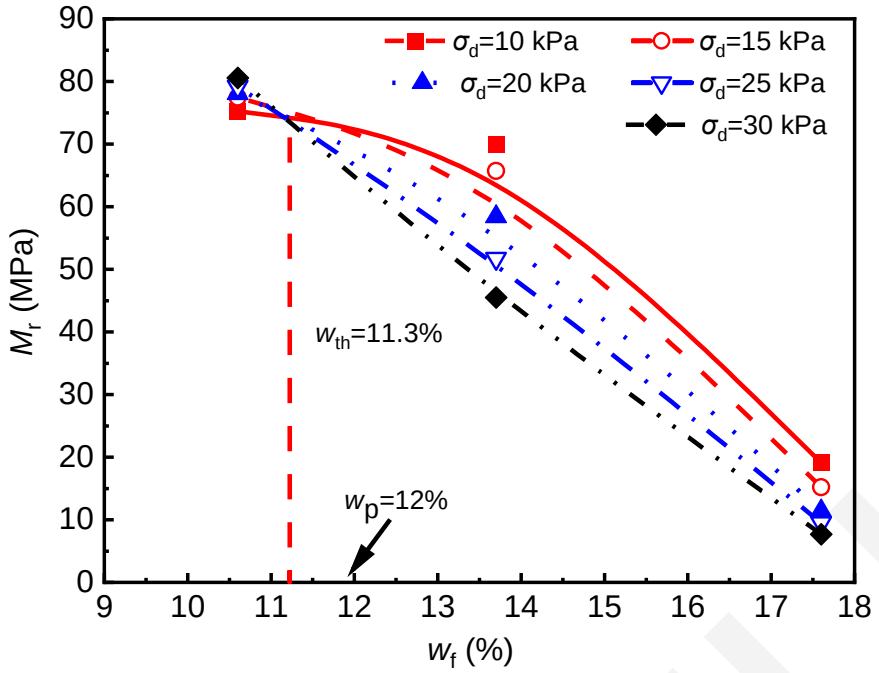
Mercury intrusion porosimetry technique

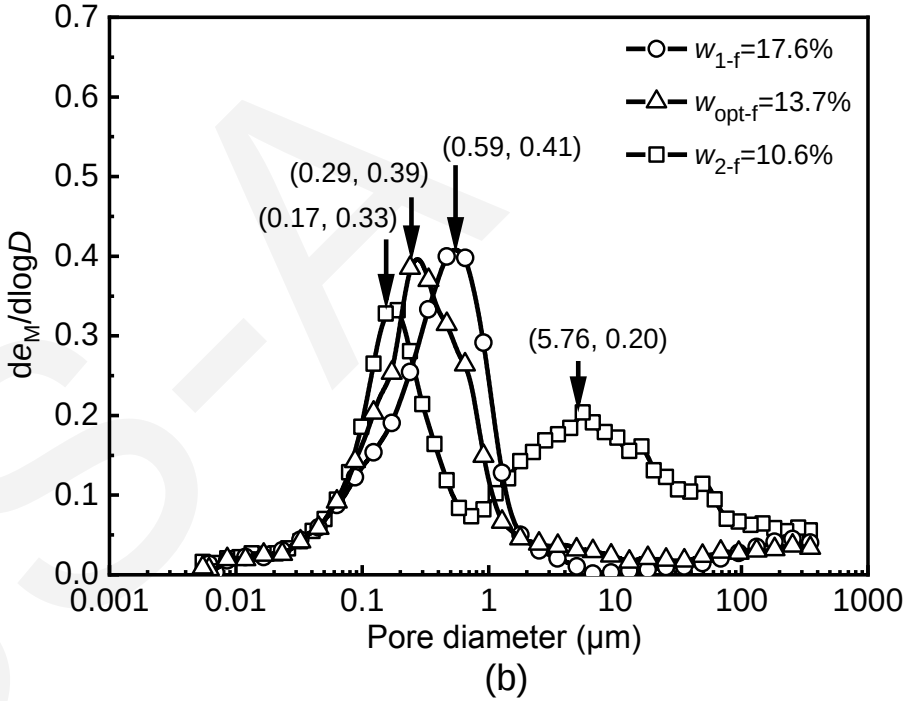
Autopore IV 9500

Low pressure system:
3.6 – 200 kPa

High pressure system:
0.2 – 210 MPa

Results and Conclusions





Conclusions:

(1) The rise in σ_d contributed to a decline in M_r when $w_f > w_p$ but to an increase in M_r when $w_f < w_p$

(2) A fine matrix fabric obtained at water contents of fine soil w_f=17.6% and 13.7% (>the plastic limit of fine soil w_p=12%), and a fine aggregate fabric identified at w_f=10.6% (<w_p=12%)

(3) For the fine matrix fabric ($w_f > w_p$), increasing σ_d induced a reduction in M_r, while for the fine aggregate fabric ($w_f < w_p$), increasing σ_d gave rise to the growth of M_r.

Related references

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2. **Su, Y.**, Cui, Y. J., Dupla, J. C., & Canou, J. (2022). Effect of water content on permanent deformation of fine/coarse soil mixtures with varying coarse grain contents and subjected to multi-stage cyclic loading. **Acta Geotechnica**, 17(8), 3259-3268.

3. **Su, Y.**, Cui, Y. J., Dupla, J. C., & Canou, J. (2022). Modeling the suction-and deviator stress-dependent resilient modulus of unsaturated fine/coarse soil mixture by considering soil–water retention curve. **Acta Geotechnica**, 17(9), 3747-3763.

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