

Noise and vibration control in multiplex cinemas

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Topics

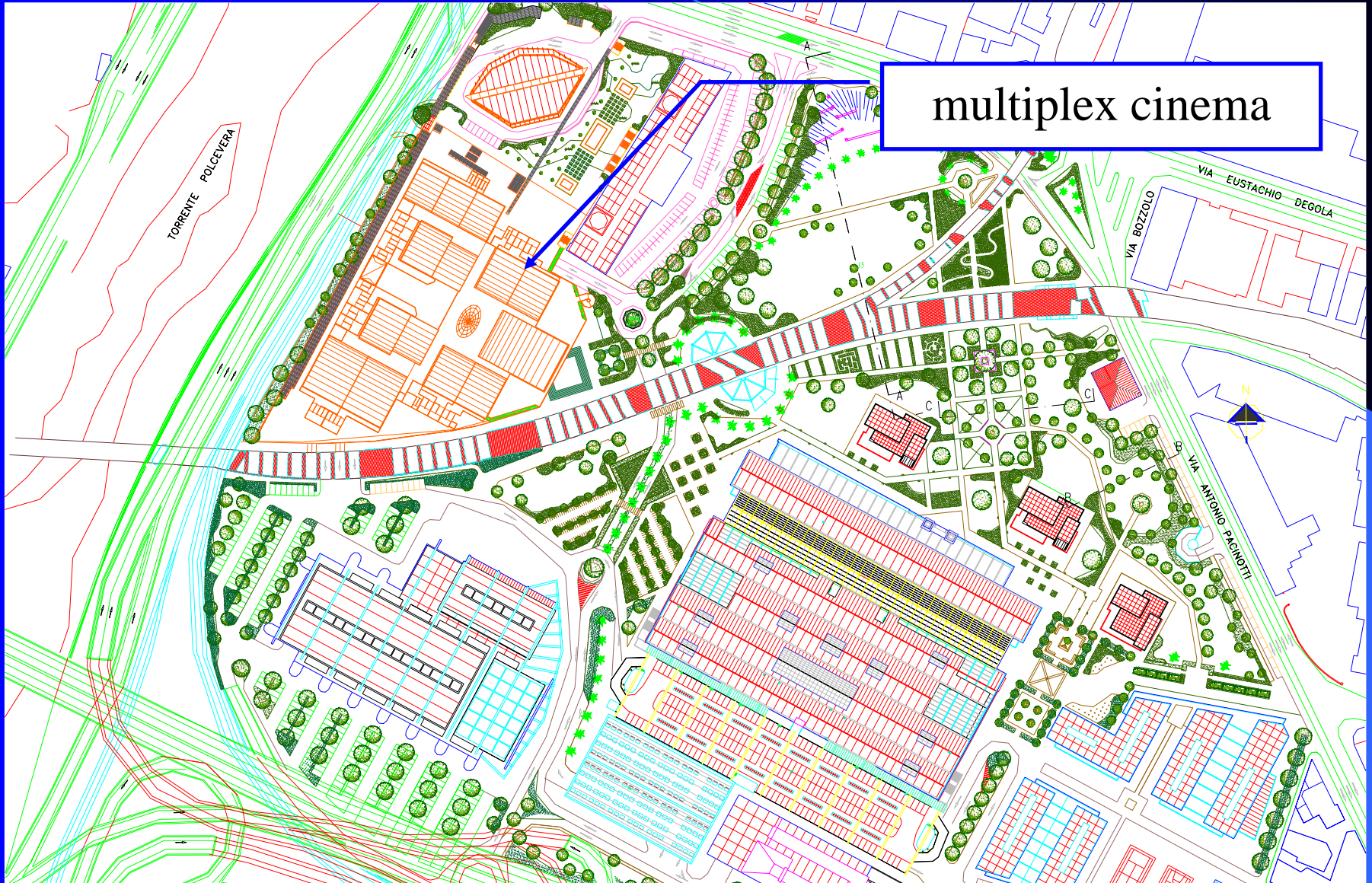
- Design and realization of a new multiplex cinema in Genoa
- Severe environmental conditions (industrial and trainway noise and vibrations, close to airport and docks)
- Strict specification in terms of acoustical and vibration control set by the customer

Overview



Site for the
construction of the
multiplex cinema

Plan



Significant Numbers

- 5 floors: 2 parking, 1 commercial, 1 cinema, 1 technical
- 14 cinema rooms, 4980 m²
- 1 x 499 seats, 6x216 seats, 5x143 seats, 2x322 seats = 3154 total seats
- Entrance and services 2838 m²
- Shops and restaurants: 9500 m²
- 18800 m² parking area (2 floors), 720 cars

Acoustical specifications (UCI)

Apparent Sound Reduction Index (ISO-140/4, ISO-717)

- External walls $R'_{w} = 55$ dB
- Internal walls $R'_{w} = 50$ dB
- Fire-resistant walls $R'_{w} = 55$ dB
- Wall between cinema rooms $R'_{w} = 65$ dB
- Roof $R'_{w} = 50$ dB
- Floor $R'_{w} = 60$ dB
- Internal doors $R'_{w} = 45$ dB
- Wall of the projection room $R'_{w} = 50$ dB

Acoustical specif. (*Italian Law*)

Apparent Sound Reduction Index (ISO-140/4, ISO-717)

- External walls $R'_{w} = 42$ dB
- Internal walls $R'_{w} = 50$ dB
- Fire-resistant walls $R'_{w} = 50$ dB
- Wall between cinema rooms $R'_{w} = 50$ dB
- Roof $R'_{w} = 42$ dB
- Floor $R'_{w} = 50$ dB
- Internal doors ---
- Wall of the projection room ---

Background noise

- UCI requires that the Maximum SPL with Slow time constant complies with NR-30 curve ($L_{\max, \text{slow}} < \text{NR30}$) – this includes any source of noise, including passage of trains or aircrafts
- The Italian Law requires that the noise produced by steady-state equipment (HVAC) has an A-weighted equivalent level less than 35 dB(A) ($L_{A, \text{eq}} < 35 \text{ dB(A)}$)
- **The UCI requirements are much more stringent than the Italian Law**

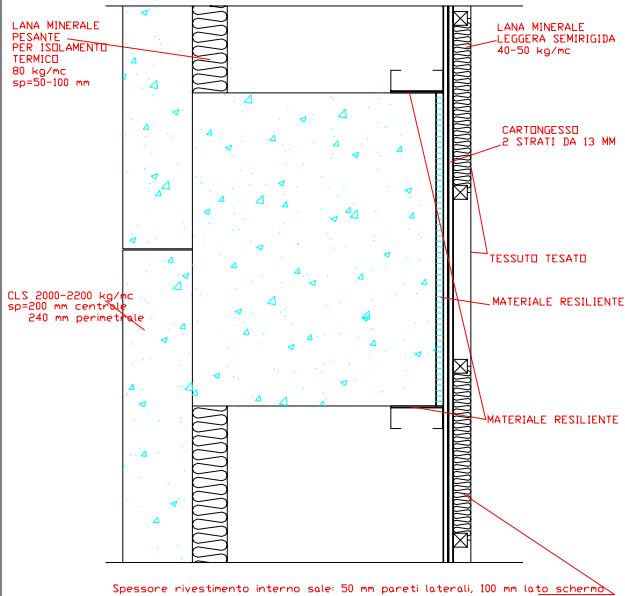
Vibration limits

- UCI requires that continuous vibrations are less than the curve 1 of BS-6472 (1992)
- UCI requires also that the vibrations are less than the maximum allowed for building of category 5 in DIN-4150-2
- In practice, the Italian standard UNI-9614 was applied, which specifies a maximum weighted acceleration level of 71 dB

Technical details

MULTISALA FIUMARA GENOVA ISOLAMENTO ACUSTICO / PARETI

SEZIONE A
ESTERNO LATO LUNGO PILASTRO

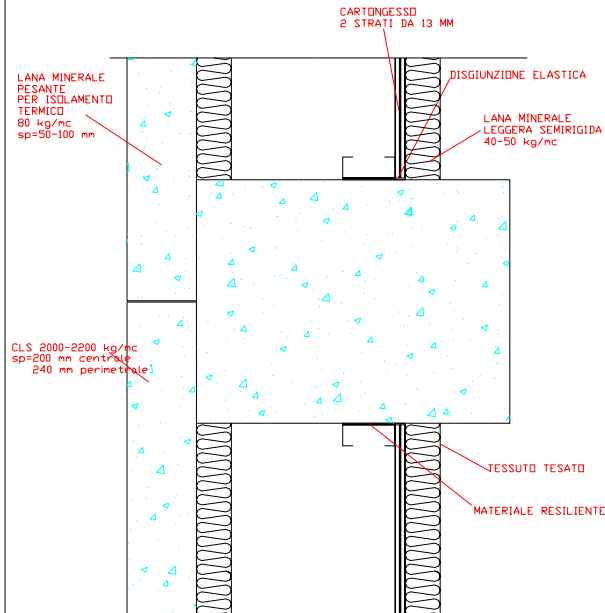


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SEZIONE B
ESTERNO LATO CORTO PILASTRO - PARETI LATO SCHERMO

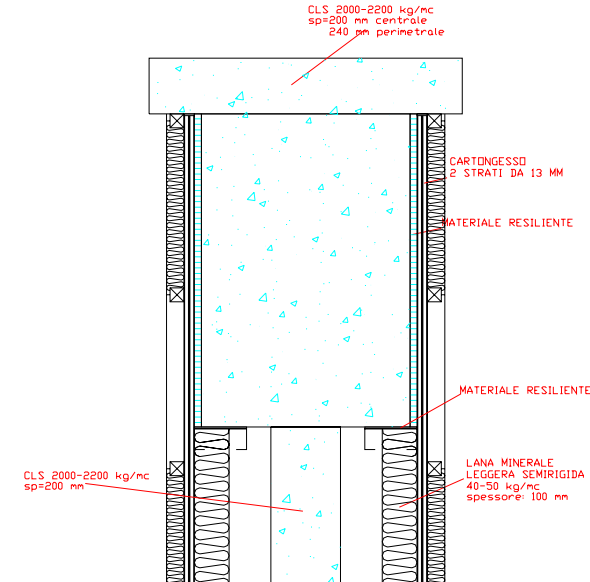


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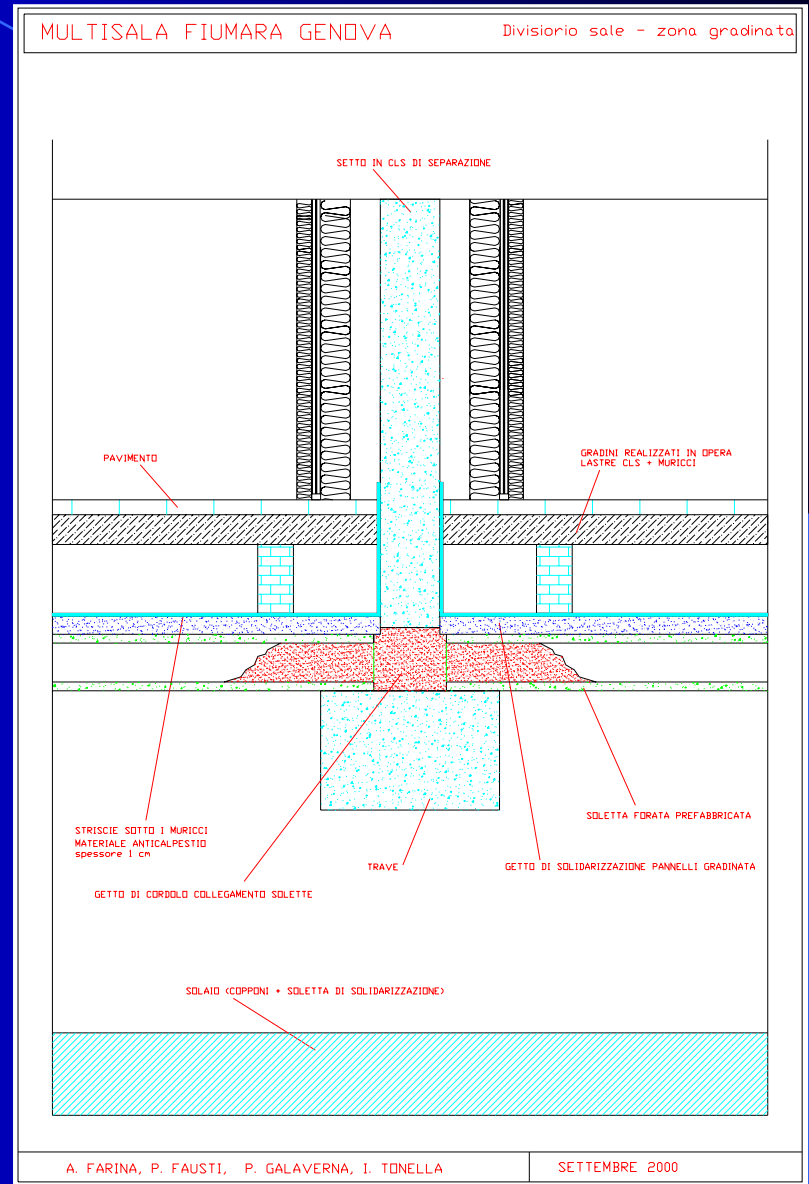
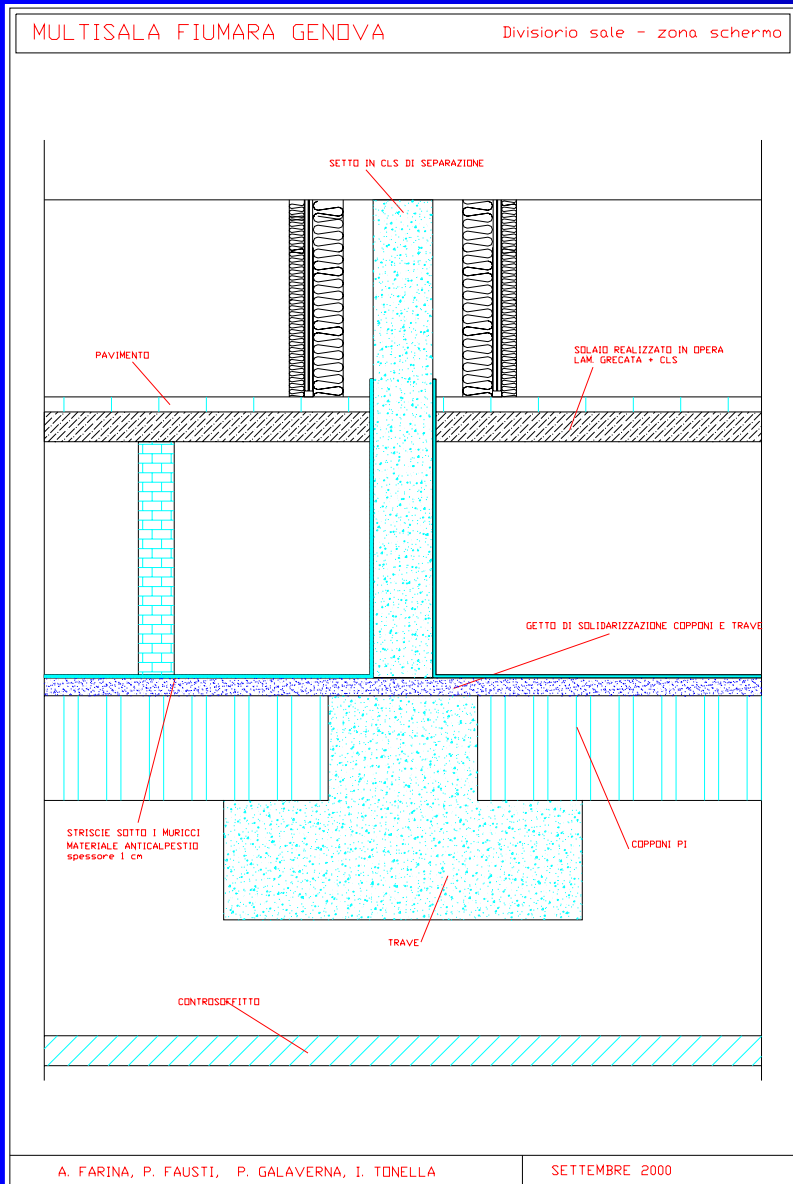
SEZIONE C
ESTERNO FRA PORTE DI SICUREZZA



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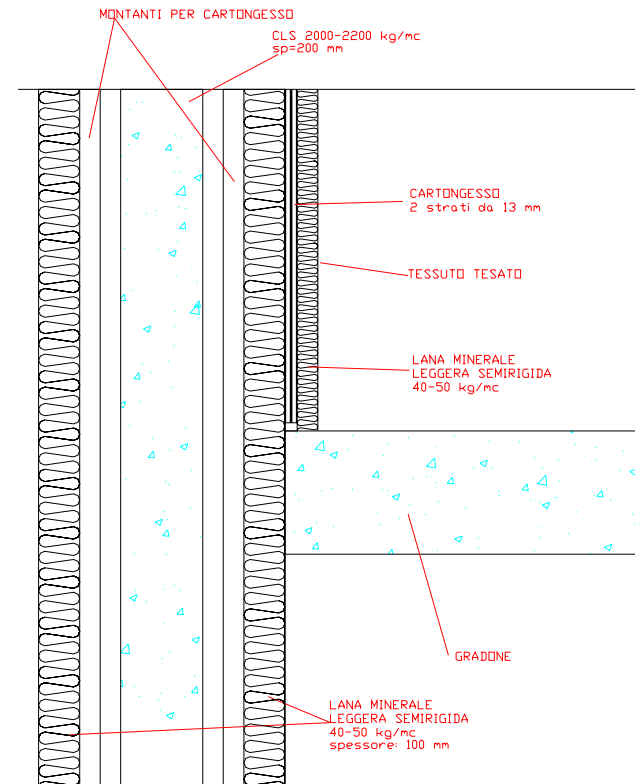
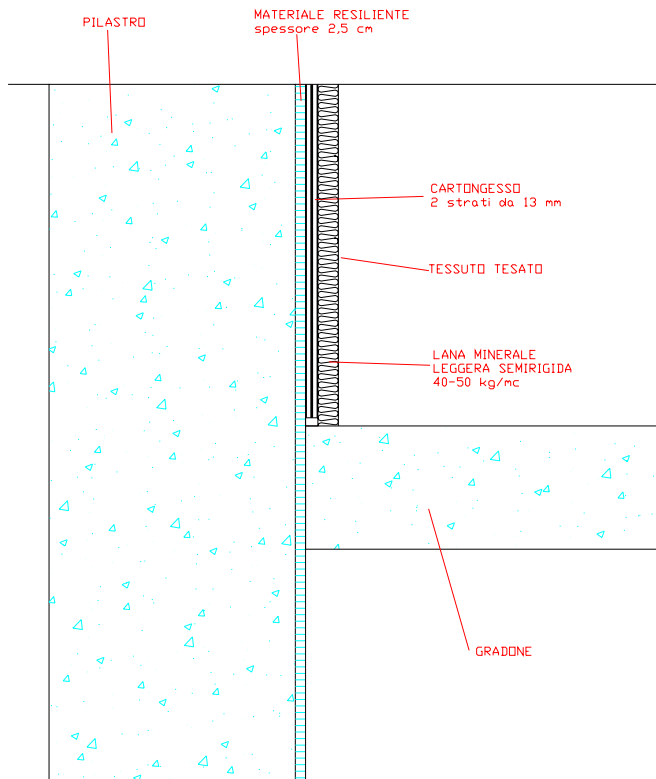
Technical details



Technical details

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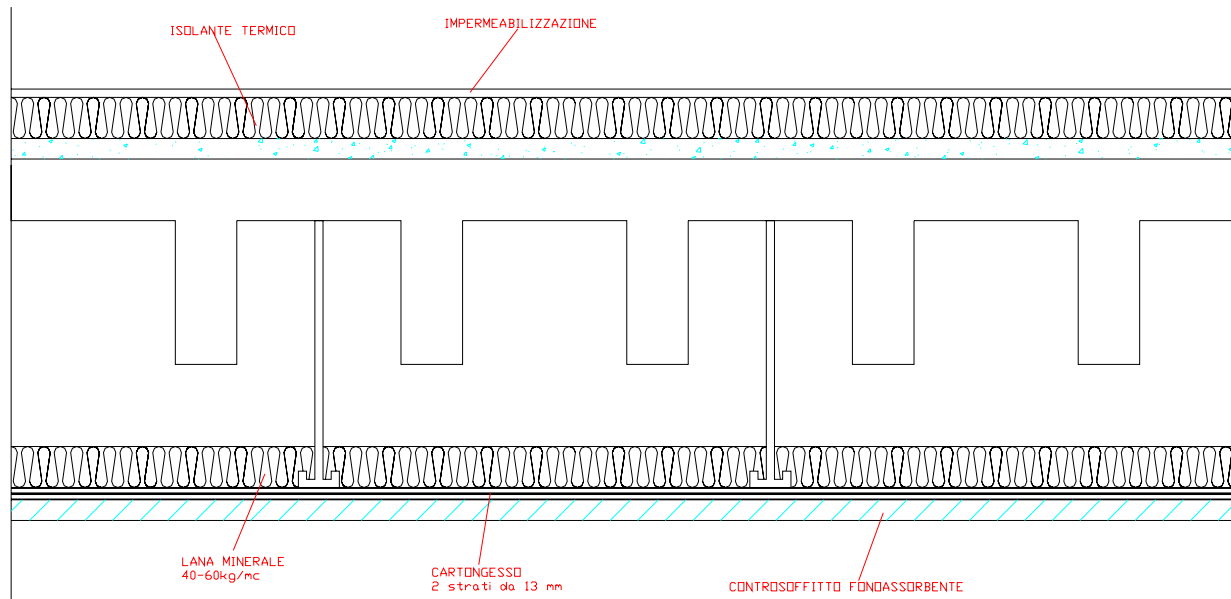
SEZIONI VERTICALI PARETI TRA SALE



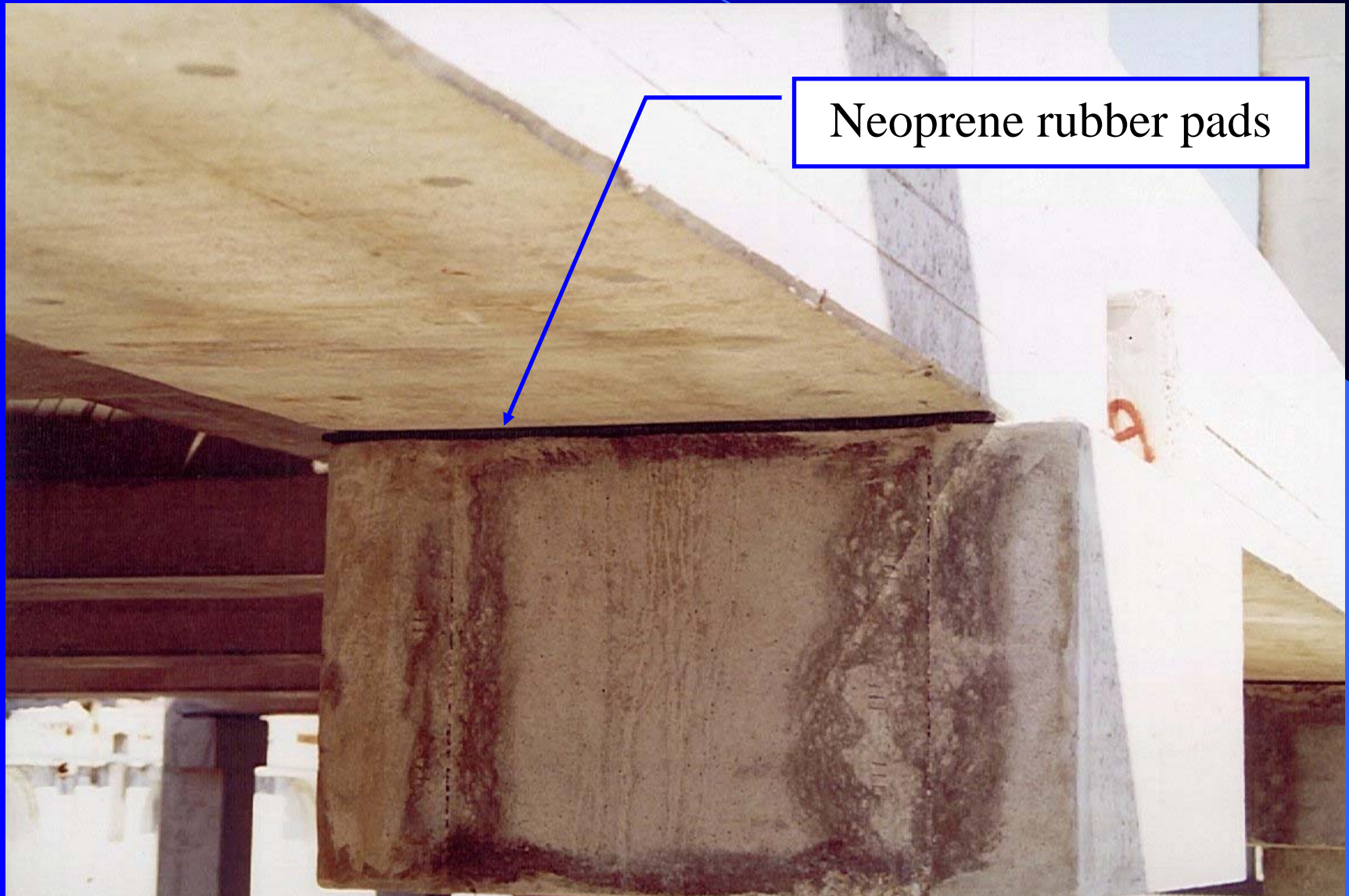
Technical details

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SEZIONE DELLA COPERTURA

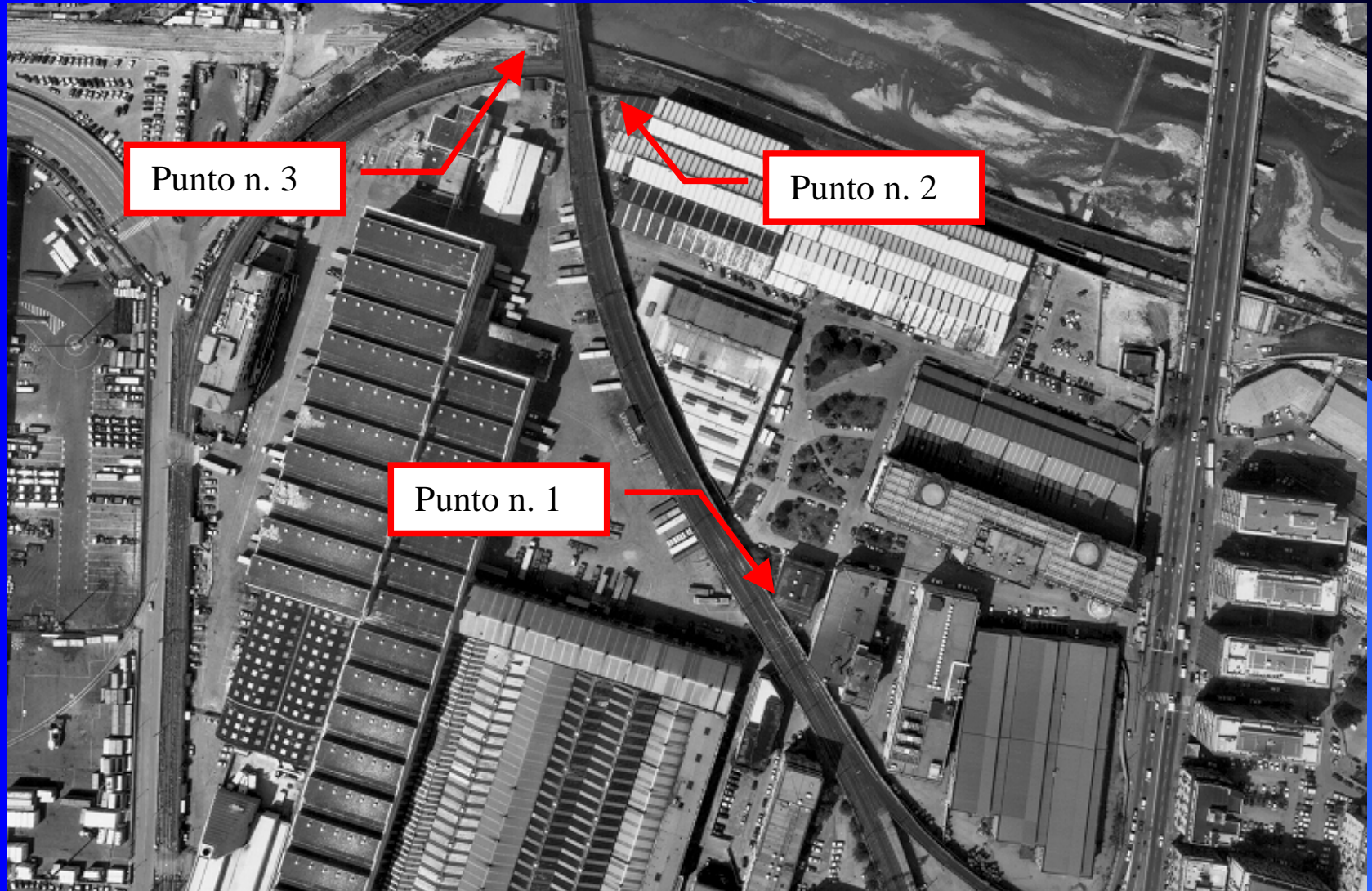


Vibration control



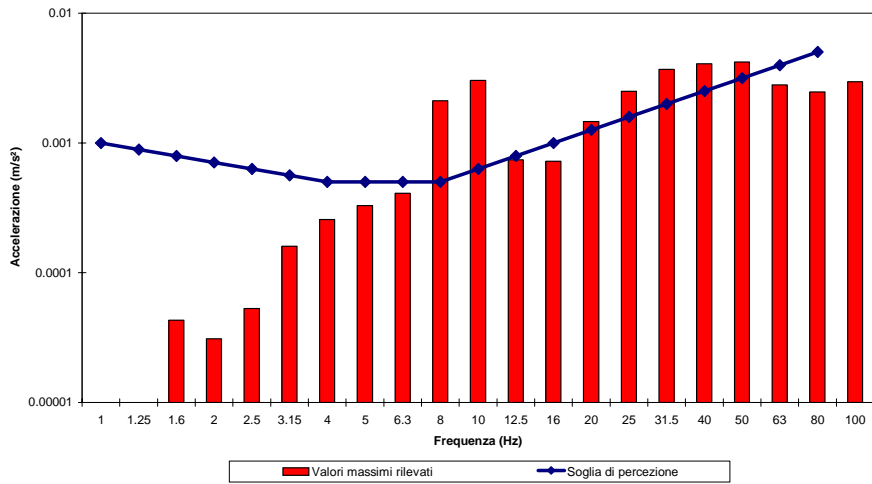
Neoprene rubber pads

Preliminary measurements

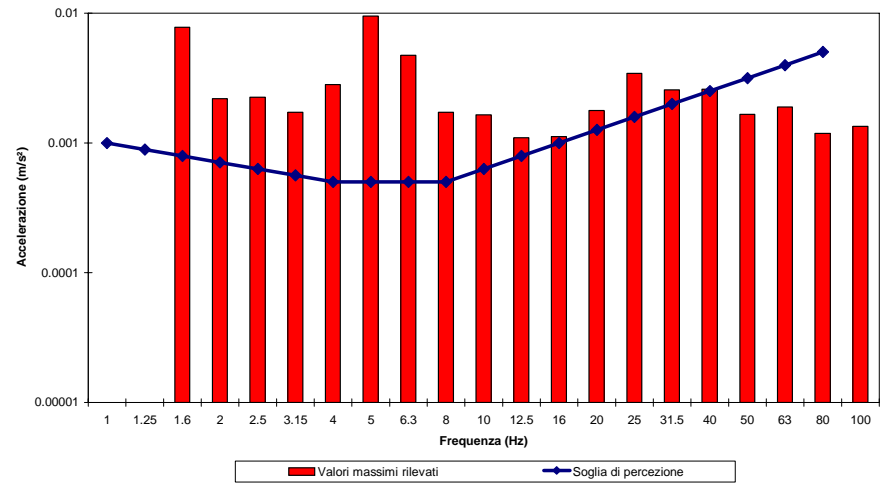


Preliminary measurements (vibrations)

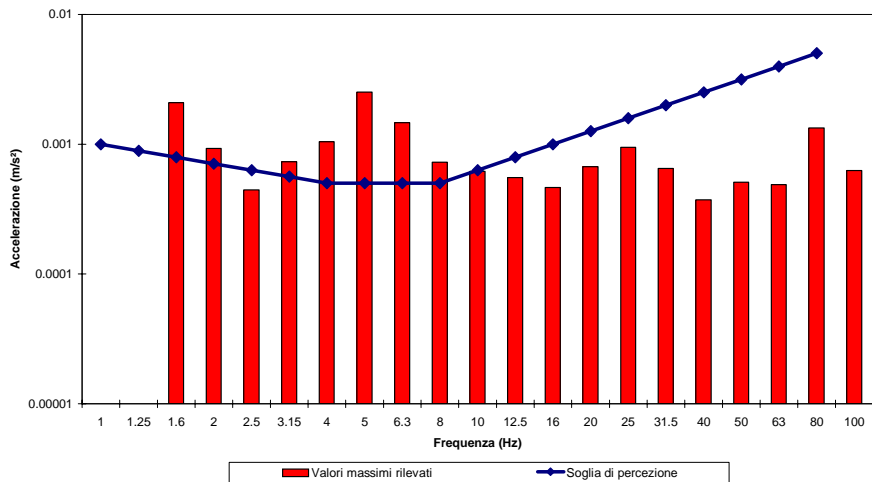
Spettro di accelerazione massima - punto n. 1



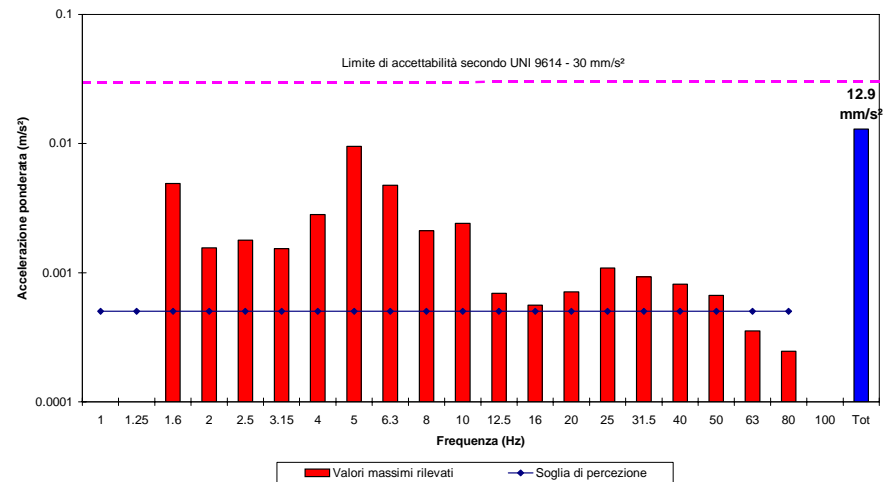
Spettro di accelerazione massima - punto n. 2



Spettro di accelerazione massima - punto n. 3



Spettro accelerazione massima ponderata

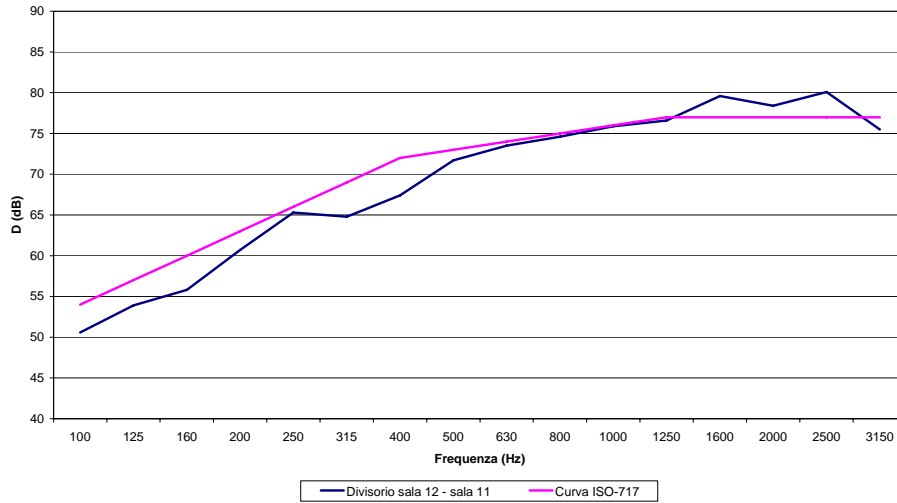


Realization

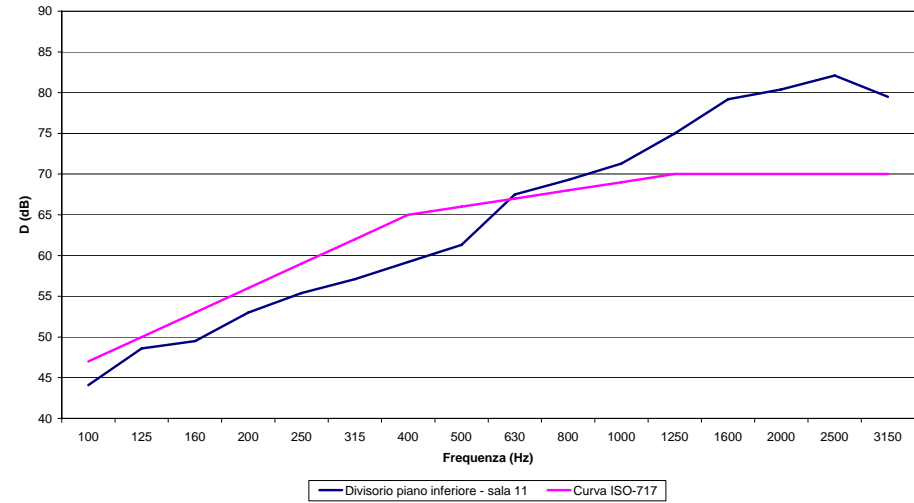


Final verification measurements

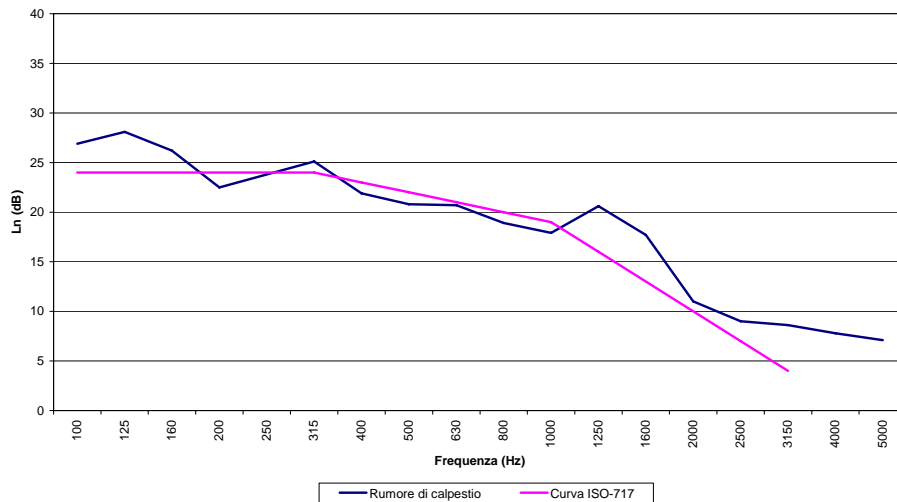
Isolamento fra sala 12 ed 11 - Dw = 73 dB (indice ISO717 a 500 Hz) - DL = 71 dB(A)



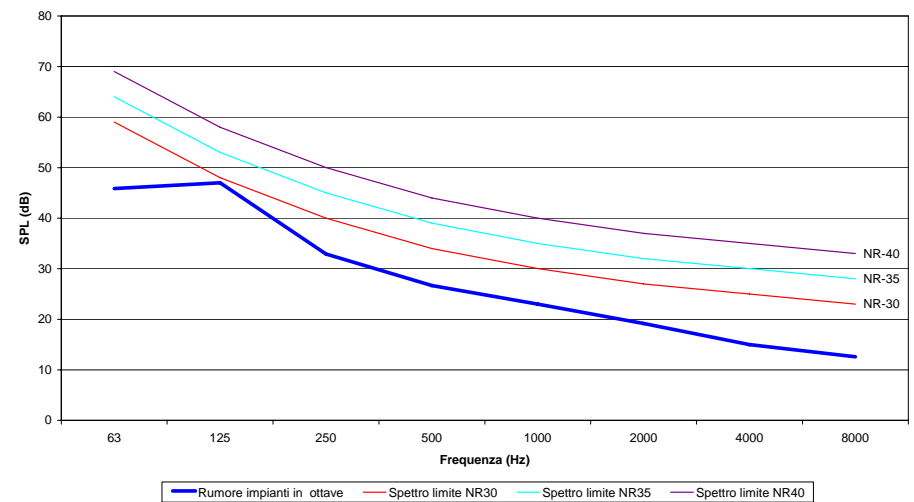
Isolamento fra piano inferiore e sala 11 - Dw = 66 dB (indice ISO717 a 500 Hz) - DL = 66 dB(A)



Rumore di calpestio normalizzato - sala 11 - Dnw=22 dB - LAeq = 28.8 dB(A)

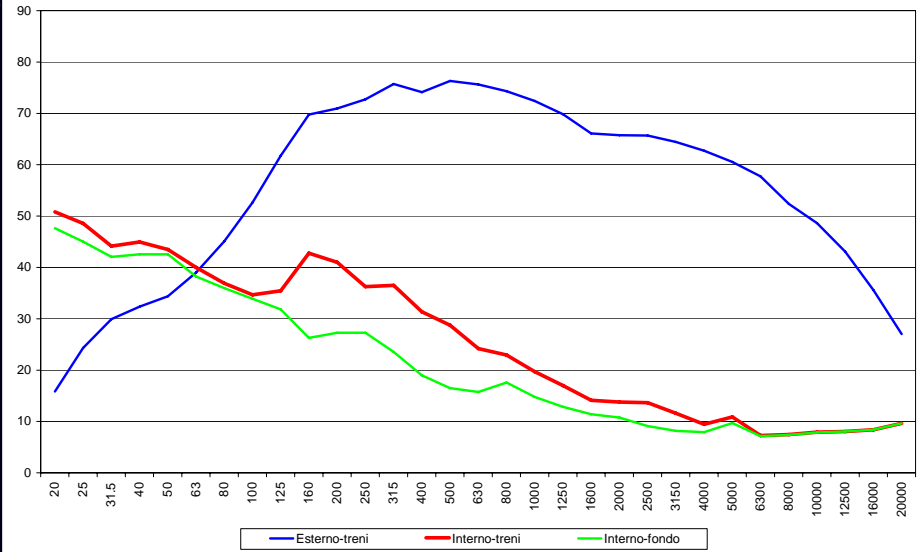
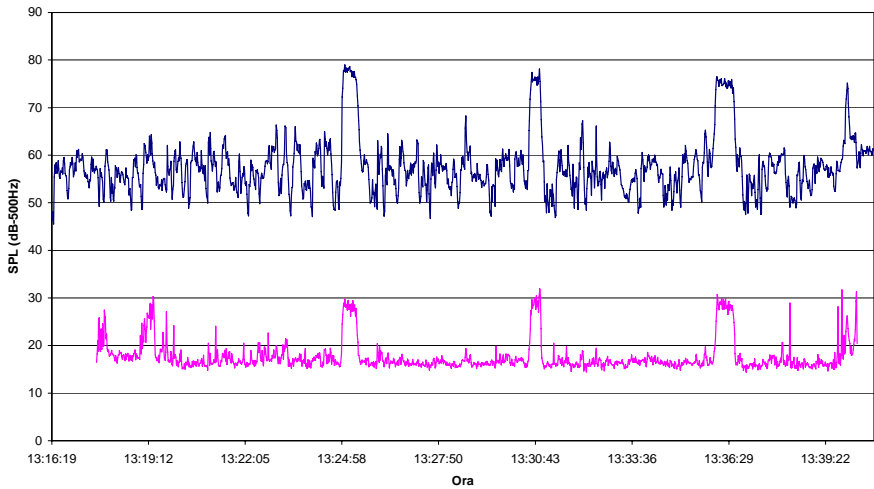


Verifica curve NR - rumore impianti sala 12

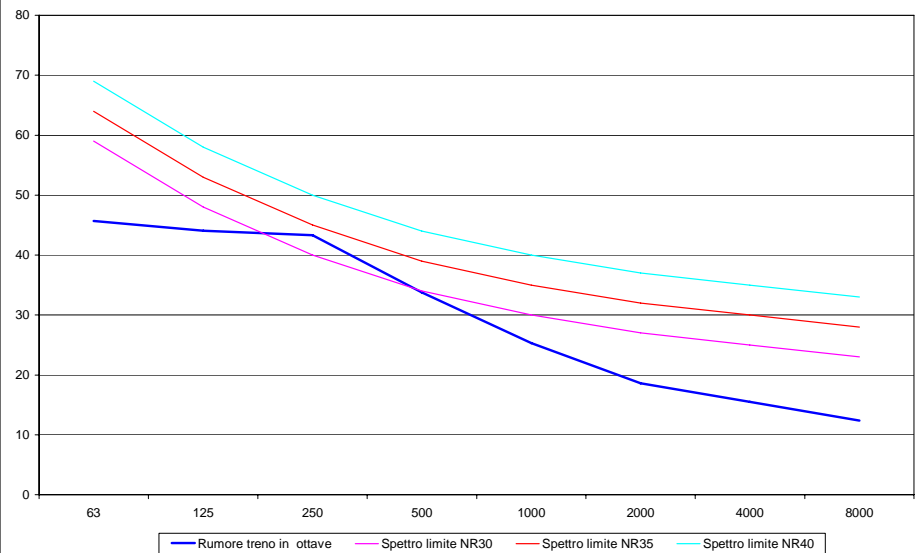
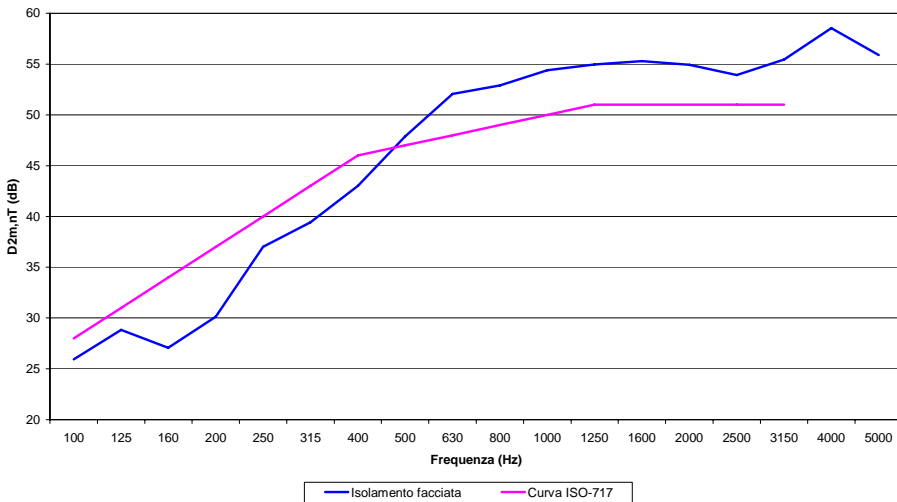


Final verification measurements

Profilo Esterno/Interno



Spettro Isolamento Facciata sala 11 - Dn2m,nT, w = 47 dB



Vibration measurements

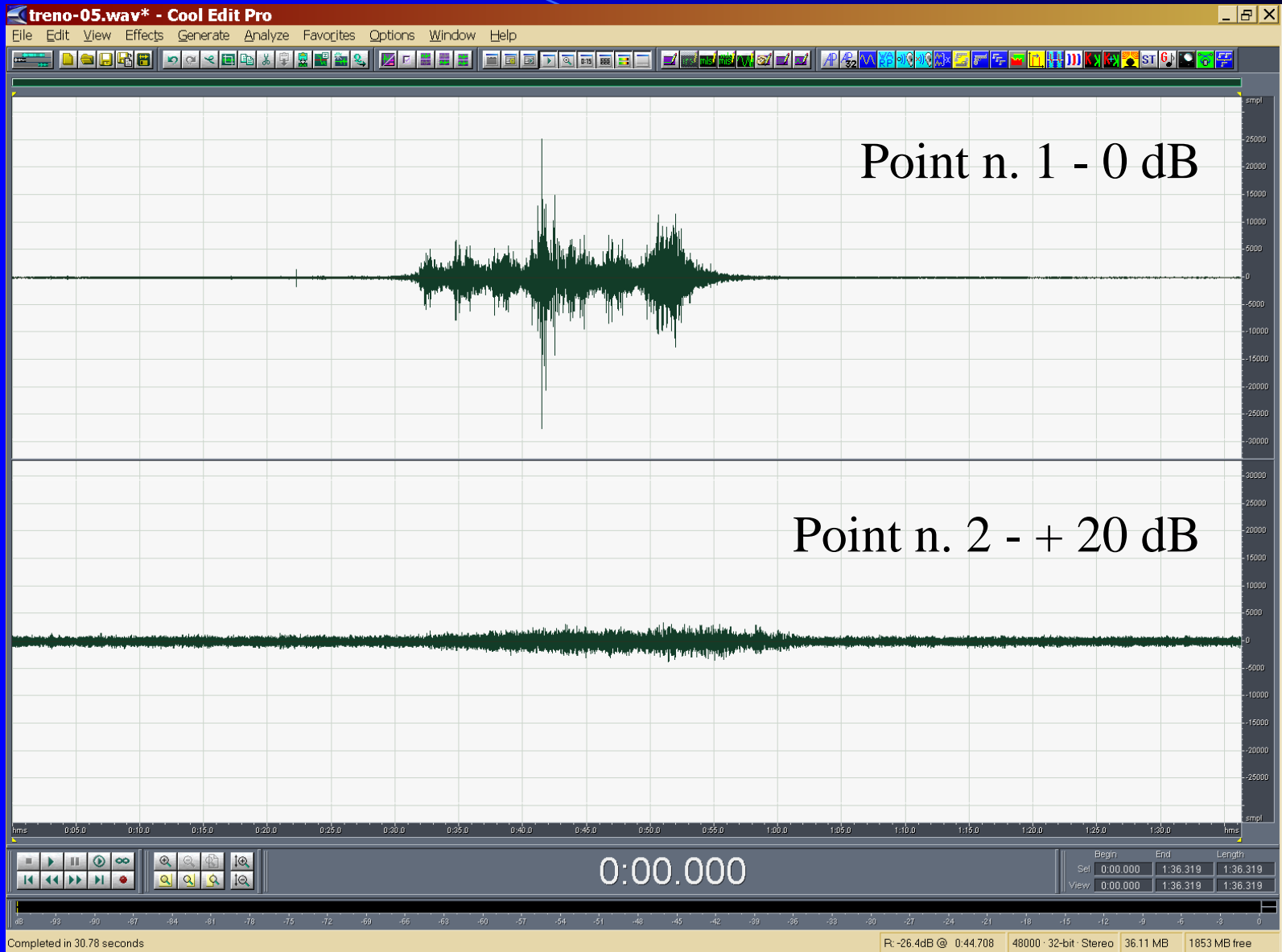


Point n. 1

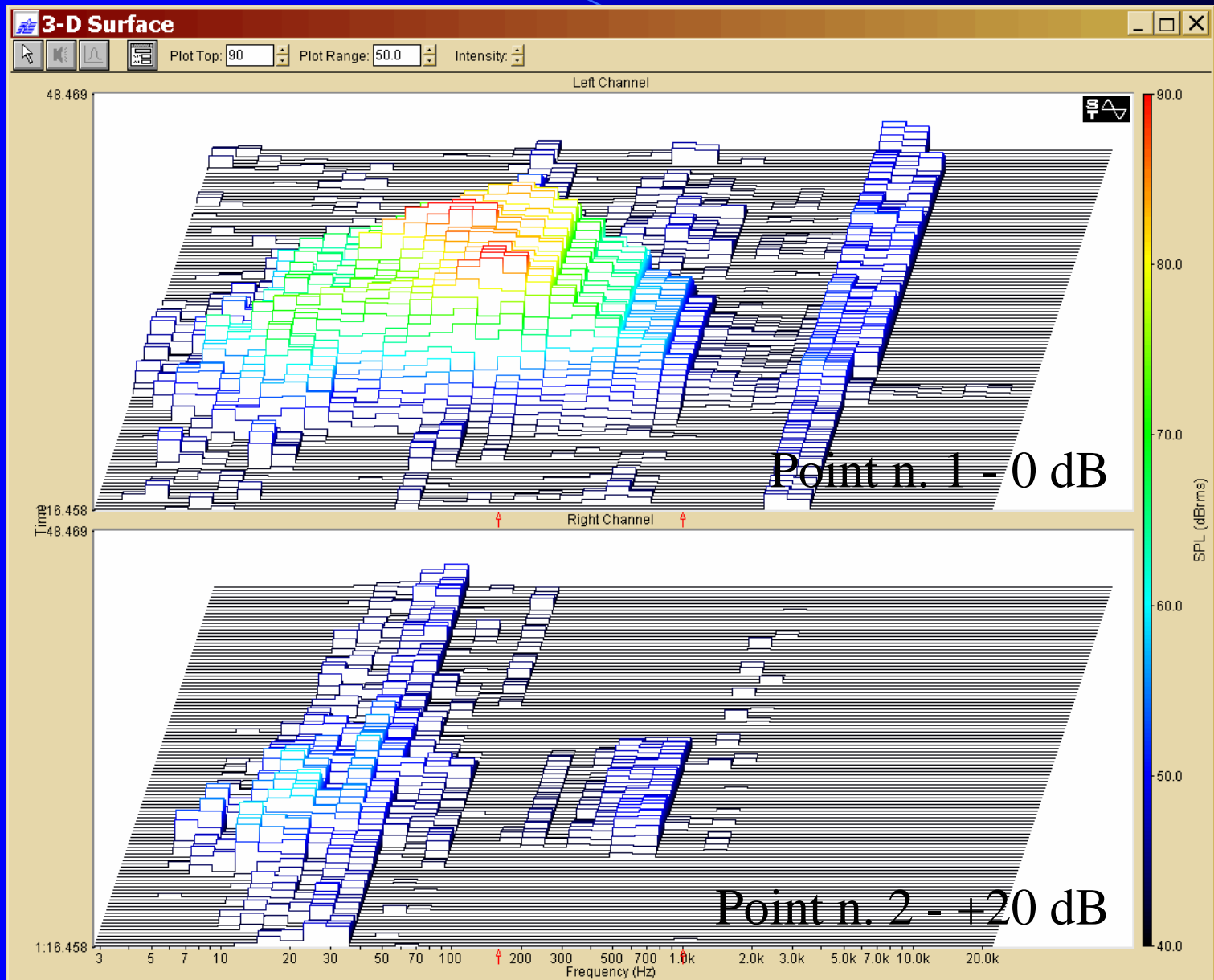


Point n. 2

Vibration measurements

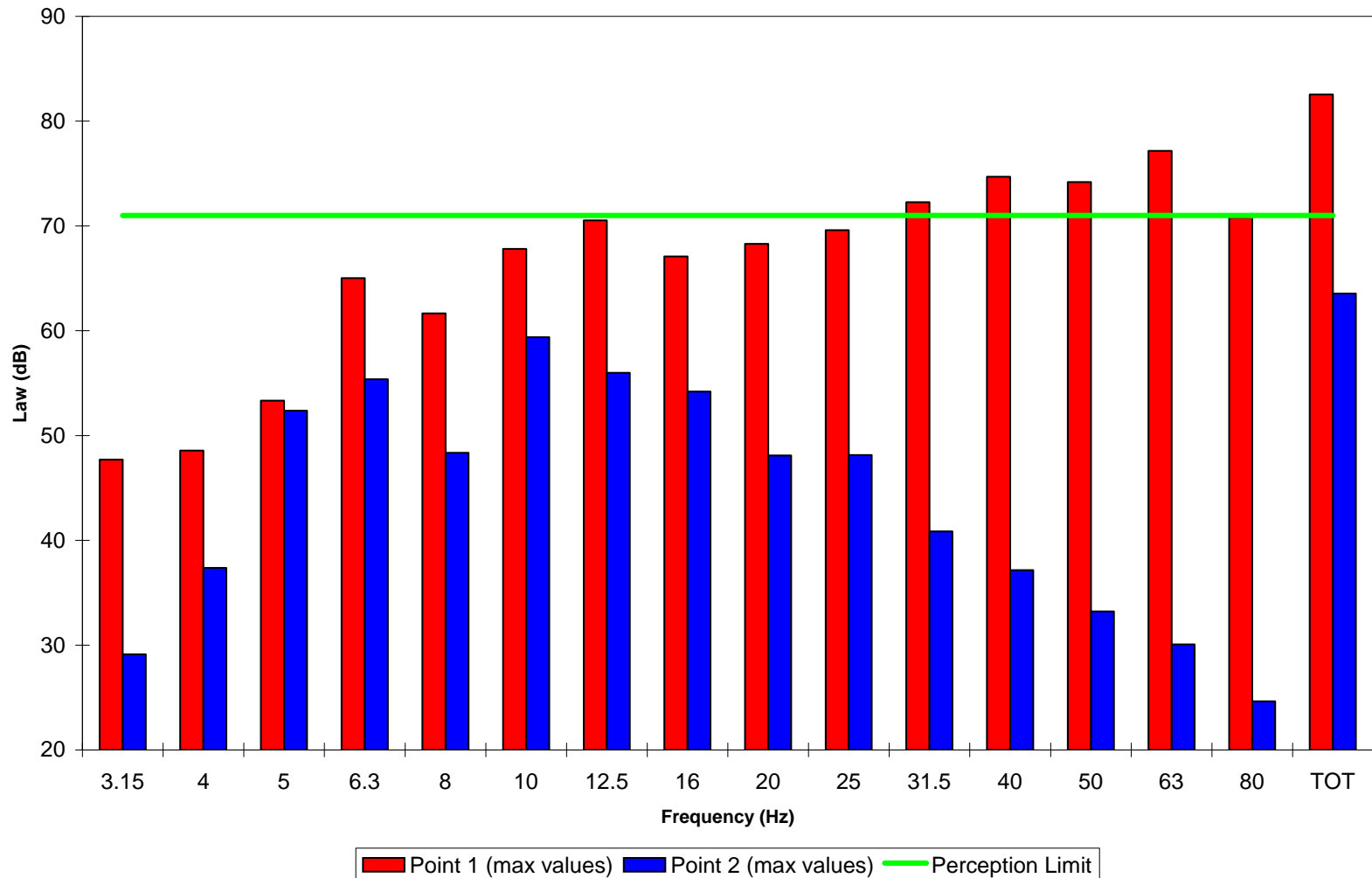


Vibration measurements



Vibration measurements

Weighted Acceleration Spectrum



Conclusions

- Almost all noise and vibrations specifications were fulfilled
- The rubber support of horizontal structures was able to decouple vibrations above 5 Hz
- The multilayer walls employing triple gypsum boards gave sound insulation much higher than expected
- Proper soundproofing was required for reducing the HVAC noise below the NR-30 curve