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
Overview

Site for the construction of the multiplex cinema
Plan

multiplex cinema
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 $R'w = 42 \text{ dB}$
- Internal walls $R'w = 50 \text{ dB}$
- Fire-resistant walls $R'w = 50 \text{ dB}$
- Wall between cinema rooms $R'w = 50 \text{ dB}$
- Roof $R'w = 42 \text{ dB}$
- Floor $R'w = 50 \text{ dB}$
- Internal doors ---
- Wall of the projection room ---
UCI requires that the Maximum SPL with Slow time constant complies with NR-30 curve \(L_{\text{max,slow}} < \text{NR30}\) – 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) \(L_{A,\text{eq}} < 35 \text{ dBA}\).

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
Technical details
MULTISALA FIUMARA GENOVA

SEZIONE DELLA COPERTURA

ISOLANTE TERMICO

IMMOBILIZZAZIONE

LANA MINERALE 40 LONG/AC

PARETE SEMI 5 CM O 10 CM

CENTROFITTETE FONDOASSORBENTE

A. FABBIA, R. FAUSTI, P. GALAVERRA, L. TONELLA

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Vibration control

Neoprene rubber pads
Preliminary measurements

Punto n. 1

Punto n. 2

Punto n. 3
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

Valori massimi rilevati
Soglia di percezione

Valori massimi rilevati
Soglia di percezione

Limite di accettabilità secondo UNI 9614 - 30 mm/s²
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
Vibration measurements

Point n. 1

Point n. 2
Vibration measurements

Point n. 1 - 0 dB

Point n. 2 - + 20 dB
Vibration measurements

Point n. 1 - 0 dB

Point n. 2 - +20 dB
Vibration measurements

Weighted Acceleration Spectrum

Frequency (Hz)

Law (dB)

Point 1 (max values)  Point 2 (max values)  Perception Limit
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