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EFFECT OF PRE-LOAD ON THE DYNAMIC STIFFNESS OF IMPACT INSULATION MATERIALS AND ON THE PREDICTED IMPACT SOUND INSULATION

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1. INTRODUCTION

The dynamic stiffness is the main parameter to assess the acoustical properties of materials used under floating floor constructions. Based on theory and practical experience the impact sound improvement of a bare floor by a floating floor can be judged on the basis of the knowledge of the dynamic stiffness of the insulation material and the surface mass of the floor plate.

This paper deals with the influence of a preload on the dynamic stiffness of impact sound insulation materials and on the estimated impact sound insulation in comparison to data measured in field situations.

2. MATERIAL TESTING

Procedures

ISO-Standard. The dynamic stiffness of materials used under floating floors is measured according to ISO 9052-1 [1]. Meanwhile this standard has been adopted as CEN-standard forming the basis for judging the impact sound insulation properties of insulation materials traded within the European Community (EC). According to the standard, the test specimen of dimensions (200 x 200) mm^2, laid to a massive base, is subjected to a loading plate with a mass of (8 ± 0,5) kg. The resulting load of 2 kNm^{-2} corresponds to average loads put to floors in dwellings. The system can be exitated by sinusoidal signals, white noise or pulse signals. For sinusoidal signals, by varying the frequency of exitation the resonance frequency is obtained from which the apparent dynamic stiffness per unit area of the specimen is calculated. In case of porous resilient materials, such as mineral wool, the dynamic stiffness of the enclosed gas has to be added. For non-porous materials such as polystyrene foam materials or for materials with high airflow resistivity ($r \geq 100$ kPa s m^{-2}) the dynamic stiffness of the enclosed air has not to be taken into account.

DIN-standard. In the German speaking countries (A, CH, D) so far the DIN-standard DIN 52214 has been applied which subjected the test specimen to a pre-load of 50 kNm^{-2} for a time interval of 2 minutes prior to the measurement of dynamic stiffness [2]. In the past, the pre-load was introduced in order to decide whether an insulation material will be appropiate for use under floating floors. In case the compression was higher than 5 mm compared to a reference value obtained under a load of 0,25 kNm^{-2} the material was rejected for use under floating floors.

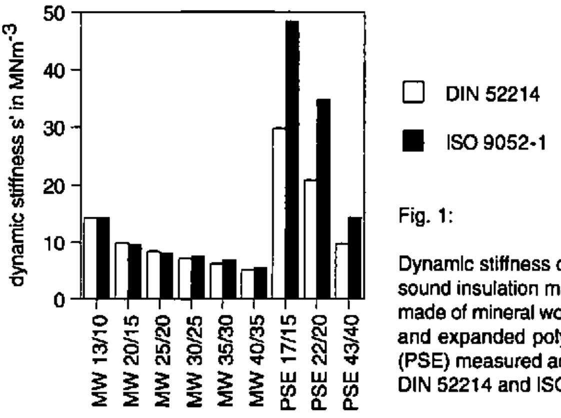

Fig. 1:

Dynamic stiffness of impact sound insulation materials made of mineral wool (MW) and expanded polystyrene (PSE) measured accord. to DIN 52214 and ISO 9052-1

Results

The dynamic stiffness of common impact sound insulation materials made of mineral wool (MW) and expanded polystyrene foam (PSE) were measured according to the measurement procedures given in both standards. The results show that the pre-load influences the measured value of the dynamic stiffness depending on material type (Fig. 1). While for slabs made of mineral wool (MW) with preferably horizontal fibre orientation the pre-load shows no significant influence on the measured value of the dynamic stiffness, for expanded polystyrene (PSE) the measured dynamic stiffness depends strongly on the pre-load. The increase for the latter material group is about 50-70% without pre-load in comparison with a pre-load of 50 kNm^{-2}. Under practical conditions during installation on site impact sound insulation materials are not subjected to a pre-load. This means that the pre-load specified in DIN 52214 causes an irregular influence compared to the properties of the impact insulation material installed.

3. ESTIMATION OF ACOUSTIC PERFORMANCE

Based on *Cremer*'s theory the reduction of impact sound pressure level ΔL of a floating floor of infinite size increases with 12 dB/octave [3]. Calculated values correspond quite well with laboratory measurement results on floating floors made of asphalt-mastic or dry floor constructions. Due to their lower loss factor, cement and calcium-sulphate screeds with common dimensions in dwellings cannot be regarded as of infinite size causing substantial deviations from the given relation [4]. An appropiate relation for these cases leads to an increase of 9 dB/octave [5].

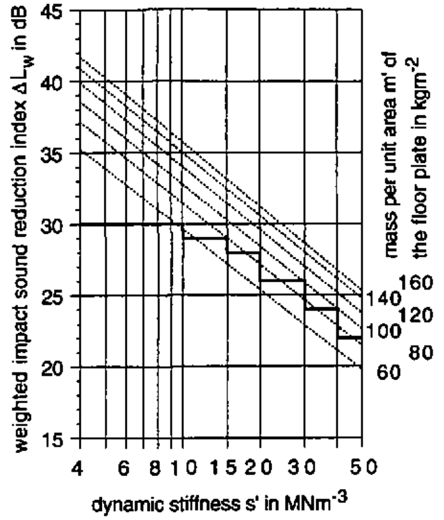

Fig. 2:

Weighted impact sound reduction index for cementitious and calcium-sulphate screeds accord. to:

···· CEN/TC126/WG2-N138

— DIN 4109, Suppl. 1 ($m' > 70\ kgm^{-2}$)

Based on these assumptions diagrams showing the weighted impact sound reduction index ΔL_W in dependance of dynamic stiffness and the surface mass of the floor plate are presented in the future CEN-calculation standard [6] dealing with estimation of impact sound transmission (Fig. 2). The calculation procedure, currently applied in Germany according to DIN 4109 does not take into account the increase of the weighted impact sound reduction index below $s' < 10\ MNm^{-3}$ and neglects the effect of varying surface mass of the floor plate.

4. COMPARISON WITH MEASURED DATA

In order to study the effect caused by the pre-load on the estimated impact sound insulation and the corresponding estimation procedure, measurement results from 27 floors in common German building situations were compared with values calculated according to DIN 4109 [7] and to the future CEN-calculation standard [6]. The first group (cases No. 1-7) consisted of floating floors on mineral wool slabs, while the second group (cases No. 8-27) were of expanded polystyrene (EPS).

The results are given as differences in weighted impact sound pressure levels "measured - estimated" (Fig. 3). Thus, the difference being negative means that the prognosis is too pessimistic compared with the measurement results. In these cases, the measured performance was better than estimated. On the other hand, positive values indicate optimistic results where the impact sound insulation in-situ is worse than estimated.

The prognosis of impact sound insulation based on DIN 4109/DIN 52214 are in general too pessimistic compared with the measured results for floors with floating floors on mineral wool slabs (cases 1-7, Fig. 3a.). In contrary, for floating floors on EPS the estimated impact sound insulation according to the DIN-procedure is mostly judged to be better than what can be proved by field measurements (cases 8-27, Fig. 3). This indicates, that the estimation of the weighted impact sound reduction index of floating floors by use of data on dynamic stiffness obtained by application of the DIN-preload leads to overall wrong estimates.

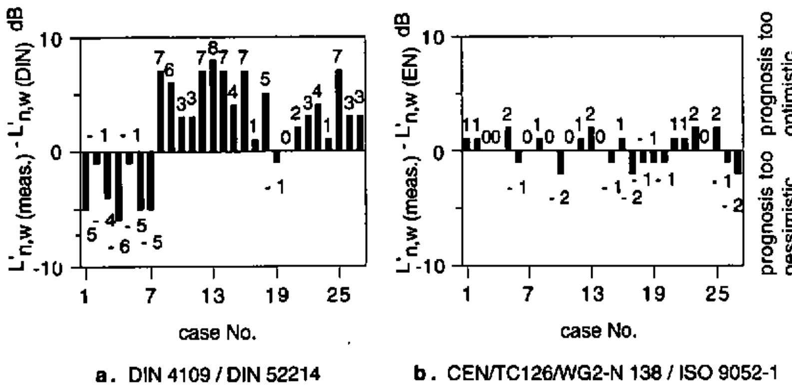

Fig. 3: Comparison between measured and estimated values of the weighted normalized impact sound pressure of floors according to ...

By estimating the impact sound insulation according to the CEN-calculation procedure and the dynamic stiffness measured without pre-load according to ISO 9052-1, the deviations to measured results in field situations decrease. In addition, no grouping effect depending on material type occurs.

5. CONCLUSION

The dynamic stiffness measured according to ISO 9052-1 without pre-load represents correctly the material characteristics compared with acoustical performance of materials installed on site.

References

[1] ISO 9052-1: 1989 (E), Acoustics, Determination of dynamic stiffness, Part 1: Materials used under floating floors in dwellings.

[2] DIN 52214, Bauakustische Prüfungen, Bestimmung der dynamischen Steifigkeit von Dämmschichten für schwimmende Estriche, Dezember 1984.

[3] Cremer, H.; Cremer, L.: Theorie der Entstehung des Klopfschalls, Frequenz 3 (1948), S. 61-71.

[4] Metzen, H.A.: Zur Beurteilung der Trittschallminderung schwimmender Estriche auf Grundlage der dynamischen Steifigkeit von Dämmschichten, wksb, Neue Folge, Heft 36 (1995), pp. 16-23.

[5] ÖNORM B 8115-4, Schallschutz und Raumakustik im Hochbau, November 1992 .

[6] CEN/TC 126/WG 2-N 138: Building Acoustics, Estimation of acoustic performance of buildings from the performance of products, Part 2: Impact sound insulation between rooms, Draft december 1994.

[7] DIN 4109, Supplement 1: Sound insulation in buildings, Design examples and calculation procedure, November 1989.