

## Report JDQA-2012-1

Sound Transmission Ratings for 5 Floor Assemblies with Armoroc concrete deck panels on TOTAL JOISTS by iSPAN Systems LP

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The objective of this study is to estimate sound transmission ratings (Sound Transmission Class according to ASTM E413 and Impact Insulation Class according to ASTM E989) for a set of five floor assemblies with TOTAL JOISTS supporting a floor deck of Armoroc fiber-reinforced concrete panels. This set of assemblies includes the base floor assembly plus four floors with floor finishes installed over the concrete deck panels of the base assembly.

The estimates were established by extrapolation from previous acoustic tests of similar assemblies with TOTAL JOISTS, combined with data on similar generic constructions from published reports. The main report presents the STC and IIC estimates in concise tabular format. An appendix to the report gives details on the source data used, and the analysis process, to facilitate engineering assessment of the results by third party evaluators.

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## THE BASE FLOOR ASSEMBLY

The base floor assembly has a deck of Armoroc fiber-reinforced concrete panels supported by a TOTAL JOIST floor assembly, with insulation batts between the joists, and a ceiling of 15.9 mm fire-rated gypsum board suspended on resilient metal channels. The elements are the same as those of the specimen for NRC Contract Report B3454.1, with the substitution of Armoroc panels for USG Fortocrete panels:

- Armoroc fiber-reinforced concrete panels, 19 mm (3/4 in.) thick;
- Assembly of TOTAL JOISTS 305 mm (12 in.) deep, spaced 610 mm (24 in.) on center, with bridging and blocking;
- Glass fiber insulation batts between the joists, nominal 89 mm (3.5 in.) thick;
- Resilient metal channels spaced 305 mm (12 in.) on center, screwed to the bottom of the joists;
- Ceiling of 15.9 mm (5/8 in.) thick USG/CGC FireCode C gypsum board, screwed to the resilient metal channels.

Floor Assembly	STC ( ±1 )	IIC ( ±2 )	Based on NRC Test
<b>Base assembly</b> Bare Armoroc concrete panels	56	33	B3454.1
<b>With vinyl flooring</b> Vinyl sheet flooring (2.5 mm thick, 0.93kg/m <sup>2</sup> ) glued to the Armoroc panels	56	41	B3454.1
<b>With carpet on pad</b> 11 mm carpet (1.9 kg/m <sup>2</sup> ) on 9 mm carpet underlay (1.1 kg/m <sup>2</sup> ) laid over Armoroc panels	58	62	B3454.2
<b>With laminate flooring on pad</b> 8 mm Pergo engineered laminate flooring(7.3 kg/m <sup>2</sup> )on 2 mm foam underlay (0.06 kg/m <sup>2</sup> ) laid over Armoroc panels	60	45	B3454.3
<b>With ceramic tile on underlayment</b> 6 mm thick ceramic tile and grout (11.3 kg/m <sup>2</sup> ) on 13 mm Fiberock underlayment(13.2 kg/m <sup>2</sup> ) screwed to the Armoroc panels	58	35	B3454.8

**Table 1:** Estimated sound transmission class (STC) ratings according to ASTM E413 and impact insulation class (IIC) according to ASTM E989 for the floor assemblies with flooring finishes as indicated. Note that these ratings apply to direct sound transmission through the floor assembly, in the absence of structure-borne flanking transmission (which is the rating specified in current building codes in Canada and the USA). Actual sound insulation in a building (ASTC or NNIC for airborne sound, or AIIC for impact sound) may be lower.

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## APPENDIX: SOURCES AND ANALYSIS

The estimates were developed by extrapolation from sound transmission data on similar assemblies – both assemblies with TOTAL JOISTS and assemblies with generic steel joists.

### Reference assembly for base floor

An obvious point of reference is specimen B3454.1 (from reports on NRC contract B3454), which has Fortocrete fiber-reinforced concrete panels on 305 mm iSPAN joists (now designated as TOTAL JOISTS by iSPAN Systems LP). The components of specimen B3454.1 are identical to those of the base specimen of concern here, except that the Fortocrete deck panels are replaced by Armoroc panels in the present design.

### Assessing the difference for the base floor

To estimate how the change in the physical characteristics of the floor deck would affect STC and IIC, the change was calculated using regression expressions developed by the National Research Council of Canada (NRC). NRC has performed several major studies of sound transmission through common floor assemblies, in collaboration with a broad group of industry partners. These are described in detail in NRC reports IR-811 and RR-169, which are publicly available at <http://www.nrc-cnrc.gc.ca/eng/ibp/irc/publications/index.html>. A systematic analysis of the combined data from these studies is presented in RR-169. This includes regression analysis of the sound transmission results. For airborne sound transmission (STC) the regression analysis was performed on a set of 170 floors with various types of joists and gypsum board ceilings supported on resilient metal channels. For impact sound transmission (IIC), the data were separated into two sets – 144 floors with “wood” decks and 15 with concrete or gypsum concrete surfaces – because “hardness” of the top surface tends to mask dependence on other construction details. The regression analysis established dependence of the STC and IIC on variables such as mass of the surfaces, joist spacing, type and thickness of insulation, etc.

The only pertinent variable that changes between B3454.1 and the present base assembly with Armoroc is the mass of the floor deck:

- For specimen B3454.1 the Fortocrete panels had a measured surface density of 23.38 kg/m<sup>2</sup> and nominal thickness of 19 mm (3/4 in.);
- For the current base assembly, the 3/4 -inch thick Armoroc panels have an expected surface density of 23.47 kg/m<sup>2</sup> (published density of 77 lb./cu. ft., thickness of 3/4-inch)

On the basis of these surface densities, the regression expressions indicate that:

- STC should change by  $14.2 \log(23.47/23.38) = +0.02$  dB
- IIC should change by  $43.6 \log((23.47+12.3)/(23.38+12.3)) = +0.05$  dB

***Thus acoustical performance should be marginally better with the Armoroc panels, but the difference is very small, so the STC and IIC ratings (which are limited to integer values) are unchanged.***

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### **Assessing the effect of added flooring**

The second stage of the analysis dealt with estimating the effect of adding four common types of flooring to the base floor. The changes are quite different for the airborne and impact estimates. To perform these estimates, additional sources of data were used, including:

- Other specimens from reports on NRC contract B3454 provide sound transmission data for the same base assembly with Fortocrete panels covered by three of the floorings: carpet (Report B3454.2), laminate flooring (Report B3454.3) and ceramic tile (Report B3454.8). In each of these cases, the same corrections given above for the base floor were applied to account for the change from Fortocrete to Armoroc; because these corrections are very small, the resulting STC and IIC values with these floorings match those measured for the corresponding floors in the B3454 series.
- To obtain an estimate for the case with vinyl flooring, unpublished results from the NRC laboratory for flooring added to various assemblies being tested for clients were used. These tests were funded by NRC (with the clients' permission) to obtain data to provide a framework for future consideration of IIC requirements in the National Building Code. In these cases, all the bare floors had gypsum concrete topping at least 25 mm thick. The improvement measured with the standard tapping machine when the vinyl flooring was added on these decks (which are heavier and less "hard" than the Armoroc panels) provides a slightly conservative estimate of the improvement expected due to adding vinyl flooring over the base floor with Armoroc panels.

These comparisons, which all involve small changes from measured cases, provide the basis for credible estimates for the STC and IIC when the base floor with Armoroc is enhanced with the four types of added flooring.