FURTHER PREDICTION OF HEAVY WEIGHT DROPS ON RESILIENT SPORTS FLOORS IN EXISTING BUILDINGS

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1 Introduction

The issue of heavy weight drops in buildings has been an issue for a number of years [1–6]. Currently, the assessment of the noise and vibration due to heavy weight drops in an existing building can be quite cumbersome. All of the potential floor coverings and the heavy weights need to be shipped to site. Typically, the impact sources used onsite are whatever happens to be present at the site. Overall, this testing regimen is quite arduous, time consuming, and not very repeatable. In recent years, the authors have built a drop tower to repeatedly test fitness flooring performance in a controlled environment [4–6]. This paper looks at ways to predict the in situ performance of fitness flooring by incorporating force pulse data collected from a drop tower and measured transfer functions. This would be a narrow band analysis that can be converted into one-third octave bands as opposed to the one-third octave band analysis that others [7] have suggested. That analysis used a method similar to the Delta IIC in ASTM E2179 [8].

2 Experimental Setup

For this experiment, three different performance levels of fitness flooring were used. They are, in increasing performance order, GenieMat FIT08, a 8 mm recycled rebounded rubber sheet, GenieMat FIT30, a 30 mm recycled rebounded rubber tile and GenieMat FIT70, a 70 mm recycled rebounded rubber tile.

The fitness flooring tiles were installed on a second floor composite deck at the Pliteq laboratory in Woodbridge, ON for a sudo-field test. A machined, semi-spherical mass was lifted to an initial height of 0.5m above the fitness floor Fig 1. It was released from rest and allowed to impact once before it was caught. Two accelerometers were placed on the same composite deck as the fitness tiles a few meters away. The vibration at each accelerometer was measured due to drops on each of the different fitness flooring solutions.

The force pulse was measured on the three different fitness flooring with Pliteq's proprietary drop tower Fig 1. Two carriages are supported on low friction rails as to only allow one axis of motion. The upper carriage lifts the lower carriage to a selected height and releases it so that the lower carriage will impact the test specimen with close to free-fall like conditions. The lower carriage can be fitted with various load plates to adjust the mass of the lower carriage and impact foot shape can be changed to simulate different types

Figure 1: Sudo field testing of fitness tiles

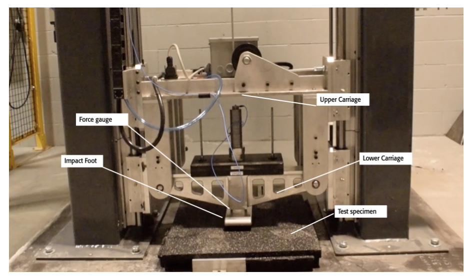

Figure 2: Heavy Weight Drop Tower at rest

of weight impacts. A load cell measures the impact force pulse. For this experiment, the weight of the lower carriage was adjusted to match the semi-spherical mass used for the sudo-field test and released from 0.5m

An impact sledge hammer was used to impact the same location as the heavy weight drop on the composite deck. The force impulse and the resulting accelerations were measured. The impact hammer input force and resulting vibration were used to calculate a transfer function. This

transfer function was combined with the force pulse obtained from the drop tower to derive an estimated acceleration that can be compared to the actual measured vibration.

3 Results and Analysis

The measured force pulse on the three types of fitness flooring are shown in Fig 3. These measurements were obtained from the drop tower after improvements were made to reduce high frequency noise compared to what was used previously [6]. As expected, as the fitness flooring increases in performance, the force pulse decreases in amplitude and increases in contact time. The frequency response also changes such that the cutoff frequency of the apparent low pass filter decreases.

These force pulses were combined with the measured transfer function to calculate an estimated time history and frequency response of the resulting vibration due to a heavy

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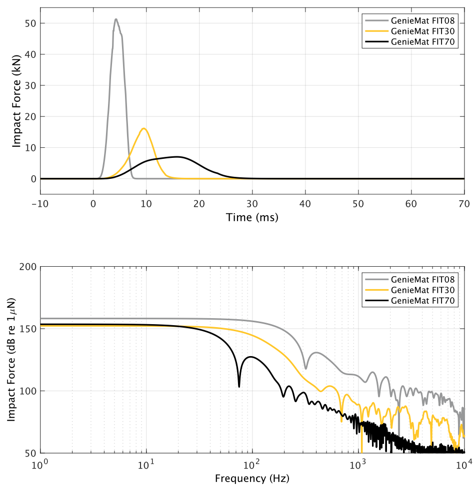

Figure 3: Measured Force Pulse on GenieMat® FIT

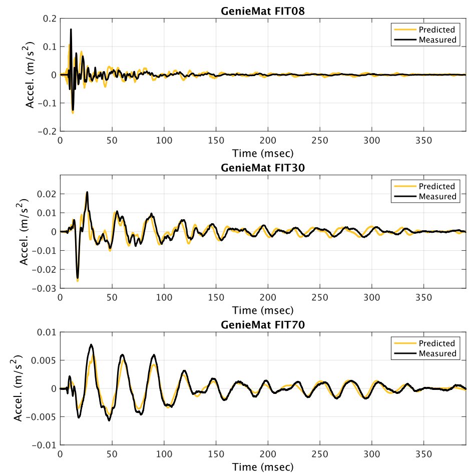

Figure 4: Predicted vs Measured Vibration in Time Domain

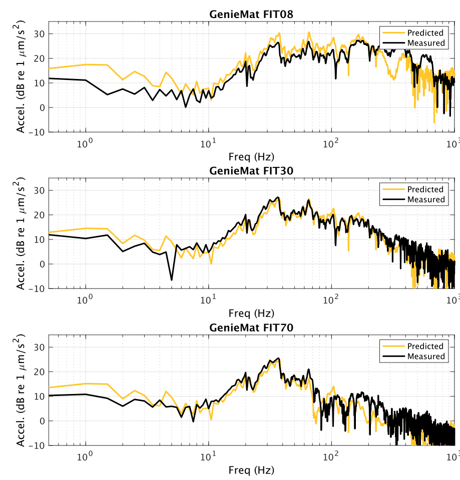

Figure 5: Predicted vs Measured Vibration in Frequency Domain

weight drop. The predicted verse measured time history is shown in Fig 4. The predicted verse measured frequency response is shown in Fig 5.

The three sets of time histories and frequency responses show good agreement. The frequency response estimates for all three fitness floorings show the best agreement with the measured response above 10 Hz. Below 10 Hz, the predicted level is always greater than the measured response, therefore, the estimate can be used as a worse case. The predicted frequency response for impact on GenieMat FIT30 and GenieMat FIT70 is very close above 10 Hz. However, the predicted frequency response for the impact on GenieMat FIT08 is higher then the measured. This may be a result of nonlinear damping in the structure that is present as the amplitude of vibration increases. Further work is warranted.

4 Conclusions

As previously shown, the force pulse of a heavy weight dropped on fitness flooring can be measured in a controlled laboratory environment. A transfer function between the impact force at one location and the acceleration at a second location can be measured. This transfer function can then be combined with the laboratory measured force pulse to obtain an estimated time and frequency response. This calculated estimate shows good agreement with the in situ measured time and frequency response due to a heavy weight impact. Further work is needed to improve the methodology and to extend this methodology over larger distances and building types.

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