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Building glass OITC in warm temperature

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Abstract

Glass installed for building façade ideally possesses significant level of outdoor indoor transmission class (OITC) so it does not decrease OITC of conventional wall façade significantly. This study is about OITC of glass building in the temperature warmer than the one outlined by ASTM E-90, as it is commonly experienced in a tropical environment. Monolithic, laminated and tempered glass were tested using ASTM E-90 and calculation of OITC was conducted using ASTM E1332-90. Modification of room temperature was made to replicate warmer temperature like the temperature in a tropical environment, whilst other specifications was made based on ASTM E-90. The test showed that at higher frequency of 630 Hz and above, laminated glass performed slightly better insulation compared to monolithic and tempered but the OITC of laminated glass was dropped to 29, caused by a very sharp coincidence dip at frequency of 125 Hz which was 17 dB only. This explains that within temperature approximately 5°C warmer than the one outlined by ASTM E-90, laminated glass used for building façade would not perform noise insulation better; it is different from many earlier studies which concluded laminated glass had better sound insulation compared to monolithic and tempered glass in term of STC and OITC.

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Keywords: monolithic glass, laminated glass, tempered glass, warm temperature, OITC

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1. Window Glazing

Substitution of conventional masonry walls by glass walls is now widely applied, especially for high-rise buildings. However, glass producers and users are mostly put their outmost concern to solar and thermal control of the glass. A very little attention is put to consider sound transmission aspect. As glazing walls are usually thinner than masonry walls, the sound insulation property decreases accordingly [1,2,3]. In order to provide similar sound insulation like masonry walls, glazing walls should possess significant outdoor-indoor transmission class (OITC) close to that of masonry wall which is 43 to 49 depending on the thickness [4]. Glass manufacturers' manual shares limited information on sound insulation property of their products. When available, it is mostly in terms of sound transmission class (STC). In fact, STC is a method of predicting sound insulation property of vertical building materials which is for indoor usage such as partition wall. The STC calculation does not include low sound frequencies which exist in environmental noise, especially transportation noise. This causes STC of glass may not be directly referred for sound insulation of façade installation. OITC of such vertical building elements is usually lower than the STC caused by lower transmission loss at low frequencies, i.e. 80 Hz and 100 Hz. Coincidence dip that exists in the contour may also decrease insulation property of a material from its STC to its OITC, especially when the dips are at low frequency of 80 Hz and 100 Hz [5].The occurrence of coincidence dip is controlled by material's stiffness and thickness and happens at the point where the sound transmitted through the material equals the natural frequency of the material installed [6,7]. The thicker and stiffer the glass is, the lower the frequency at which the 'dip' occurs is [7,8]. When specific frequencies are targeted for noise reduction, an analysis of where the frequency 'dip' appears for any glass types under consideration is important. When all of 1/3 octave band frequency is in the noise spectrum, OITC single number may be used as reference, with particular consideration to frequency at which the frequency 'dip' appears [9]. This explains STC information provided by glass manufacturers may not be directly used as OITC.

Indoor living spaces are suggested to maintain interior noise levels at 45 to 50 dBA (approx. NC 40 to 45) or lower [10,11]. Thus, replacement of masonry wall to the lighter and thinner glass wall ideally provides interior noise levels close to that of proximity by having high OITC rating with minimum coincidence dips.

2. Glass façade in Indonesia

The use of glass façade in low and high-rise buildings is also a trend in Indonesia, either for operable windows or glass walls. The fact that this thinner material provides lower noise insulation gets worse with minor installation details and improper supporting materials. These issues are very common in Indonesia, due to loose noise regulation and limited knowledge and awareness of Indonesians on noise [12].

Leading glass manufacturers in Indonesia, i.e. Asahimas glass do not provide detailed information on noise insulation capability of glass as building façade. Asahimas provides STC of glass only excluding the OITC [13]. Although currently it is not required by the International Building Code [14] nor by Indonesian Building Regulation [15] and in most cases STC is not sufficient for outdoor usage, information on façade OITC is important, especially due to rapid increment on environmental noise.

Studies on acoustical property of glass have been conducted in cities and countries with different climate to that of Indonesia. Thus, they cannot be fully adopted in Indonesia. Standard for conducting acoustical testing of partitions, including glass partitions was set to comply room temperature in the range of 22 ± 5°C (ASTM [16]), which rarely happens in Indonesia. Even if molecular formation of glass only responds to temperature above 600°C [17,18], a testing condition close to daily temperature in Indonesia is considered important to see whether temperature difference between ASTM and actual daily temperature in Indonesia affects sound transmission within 1/3 octave band frequency assigned. The occurrence of certain coincidence dip which would affect the OITC single number would also be observed.

In the last ten years, many cities in Indonesia have average annual temperature of 28°C as in Jakarta, the capital city [19,20,21]. The maximum temperature might reach up to 33°C [19]. Considering this issue, investigation on glass OITC in warmer daily temperature in Indonesia was carried out. The result is reported in this paper.