WIND TUNNEL EXPERIMENT ON WIND PRESSURES ACTING ON THE SHIELDING SCAFFOLDS

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1. INTRODUCTION Temporary scaffolds are usually covered with soundproof panels or plastic sheets to prevent falling of the construction equipments from the scaffolds. However, the wall openings occurred during construction or dismantlement of the window panels, etc., can significantly increase wind pressures acting on the temporary scaffolds depending on wind direction[1)]. The increase of wind pressures can affect the stability of the scaffolds and lead to the total collapse of the scaffolds which can cause injure or dead. Only few studies have concerned about this problem. More knowledge and information is still necessary[2), 3)]. In this study, a series of wind tunnel experiments was conducted to measure the wind pressures acting on the 1/150 scale 0% porosity simplified scaffolds models. As a first step for this study, the building model without opening was used and the uniform wind condition was considered. The experimental results of the maximum and minimum pressures acting on the scaffolds are presented.

2. WIND TUNNEL EXPERIMENT In this study, three types of experiment categorized by the location of scaffolds around the building were considered: Type 1. Scaffolds cover front side of the building (the side that faces wind direction, β, of 0°), Type 2. Scaffolds cover right side of the building (the side that faces wind direction of 90°), and Type 3. Combination of type 1 and 2 (L-Shape of scaffolds cover both front and right sides of the building). A building model has a size of 128 mm wide, 248 mm long, and 126 mm high. Width-height-thickness of the scaffolds models type 1 and 2 are 132-132-7 (mm) and 252-132-7 (mm), respectively. The wind tunnel used in this study is a boundary layer wind tunnel of horizontal closed-circuit type with a test section width of 2.3 m and height of 2 m. Since the roughness of wind tunnel ground surface causes the wind boundary layer in the vertical wind speed profile (approximately 200 mm), thus the scaffolds and building models were placed in the center of the elevated turntable (at the elevation of 0.65 m) in a wind tunnel so that the models were in a uniform wind condition as much as possible. The distance between the scaffolds models and the building model is 2 mm. The experimental configuration is shown in Fig.1.The pressure sensors were uniformly distributed over 16 and 32 points on each side of the scaffolds models (the side faces against the building and the side faces surrounding) for Type 1 and 2, respectively. The wind speed used in the experiment was always set at 10 m/s. The sampling frequency and the measurement duration time were 256 Hz and 30 sec, respectively. The wind directions considered in this study were from 0 to 360 degree with 30 degree increment.

The vertical wind speed and turbulence intensity profile above the turntable surface are shown in Fig.2. It can be seen that the wind boundary layer height is low as about 35 mm and the turbulence intensity is less than 1% at the height in the gradient wind.

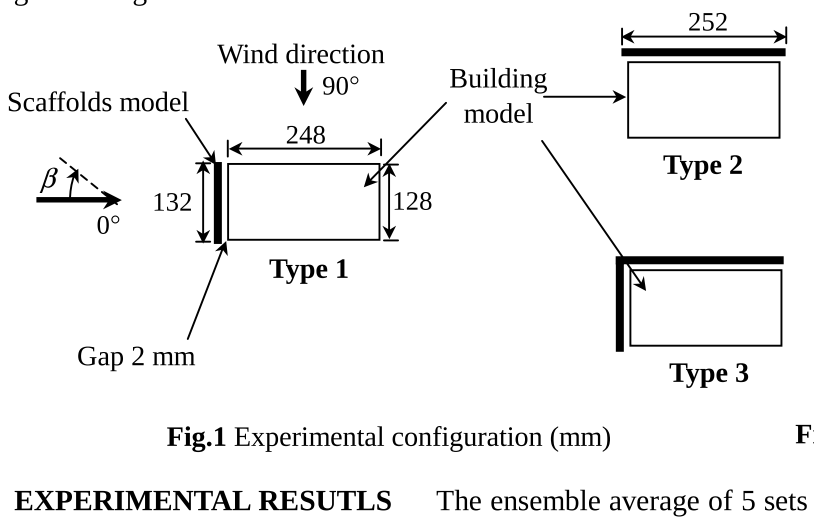

Fig.1 Experimental configuration (mm)

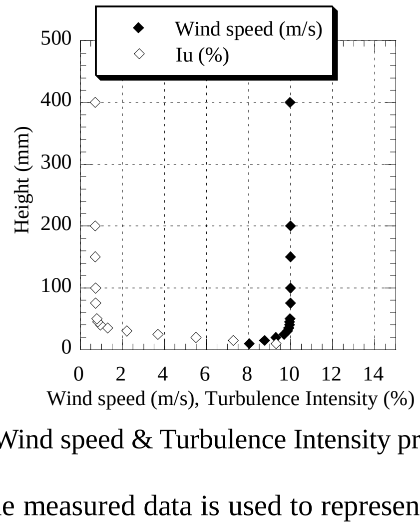

Fig.2 Wind speed & Turbulence Intensity profile

3. EXPERIMENTAL RESUTLS The ensemble average of 5 sets of the measured data is used to represent the mean wind pressure acting on the scaffolds models. Fig. 3a-c show the experimental results presented in terms of the resultant pressure coefficient distribution (plotted in contour lines), $C_p = (P_{out} - P_{in})/P_{ref}$, where P_{out} is the pressure acting on the outer side of the scaffolds model (the side faces surrounding), P_{in} is the pressure acting on the inner side of the scaffolds model that faces the building model, and P_{ref} is the wind pressure at the reference height located in the gradient wind which is obtained from the Pitot tube for this study. The presented results were selected

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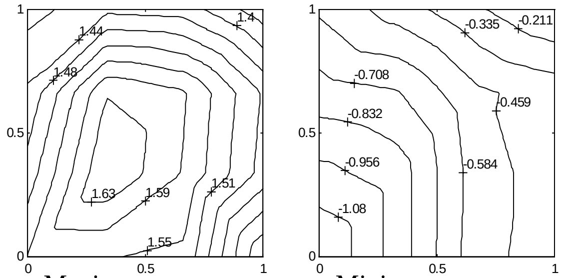
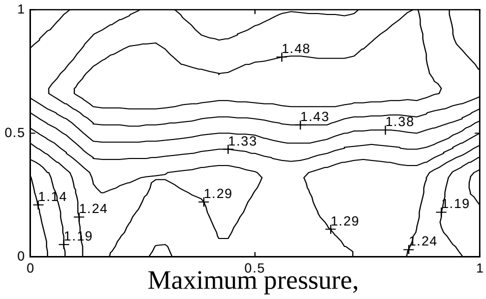
for the cases that have maximum and minimum pressures acting on each type of the scaffolds models. The plot represents the surface that is viewed from the outer side of the scaffolds models. Both x-y axes represent the width and height of the scaffolds models. They are normalized to have the maximum value of 1.

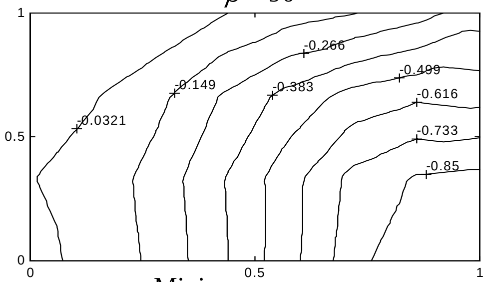


Maximum pressure, $\beta = 0°$ Minimum pressure, $\beta = 90°$

Fig. 3a Max. and Min. pressure for Type 1 scaffolds

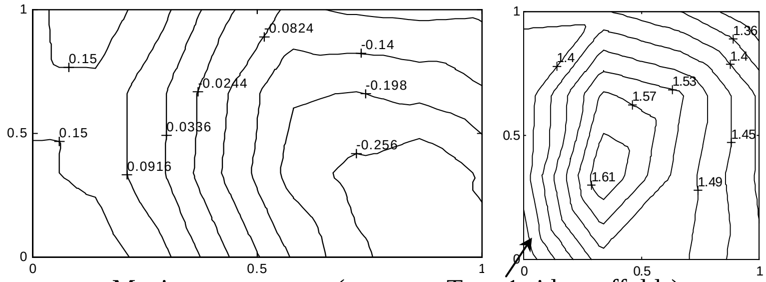


Maximum pressure, $\beta = 90°$

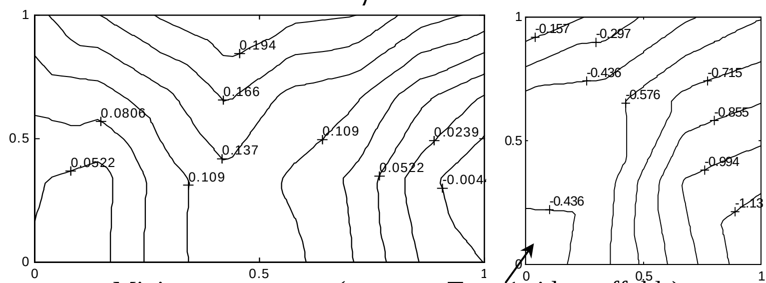


Minimum pressure, $\beta = 0°$

Fig. 3b Max. and Min. pressure for Type 2 scaffolds



Maximum pressure, (occurs at Type 1 side scaffolds) $\beta = 0°$



Minimum pressure, (occurs at Type 1 side scaffolds) $\beta = 270°$

Fig. 3c Max. and Min. pressure for Type 3 scaffolds

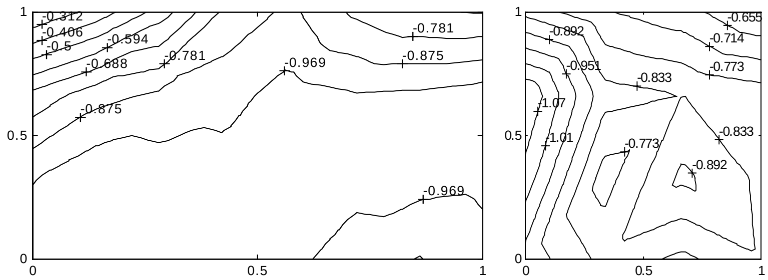


Fig. 4 Pressure distribution on Type 3 scaffolds for $\beta = 210°$

It can be seen that the pressure is maximum when the wind direction is directly acting normal to the scaffolds and minimum when the wind direction is acting along the scaffolds. However, for type 3 scaffolds, due to the different sizes of the scaffolds at front and right sides of the building models, the maximum and minimum pressures occur at type 1 side (front panel) scaffolds for the cases of β = 0° and 270°, not at type 2 side of scaffolds for β = 90° and 180°. Moreover, there are interesting results for the Type 3 scaffolds experiment for the wind direction of 210°. It is found that there are high negative pressures around the connection corner of the front and side panels of the scaffolds as shown in Fig.4. This is because there are high positive pressures acting on the inner surface of the scaffolds that faces against building due to the wind enters in the gap between building and scaffolds.

5. CONCLUSIONS The results on the wind pressures distribution acting on the simplified scaffolds models were presented. The fundamental characteristics of the wind pressures acting on the scaffolds are known. Still more information and experiments are necessary. The experiments using building model with opening are further to be considered and conducted.

REFERENCE

1) Hino, Y., et al, 2001, "Causes and Problems of Construction Accidents due to Wind", *Proceedings of the 5th Asia-Pacific Conference on Wind Engineering*, Kyoto, pp. 373-376
2) Yoshida, S., et al, 1980, "Experimental Study of Wind Forces on the Scaffold with the Protective Sheets or Soundproof Panels", *Kajima Construction Research Institute Annual Report*, No. 28, pp. 129-136 (in Japanese)
3) Hollis, E.J., 1994, "Measurement of wind forces on net covered temporary scaffolds", *Structural Safety & Reliability*, pp. 1639-1646