WIND PRESSURES ACTING ON THE SCAFFOLDS IN CASE WHEN BUILDING HAS WALL OPENINGS

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1. INTRODUCTION The accident that frequently happens during construction and is found to kill or injure both pedestrians and construction workers is the collapse of the temporary scaffolds, which are generally covered with plastic sheets or soundproof panels to prevent falling of the construction equipments. Due to the building wall openings during construction or dismantlement that wind can pass through, the scaffolds are subjected to the wind forces that were not considered in the design stage since it has never been described in the design code or regulations. The scaffolds can collapse as a result[1)]. The purpose of this study is to investigate the fundamental characteristics of the wind pressure acting on the scaffolds erected alongside of a building with openings. It is found that the wind pressures acting on the scaffolds can be different due to existence of the openings and wind direction.

2. WIND TUNNEL EXPERIMENT The prototype of the building model was a 5 story square building with the size of 19.2 m wide and long, and 18.9 m high. The prototype scaffolds had a size of 19.8 m wide and high, and covered with soundproof panels. In this study, the experimental scale was set at 1/150. Thus, the scaffolds model used in the experiment was designed as a solid panel without porosity and had a square shape of 132x132 mm^2. The pressure sensors of 61 points were distributed on each side of the model as shown in Fig.1. In order to study the effects of wall openings on the wind pressure acting on the scaffolds, all wall sides of the building model were replaced with three types of the building wall as shown in Fig.2: Type A, the building wall without opening, Type B, the building wall with 50% opening ratio in which the openings were located in the middle, and Type C, similar to type B but the wall openings were located at the left and right side edges. All models were made of acrylic. The distance between the scaffolds and building models was set at 2 mm. The wind tunnel used in this study is a

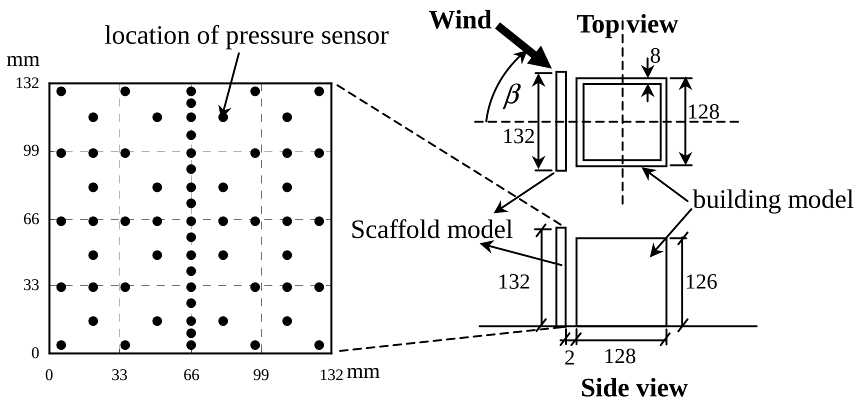

Fig.1. Model configuration & location of pressure sensors on scaffold (mm)

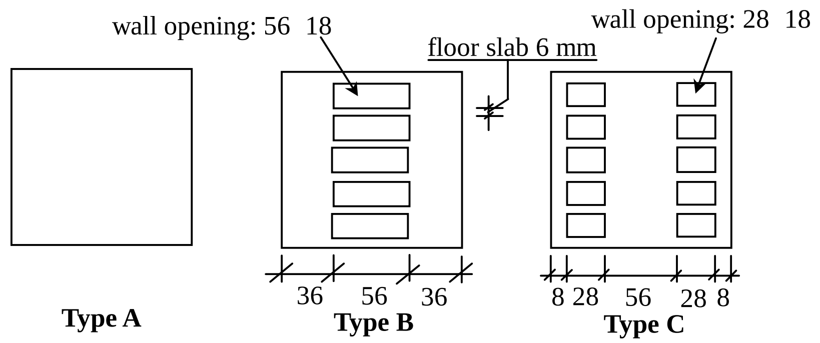

Fig.2. Type of building wall used in experiments (mm)

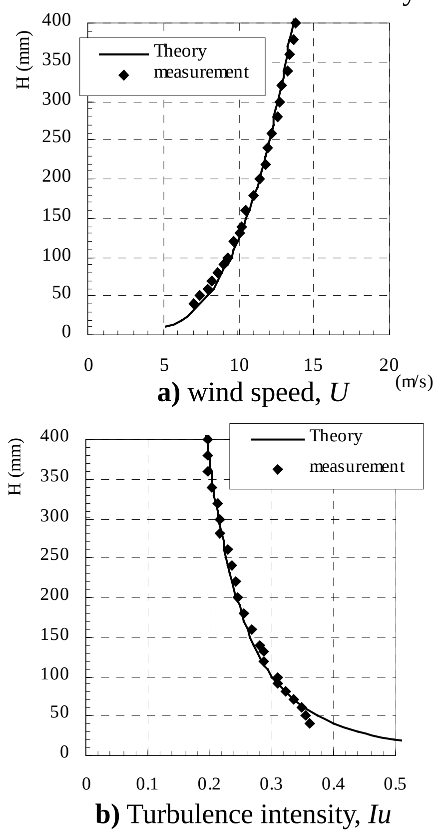

Fig.3. Wind characteristics in wind tunnel

boundary layer wind tunnel of horizontal closed-circuit type with a test section width of 2.3 m and height of 2 m. The vertical wind velocity profile of a city area was considered in the study by choosing the power law exponent, α, of 0.26. The wind profile was simulated using the roughness blocks and spires in the wind tunnel. The simulated mean wind speed and turbulence intensity profile are shown in Fig.3. The sampling frequency and the measurement duration time for measuring both wind speed and pressure were 256 Hz and 30 sec, respectively. The wind

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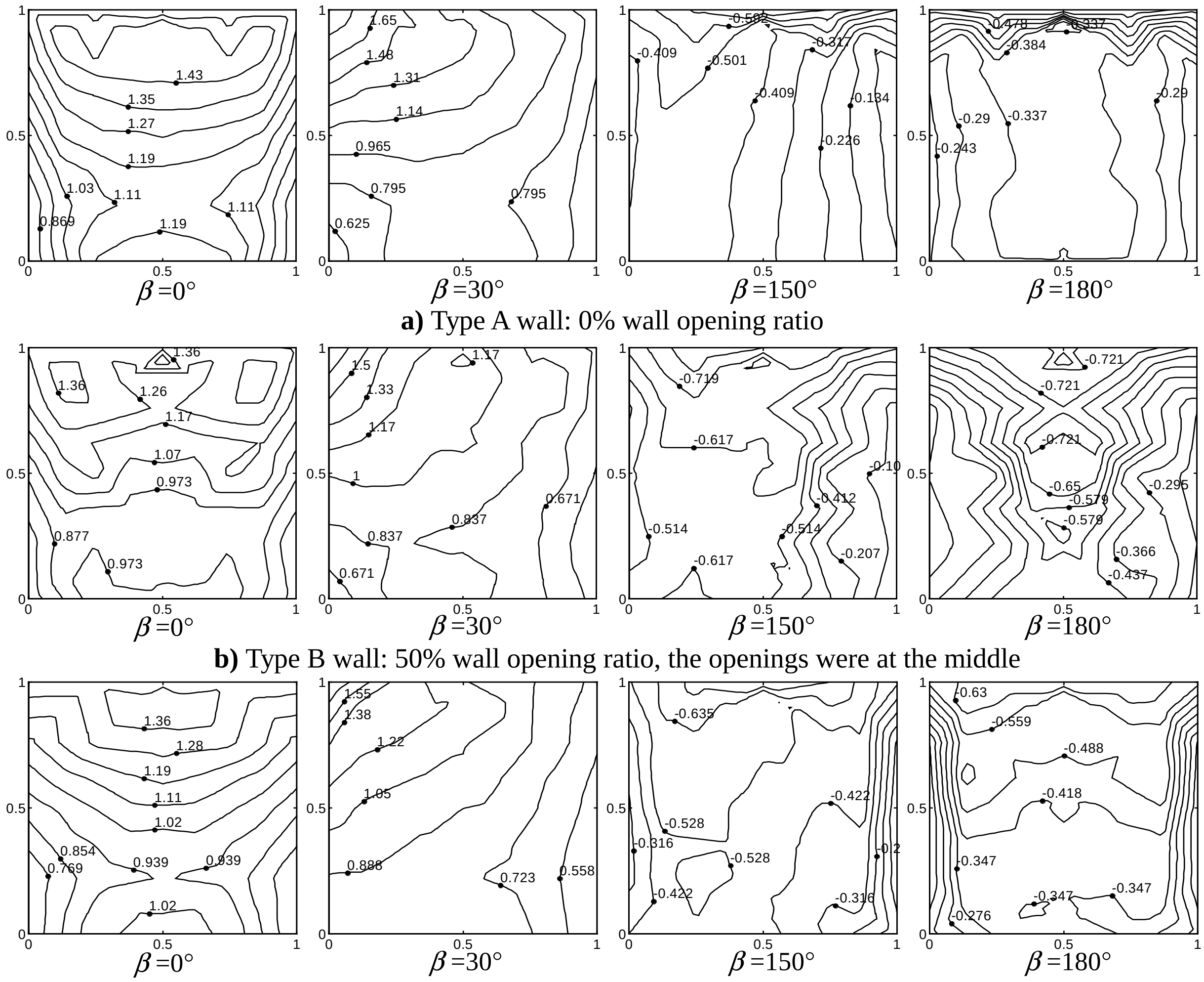
directions, β, considered in this study were from 0 to 180 degree with 30 degree increment. For each case of wind direction, the pressure measurement was taken 5 times. For all experiments, the reference wind speed was set at 10 m/s at the height of the top of the scaffolds model.

3. EXPERIMENTAL RESUTLS Fig.4 shows the results of the mean wind pressure acting on the scaffolds model presented in terms of the resultant pressure coefficient distribution (contour lines), $C_p = (P_{out} - P_{in})/P_{ref}$, where P_{out} and P_{in} are the pressure acting on the frontal and rear side of the scaffolds, respectively. P_{ref} is the wind pressure at the reference height. The presented results were selected for comparing the effects of the wall openings on the wind pressure. The plot represents the surface that is viewed from the frontal side of the scaffolds. Both x-y axes represent the width and height of the model. They are normalized to have the maximum value of 1. It is found that, for the building walls type B and C, wind that acts on the rear side of the scaffolds by entering the gap between the scaffolds and building or passing through the wall openings causes smaller positive pressure when β = 0° and about twice larger of negative pressure when β = 180° than the case of type A wall at locations near the openings. Although the magnitude of that increase negative pressure when β = 180° is not large as the positive pressure when β = 0°, it becomes the case that has maximum negative pressure (for type A wall, the maximum pressure occurs when β = 90°, however, the results are not presented here). For other wind directions that close to 0°, the wind pressure distributions for the wall type B or C are similar and slightly less than those of type A. But for the wind directions close to 180°, since wind can pass through the wall openings at the rear side of the building and act on the rear side of the scaffolds, the wind pressure distributions for the walls type B and C are different from type A.



a) Type A wall: 0% wall opening ratio

b) Type B wall: 50% wall opening ratio, the openings were at the middle

c) Type C wall: 50% wall opening ratio, the openings were at left and right edges

Fig. 4 Wind pressure distributions on the scaffold model for different types of wall

5. CONCLUSIONS The results on the wind pressure distribution acting on the scaffolds model were presented and compared between the cases of the building walls with and without openings. With the wall openings, the pressure distribution acting on the scaffolds can be different depending on wind direction.

REFERENCE

1) Hino, Y., et al, 2002, "Wind Pressure Acting on Scaffolds Erected Alongside of the Building with Holes in Exterior Walls", *Proc. of the 2nd Int. Symposium on Advances in Wind & Structures*, Korea, Busan, pp. 463-470