the upper and lower surface of the cylinder. This transition region from the experimental data of Shim[27] is not as readily perceived as in the LES computation, in that the measurements were taken in 10-degree increments from the forward stagnation point to the opposite side of the cylinder. For the discernible wiggle from the present calculations in the range of $\theta \in [80, 120]$, the likely reason is entrainment of shear layer fluid on to the cylinder surface owing to the interference from the close arrangement of cylinders.

To the best of the authors' knowledge, there is so far no information available on the pressure distribution around the surfaces of cylinders in a tube bank from LES. It is of interest, thus, to show mean pressure distribution around the surface of the downstream cylinders in terms of the equation 24, and to further compare the results measured by Shim [27]. As far as the positive values of base $\overline{C}_p$ obtained from the downstream cylinders are concerned, it also results from the definition of $\overline{C}_p$ in this work. It can be observed that the results from the two distinct approaches are very comparable across the figure 6b, c, d. Because of the wake from the first column of cylinders which impinges upon the downstream second column of cylinders, a rise of mean pressure value is to be expected within the windward side. In particular, as can be observed from the figure 6a and 6b, they display distinct shapes for mean pressure distribution. The rise of mean pressure distribution is clearly discernible within the range of $\theta \in [0^o, 40^o]$ in figure 6b. It is interesting to note that the two peaks lie nearly to the same position around $\theta = 40^o$ in Figure 6b. Moreover, it is worthwhile noting that the difference from the pressure of front stagnation point and the base pressure is reduced significantly compared to the corresponding cylinder from the first column. This is attributed to the turbulence level of approaching flow since it is located within the wake. In contrast to figure 6b, the rise is not observed for$\overline{C}_P$ from the third and forth column in figure 6c,d. This can be explained as the wake from downstream cylinders is much narrow and more mixed than the one behind the first column.

The r.m.s value of pressure distribution around the surfaces of the four cylinders are shown in the four figures 9b,b,c,d along with the Shim[27]'s data. First to note is that the pressure fluctuates more than 50% for the downstream cylinders. This indicates that instantaneous surface pressure different from the time-averaged value significantly and further demonstrates that the URANS methodology is not suitable for the present work. Figure 9b exhibits relatively high and