

Fig. 4.59 Time-periodic vortex flow for $Ra = 11,270$ ($\Delta T = 15.0$) at $Re_j = 135$ ($Q_j = 1.0$ slpm) and $Re_\Omega = 0$ ($\Omega = 0$ rpm) for $D_j = 10.0$ mm and $H = 20.0$ mm illustrated by side view flow photos taken at the vertical plane $\theta = 0^\circ$ & 180° at selected time instants in a typical periodic cycle ($t_p = 21.1$ sec).

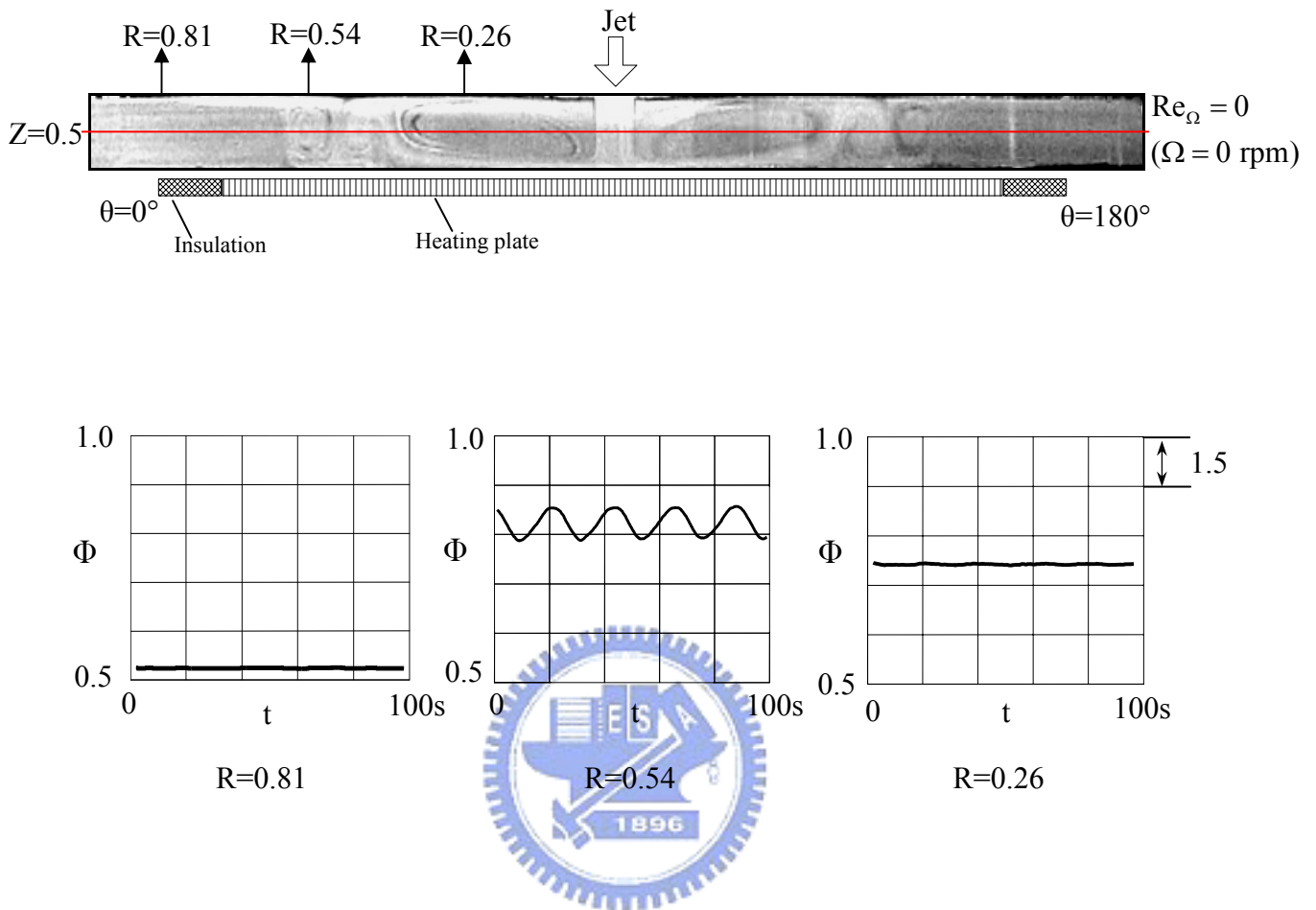


Fig. 4.60 Side view flow photo taken at the cross plane $\theta = 0^\circ$ & 180° at certain time instant in a typical periodic cycle and time records of air temperature at selected locations in middle horizontal plane $Z=0.5$ with $H=20.0$ mm for $Re_j=135$ ($Q_j = 1.0$ slpm), $Ra=11,270$ ($\Delta T= 15.0$), $Re_\Omega = 0$ and $D_j=10.0$ mm ($t_p=21.1$ sec).

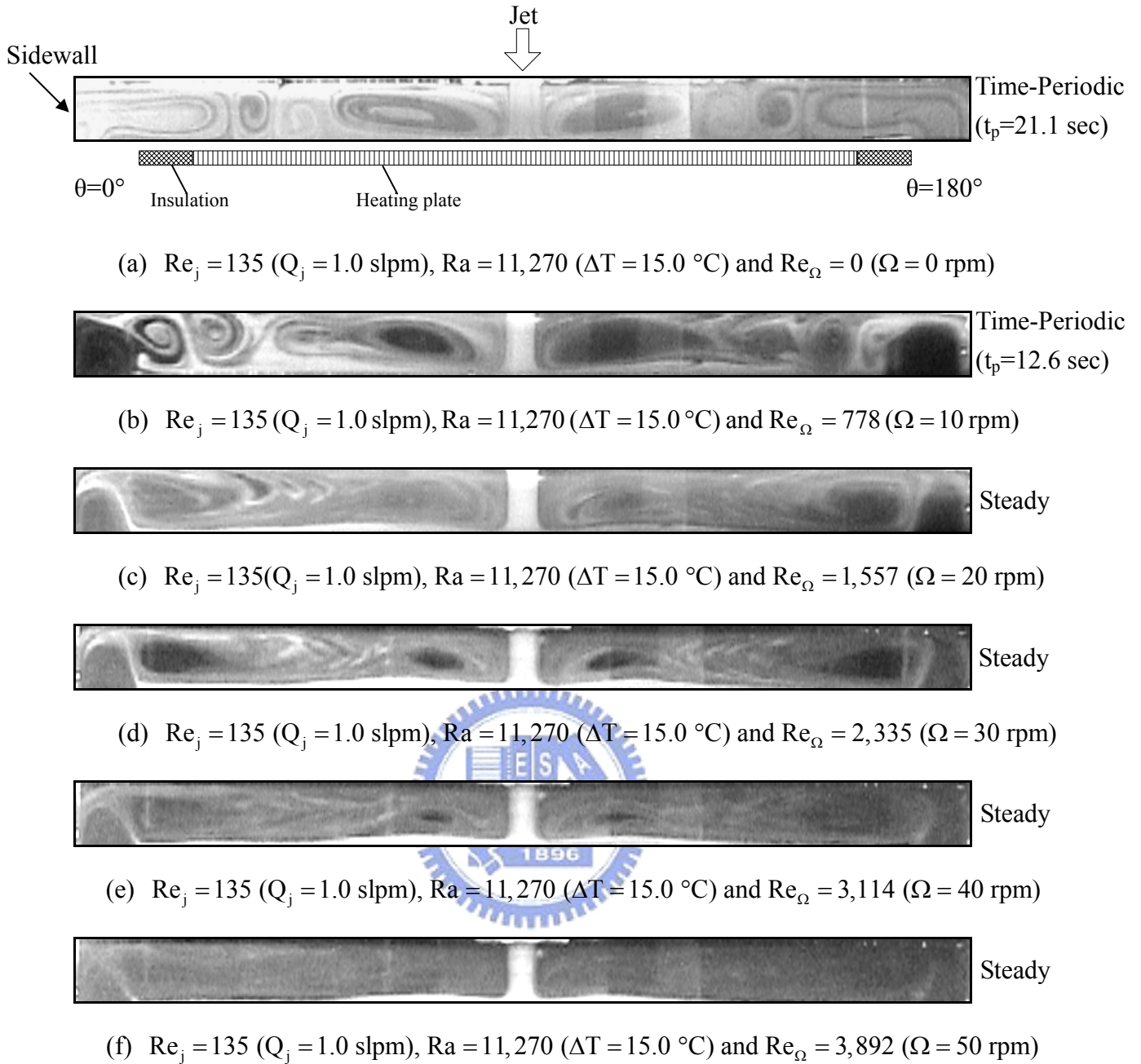
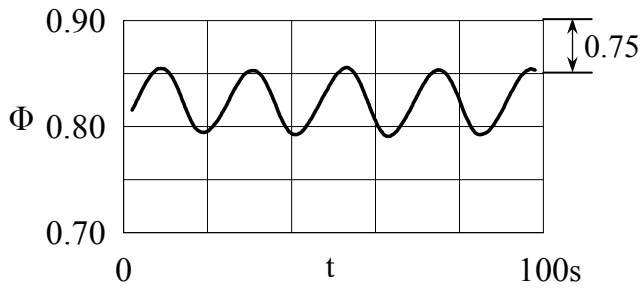
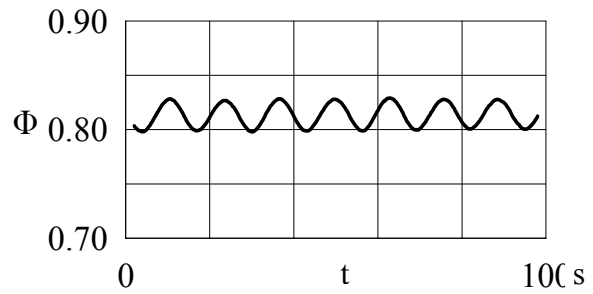


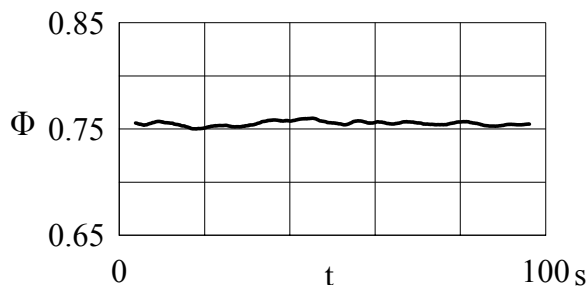
Fig. 4.61 Side view flow photos taken at the cross plane $\theta = 0^\circ$ & 180° at certain time instants in the steady or time-periodic state at $H=20.0$ mm for $Re_j=135$ ($Q_j=1.0$ slpm), $Ra=11,270$ ($\Delta T=15.0$ °C) and $Re_\Omega =$ (a)0, (b)778, (c)1,557, (d)2,335, (e)3,114 and (f)3,892.



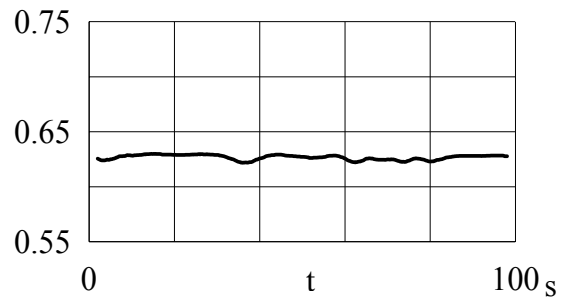
(a) $Re_{\Omega} = 0$ ($\Omega = 0$ rpm)



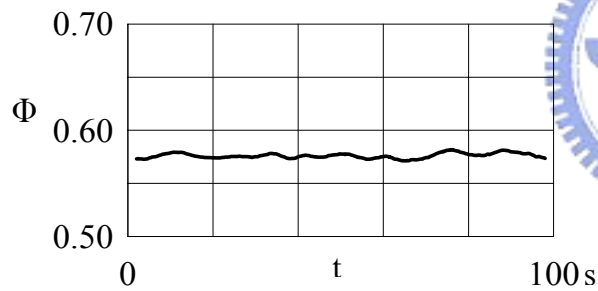
(b) $Re_{\Omega} = 778$ ($\Omega = 10$ rpm)



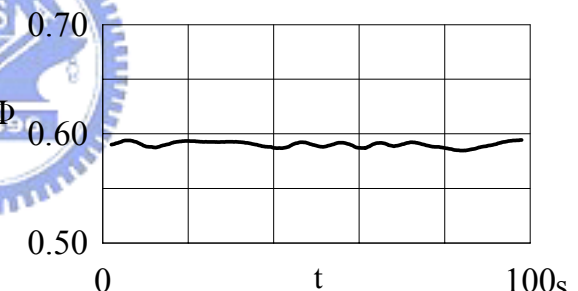
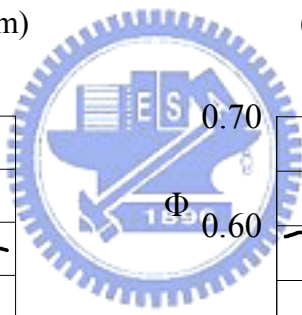
(c) $Re_{\Omega} = 1,557$ ($\Omega = 20$ rpm)



(d) $Re_{\Omega} = 2,335$ ($\Omega = 30$ rpm)



(e) $Re_{\Omega} = 3,114$ ($\Omega = 40$ rpm)



(f) $Re_{\Omega} = 3,892$ ($\Omega = 50$ rpm)

Fig. 4.62 Time records of non-dimensional air temperature for $Re_j=135$ ($Q_j=1.0$ slpm), and $Ra=11,270$ ($\Delta T=15.0$) at location $(R, Z) = (0.54, 0.5)$ on the cross plane $\theta=0^\circ$ with $H=20.0$ mm for $Re_{\Omega} =$ (a)0, (b)778, (c)1,557, (d)2,335, (e)3,114 and (f)3,892.

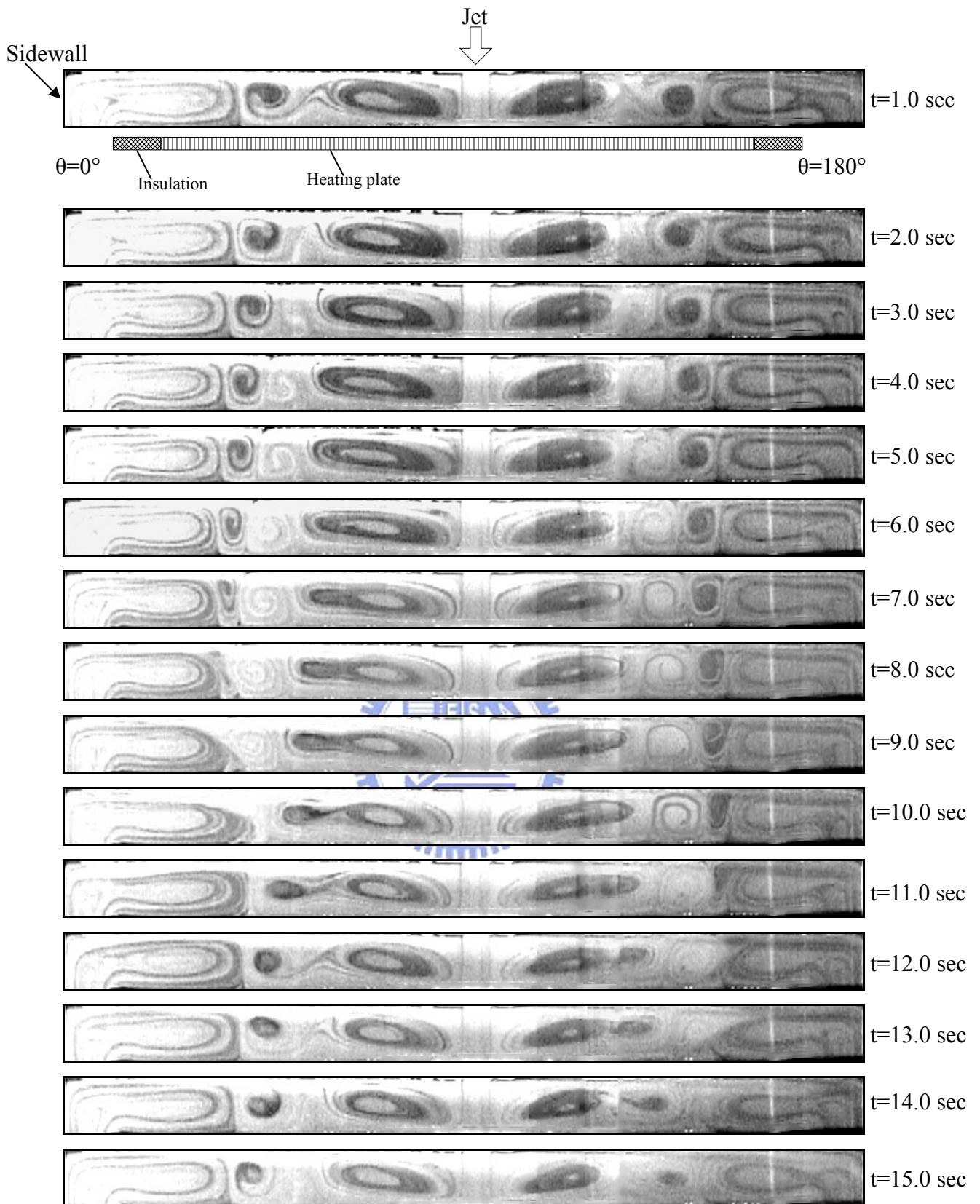


Fig. 4.63 Nonperiodic vortex flow for $Ra = 15,030$ ($\Delta T = 20.0$) at $Re_j = 135$ ($Q_j = 1.0$ slpm) and $Re_\Omega = 0$ ($\Omega = 0$ rpm) illustrated by side view flow photos taken at the vertical plane $\theta = 0^\circ$ & 180° at selected time instants in the statistical state.

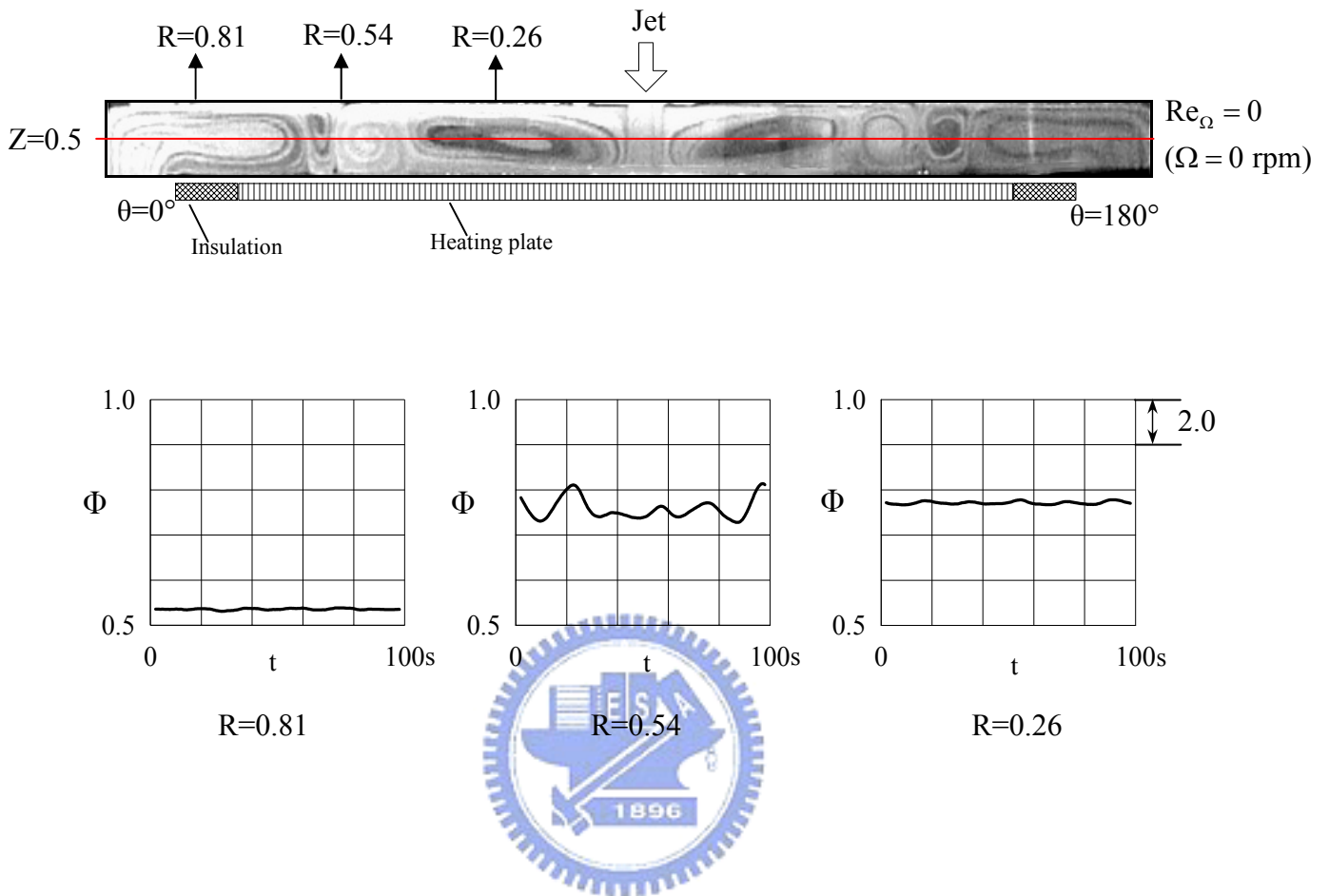


Fig.4.64 Side view flow photo taken at the cross plane $\theta = 0^\circ$ & 180° at certain time instant in the statistical state and time records of air temperature at selected locations in the middle horizontal plane $Z=0.5$ with $H= 20.0$ mm for $Re_j=135$ ($Q_j=1.0$ slpm), $Ra=15,030$ ($\Delta T=20.0$), $D_j=10.0$ mm and $Re_\Omega = 0$ (nonperiodic flow).

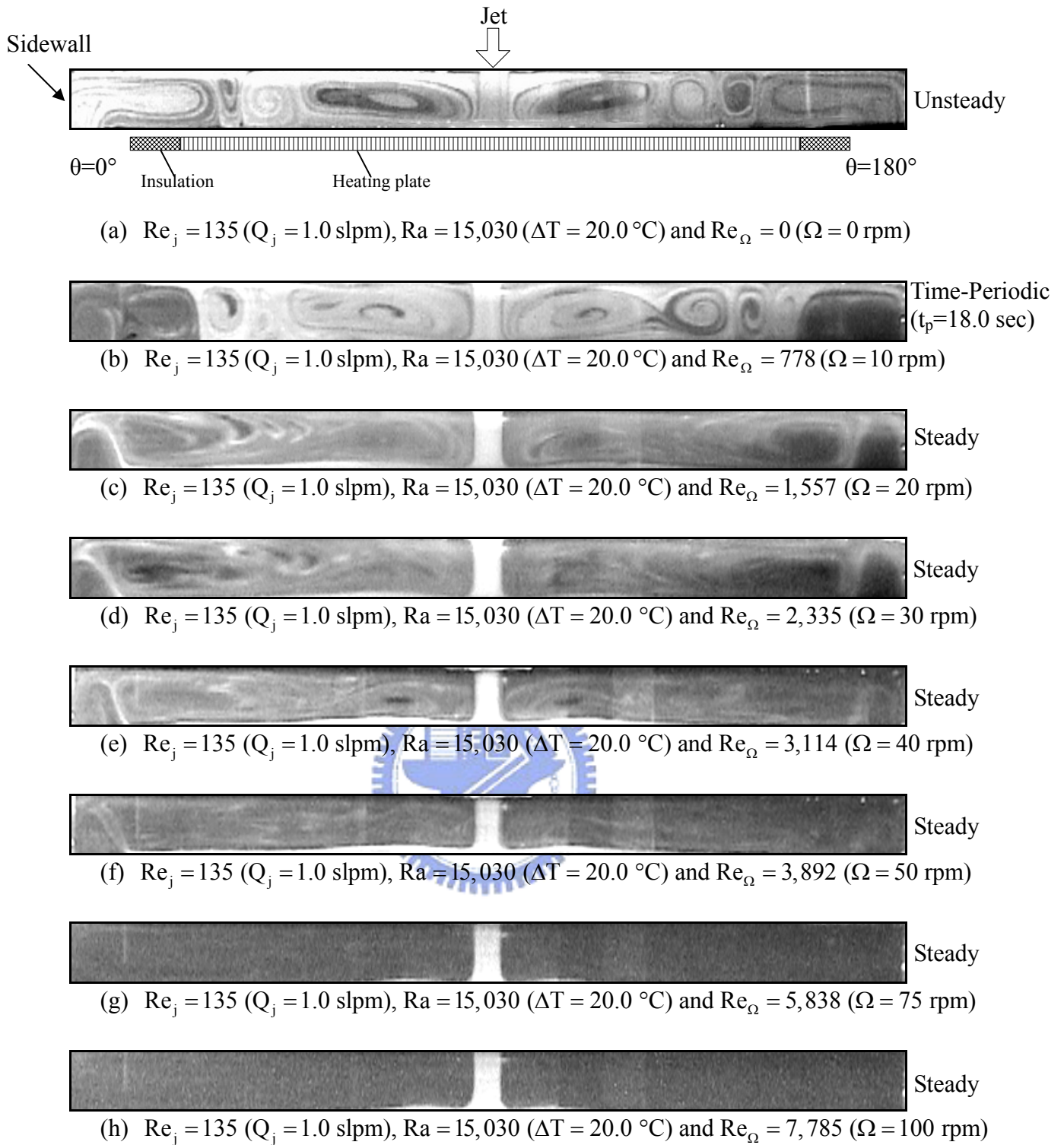


Fig. 4.65 Side view flow photos taken at the cross plane $\theta = 0^\circ$ & 180° at certain time instants in the steady or statistical state at $H=20.0$ mm for $Re_j=135$ ($Q_j=1.0$ slpm), $Ra=15,030$ ($\Delta T=20.0$ °C) and $Re_\Omega =$ (a)0, (b)778, (c)1,557, (d)2,335, (e)3,114, (f)3,892, (g)5,838, and (h)7,785.

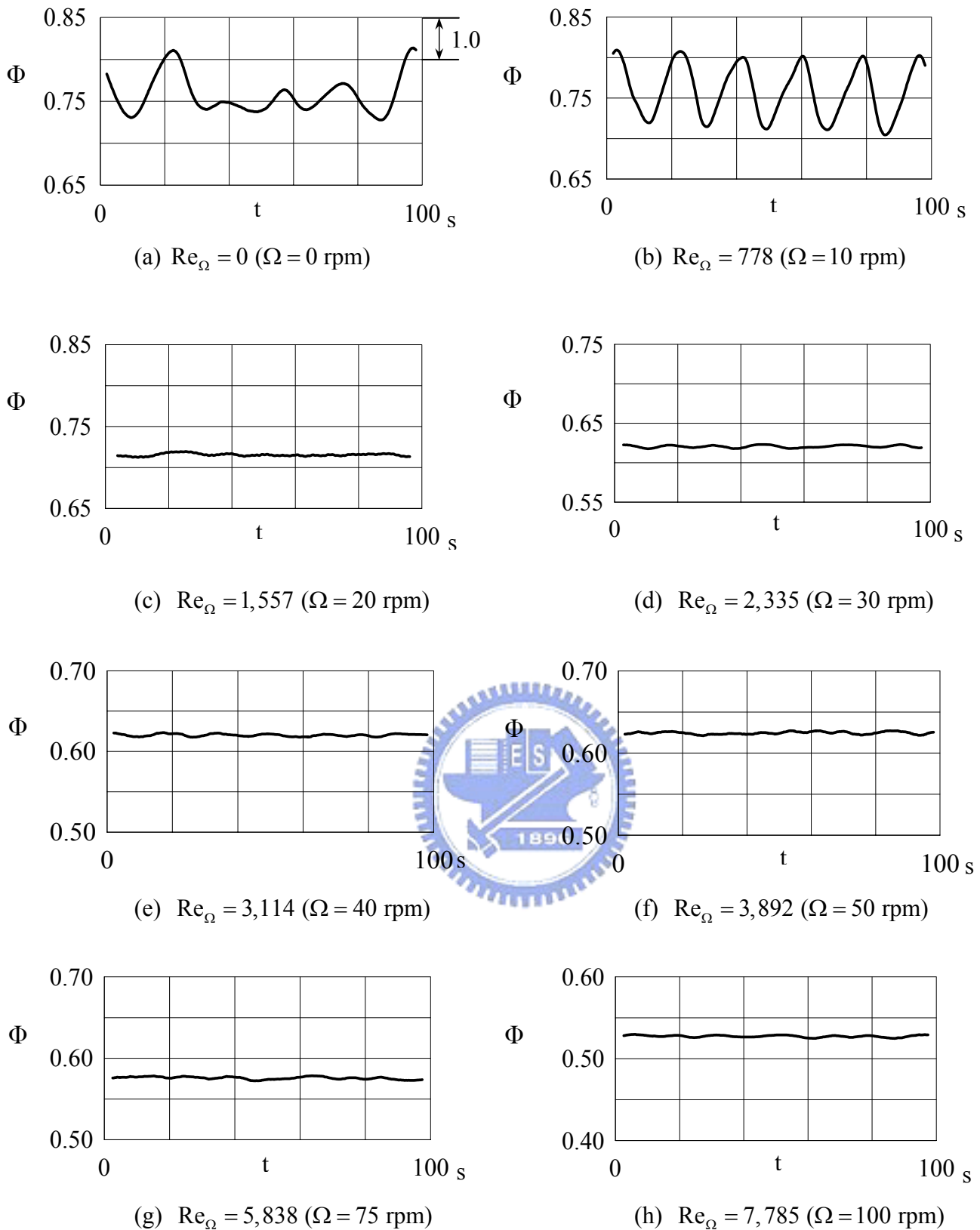


Fig. 4.66 Time records of non-dimensional air temperature for $Re_j=135$ ($Q_j = 1.0$ slpm) and $Ra=15,030$ ($\Delta T= 20.0$) at location $(R, Z) = (0.54, 0.5)$ on the cross plane $\theta = 0^\circ$ with $H=20.0$ mm for $Re_{\Omega} =$ (a)0, (b)778, (c)1,557, (d)2,335, (e)3,114, (f)3,892, (g)5,838, and (h)7,785.

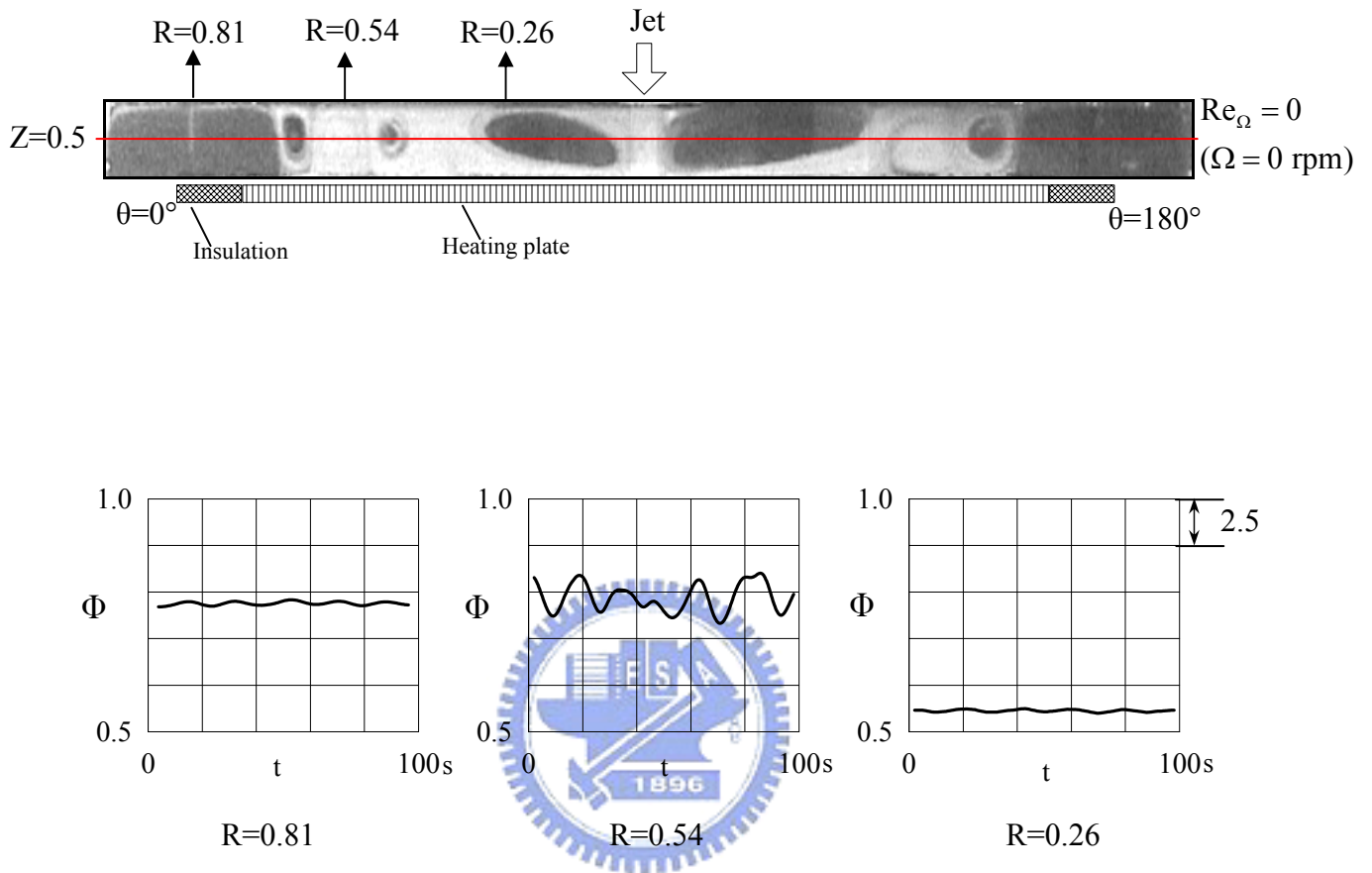


Fig.4.67 Side view flow photo taken at the cross plane $\theta = 0^\circ$ & 180° at certain time instant in the statistical state and time records of non-dimensional air temperature at selected locations in middle horizontal plane $Z=0.5$ with $H=20.0$ mm for $Re_j=135$ ($Q_j=1.0$ slpm), $Ra=18,790$ ($\Delta T=25.0$), $D_j=10.0$ mm and $Re_\Omega = 0$ (nonperiodic flow).

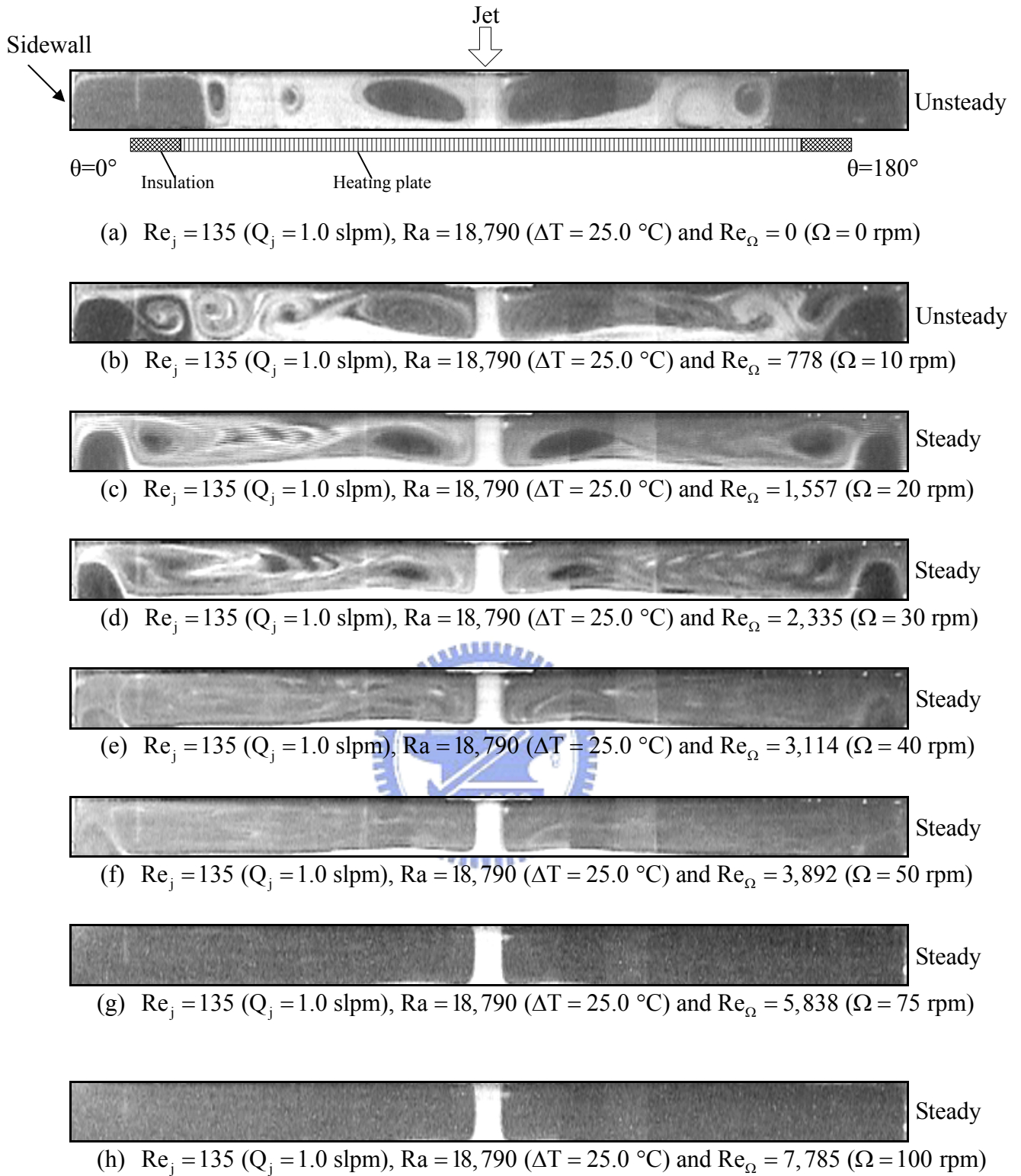


Fig. 4.68 Side view flow photos taken at the cross plane $\theta = 0^\circ$ & 180° at certain time instants in the steady or statistical state at $H=20.0$ mm for $Re_j=135$ ($Q_j=1.0$ slpm), $Ra=18,790$ ($\Delta T = 25.0$ °C) and $Re_\Omega =$ (a)0, (b)778, (c)1,557, (d)2,335, (e)3,114, (f)3,892, (g)5,838, and (h)7,785.

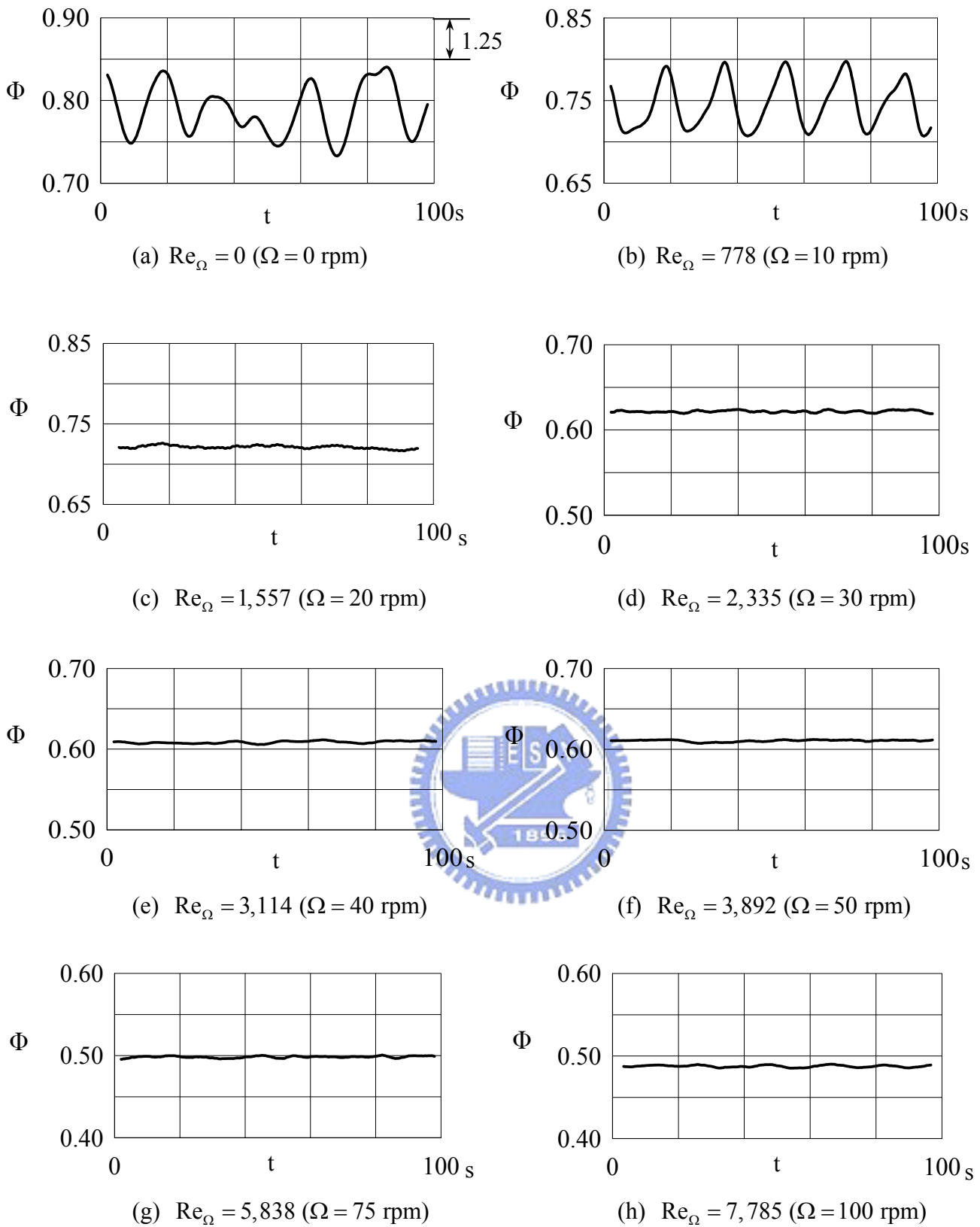


Fig. 4.69 Time records of non-dimensional air temperature for $Re_j=135$ ($Q_j = 1.0$ slpm), $Ra=18,790$ ($\Delta T= 25.0$) at location $(R, Z) = (0.54, 0.5)$ on the cross plane $\theta = 0^\circ$ with $H=20.0$ mm for $Re_{\Omega} =$ (a)0, (b)778, (c)1,557, (d)2,335, (e)3,114, (f)3,892, (g)5,838, and (h)7,785.

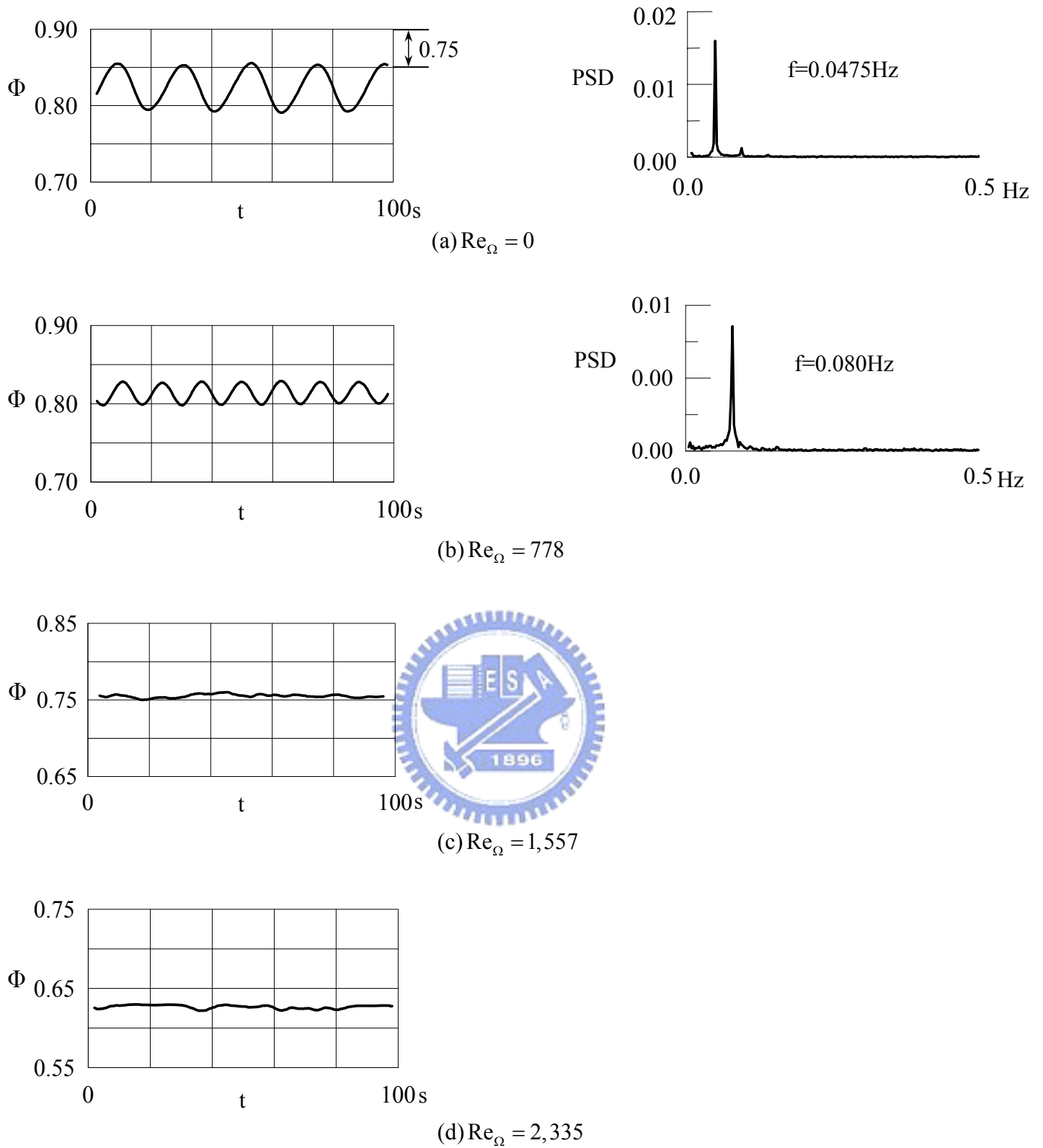
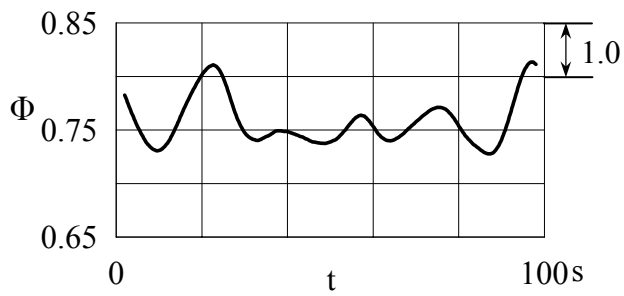
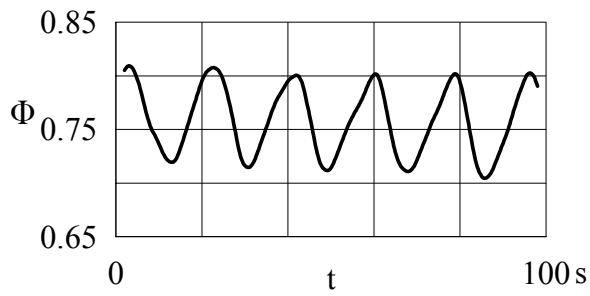


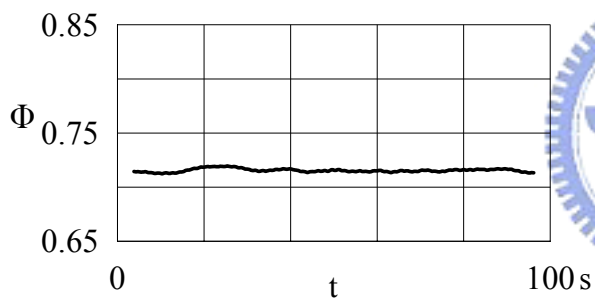
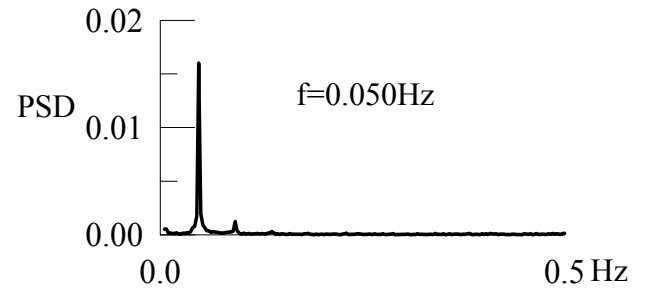
Fig. 4.70 Time records of non-dimensional air temperature and the corresponding power spectrum densities for $Re_j=135$ ($Q_j = 1.0$ slpm), $Ra=11,270$ ($\Delta T = 15.0$) at location $(R, Z)=(0.54, 0.5)$ for $\theta = 0^\circ$ with $H=20.0$ mm and $D_j=10.0$ mm for $Re_{\Omega} =$ (a)0, (b)778, (c)1,557, and (d)2,335.



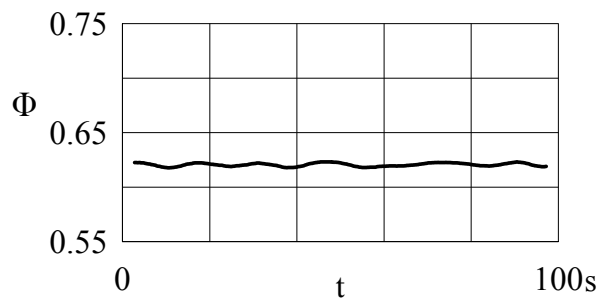
(a) $Re_{\Omega} = 0$



(b) $Re_{\Omega} = 778$



(c) $Re_{\Omega} = 1,557$



(d) $Re_{\Omega} = 2,335$

Fig. 4.71 Time records of non-dimensional air temperature and the corresponding power spectrum densities for $Re_j=135$ ($Q_j = 1.0$ slpm), $Ra=15,030$ ($\Delta T = 20.0$) at location $(R, Z)=(0.54, 0.5)$ for $\theta = 0^\circ$ with $H=20.0$ mm and $D_j=10.0$ mm for $Re_{\Omega} =$ (a)0, (b)778, (c)1,557, and (d)2,335.

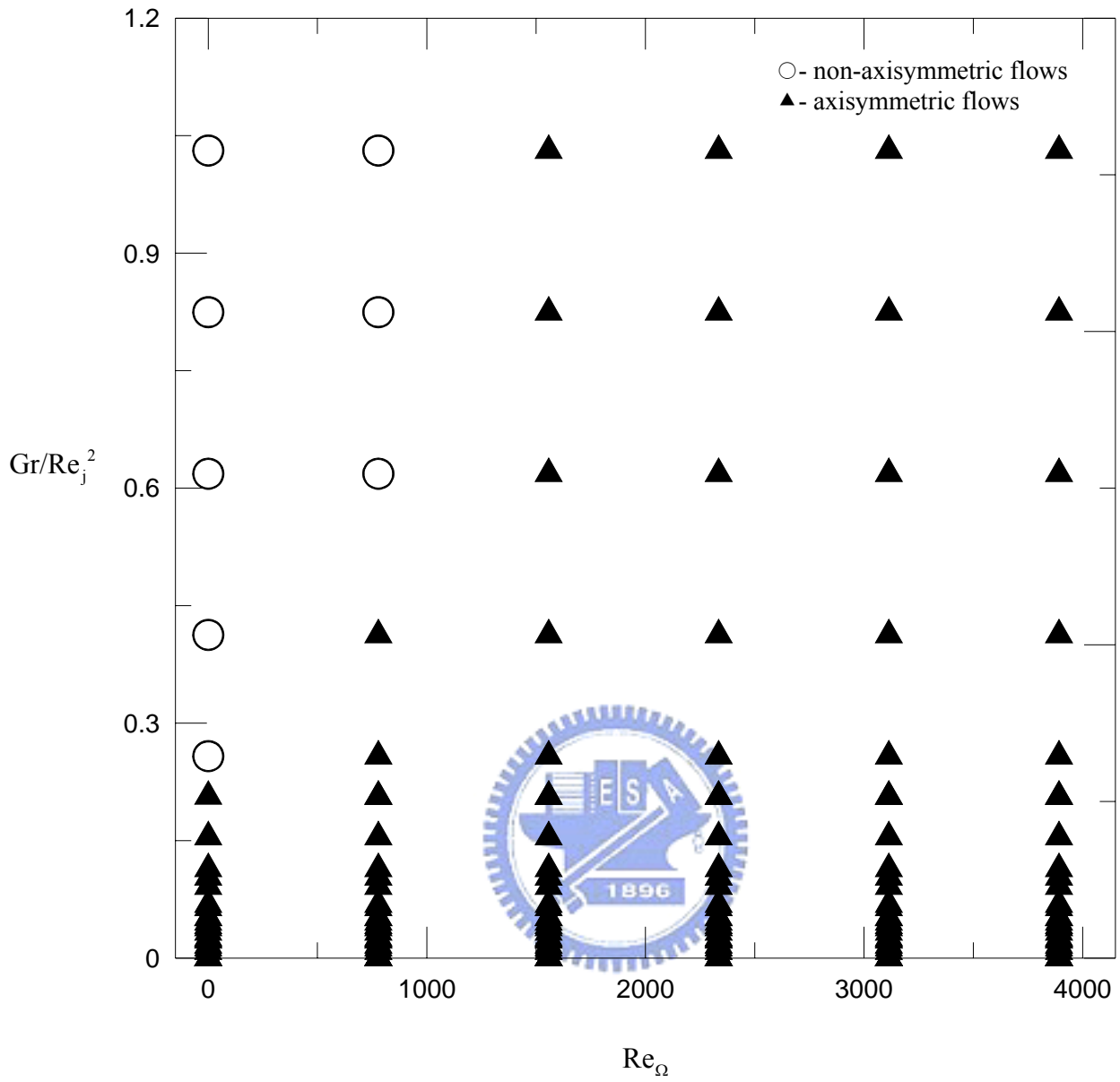


Fig. 4.72 Flow regime map delineating the axisymmetry and non-axisymmetric vortex flows for $H= 20.0$ mm.