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数値粘性の影響

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「計算安定化パラメータ」とは，「数値粘性項の係数」のこと

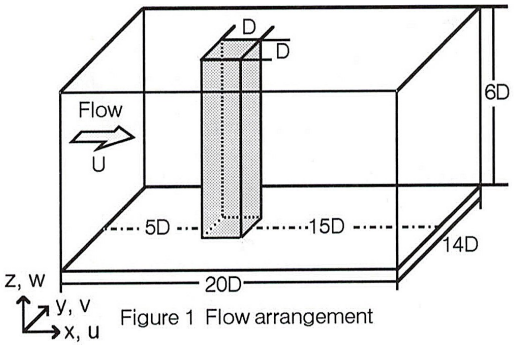
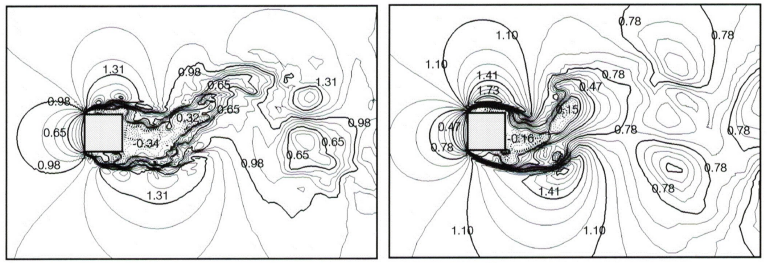


Figure 1 Flow arrangement

	Finite difference scheme of convective term	
	Central difference scheme	Additional numerical viscosity
DNS1	2nd-order accuracy[5]	no
DNS2	4th-order accuracy[5]	6th-order derivative[6]
DNS3		4th-order derivative (α=0.1)
DNS4		4th-order derivative (α=3, K-K type[7])
Reynolds number : Re=UD/ν=1000		
Mesh points (x)×(y)×(z) : 201×101×61, DNS1 ; 101×71×31, DNS2—DNS4		
Time step : 0.001, DNS1 ; 0.002, DNS2—DNS4		

Table 1 Calculation condition



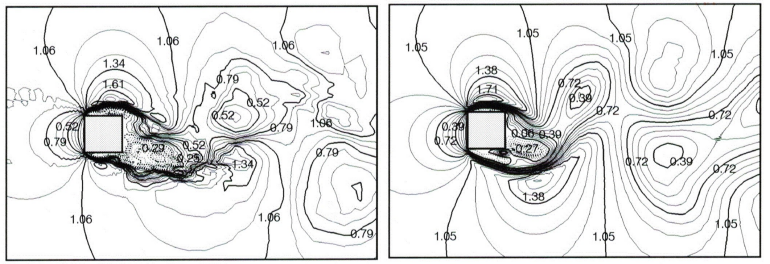


Figure 2 Instantaneous contour lines of the streamwise velocity component (u/U) in the x-y plane (z=3D), Re=1000, (a) 201×101×61 mesh points, (b)-(d) 101×71×31 mesh points

$$\left[u\frac{\partial u}{\partial x}\right]_{i,j,k} = \left[\overline{\bar{u}^{x}\,\delta_x u}^{x}\right]_{i,j,k} +$$

staggered gridに適した中心差分

計算安定化パラメータ

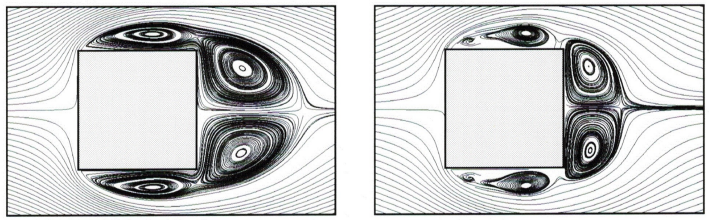
$$\alpha\left|u_{i,j,k}\right|\frac{u_{i+2,j,k} - 4u_{i+1,j,k} + 6u_{i,j,k} - 4u_{i-1,j,k} + u_{i-2,j,k}}{12\,\Delta x}$$

4階微分の数値粘性項 ⇨ α=0.05，0.1，3(K-Kスキームタイプ)

本研究：中心差分項⇨4次精度中心差分(4点差分・4点補間)

【4点差分】 $$\left[\delta_x f\right]_{i,j,k} = \frac{-f_{i+3/2,j,k} + 27\left(f_{i+1/2,j,k} - f_{i-1/2,j,k}\right) + f_{i-3/2,j,k}}{24\,\Delta x}$$

【4点補間】 $$\left[\bar{f}^{x}\right]_{i,j,k} = \frac{-f_{i+3/2,j,k} + 9\left(f_{i+1/2,j,k} + f_{i-1/2,j,k}\right) - f_{i-3/2,j,k}}{16}$$



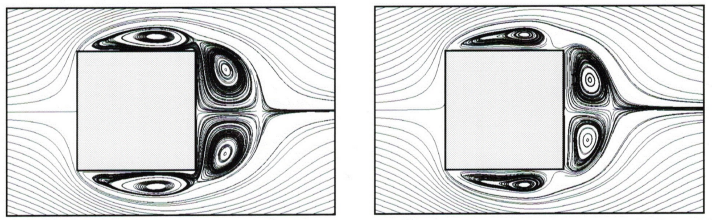


Figure 3 Streamlines for the time-averaged flow field, Re=1000, (a) 201×101×61 mesh points, (b)-(d) 101×71×31 mesh points, The spatial averaging in the spanwise direction (z) was made.

内田孝紀，大屋裕二，角柱周辺流れの3次元数値シミュレーション
-風上差分による数値粘性の影響-，日本風工学会 年次研究発表会，1999年5月より引用