实体单元与薄壁板壳单元的连接

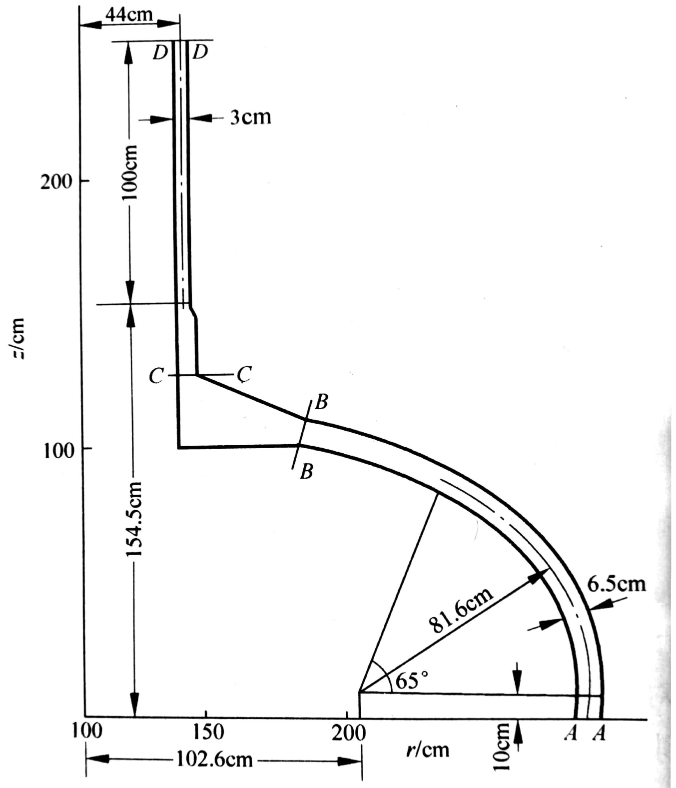
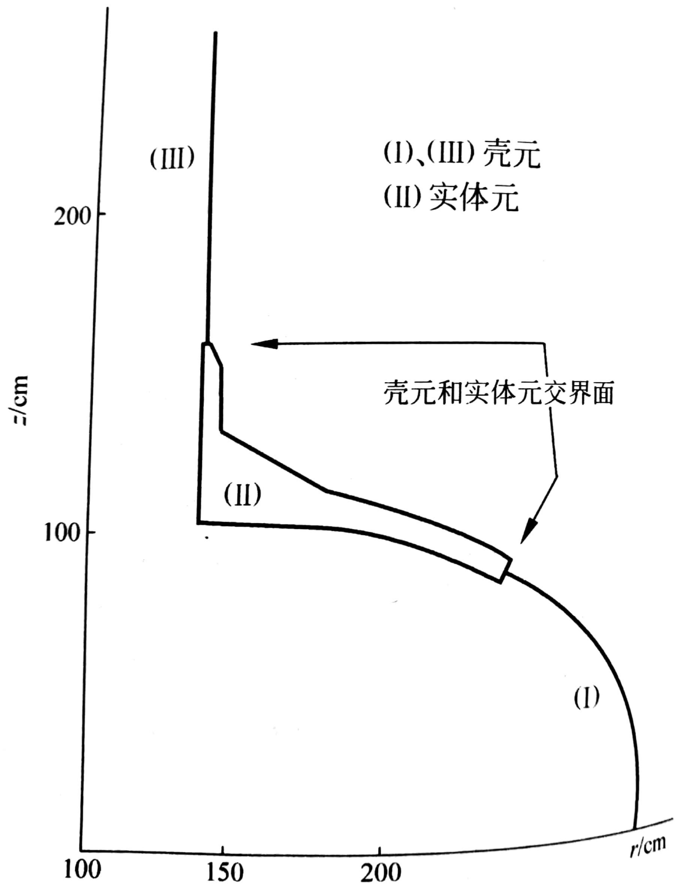


图 11.22　容器封头和接管结构



1.直接引入约束

$$K_1 d_1 = f_1, K_2 d_2 = f_2$$

$$d_1 = \begin{pmatrix} \cdots\cdots \\ u_1 \\ v_1 \\ u_2 \\ v_2 \\ u_3 \\ v_3 \end{pmatrix}, d_2 = \begin{pmatrix} u'_2 \\ v'_2 \\ \beta'_2 \\ \cdots\cdots \end{pmatrix}$$

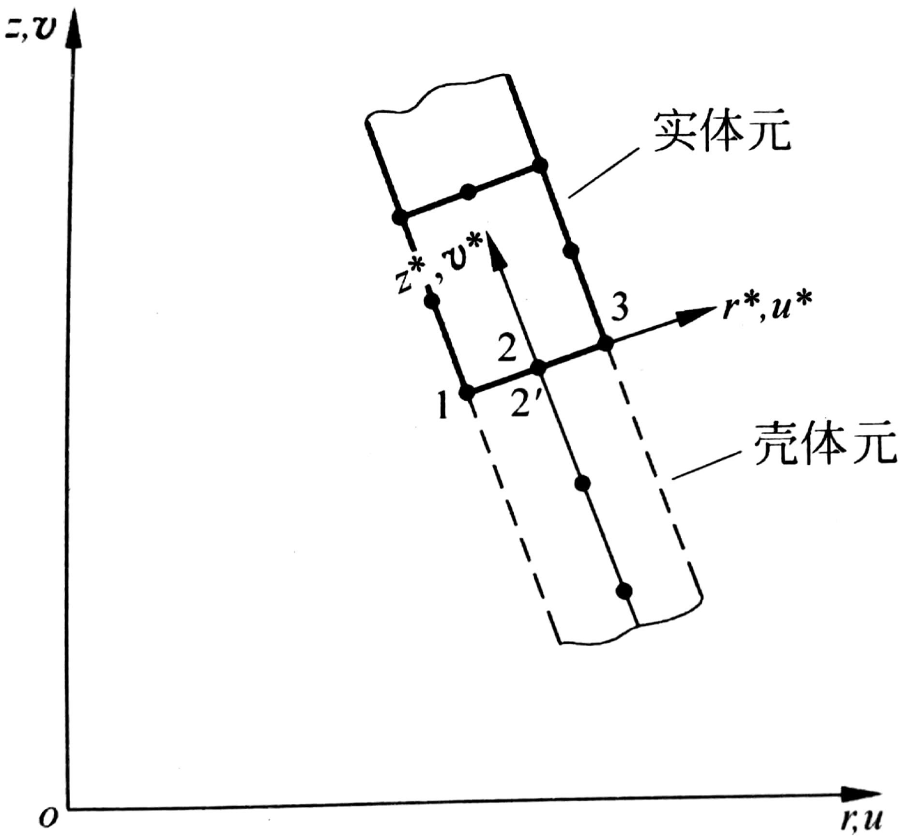


图 11.24　两种类型单元的联结

$$
\boldsymbol{C} = \begin{pmatrix} u_2 - u_{2'} \\ v_2 - v_{2'} \\ -\sin\phi(u_1 - u_2) + \cos\phi(v_1 - v_2) - \dfrac{t}{2}\beta_{2'} \\ -\sin\phi(u_3 - u_2) + \cos\phi(v_3 - v_2) + \dfrac{t}{2}\beta_{2'} \end{pmatrix} = 0
$$

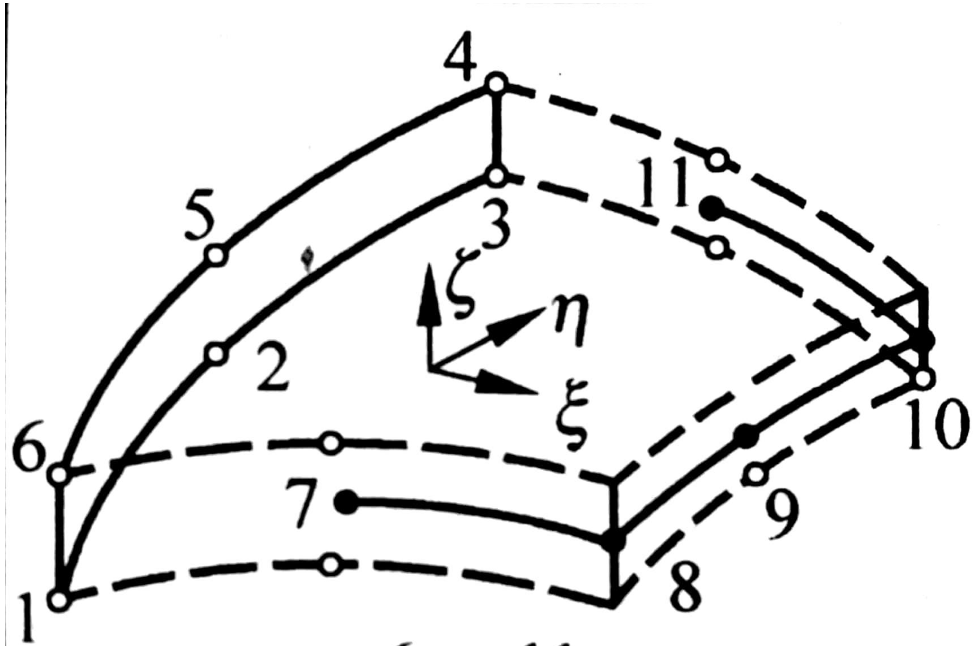
巨大的问题：
计算量、对称性

$$
\begin{pmatrix} u_1 \\ v_1 \\ u_2 \\ v_2 \\ u_3 \\ v_3 \end{pmatrix} = \begin{bmatrix} \cos\phi & 0 & \sin^2\phi & -\sin\phi\cos\phi & -\dfrac{t}{2}\sin\phi \\ \sin\phi & 0 & -\sin\phi\cos\phi & \cos^2\phi & \dfrac{t}{2}\cos\phi \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & \cos\phi & \sin^2\phi & -\sin\phi\cos\phi & \dfrac{t}{2}\sin\phi \\ 0 & \sin\phi & -\sin\phi\cos\phi & \cos^2\phi & -\dfrac{t}{2}\cos\phi \end{bmatrix} \begin{pmatrix} u_1^* \\ u_3^* \\ u_{2'} \\ v_{2'} \\ \beta_{2'} \end{pmatrix}
$$

2.过渡单元

$$\begin{Bmatrix} x \\ y \end{Bmatrix} = \sum_{J=1}^{m} N'_J(\xi,\eta)\begin{Bmatrix} x_J \\ y_J \end{Bmatrix} + \sum_{J=m+1}^{n} N_J(\xi)\begin{Bmatrix} x_J \\ y_J \end{Bmatrix} + \sum_{J=m+1}^{n} N_J(\xi)\frac{\eta}{2}t_J\begin{Bmatrix} \cos\Phi_J \\ \sin\Phi_J \end{Bmatrix}$$

$$\begin{Bmatrix} u \\ v \end{Bmatrix} = \sum_{J=1}^{m} N'_J(\xi,\eta)\begin{Bmatrix} u_J \\ v_J \end{Bmatrix} + \sum_{J=m+1}^{n} N_J(\xi)\begin{Bmatrix} u_J \\ v_J \end{Bmatrix} + \sum_{J=m+1}^{n} N_J(\xi)\frac{\eta}{2}t_J\begin{Bmatrix} -\sin\Phi_J \\ \cos\Phi_J \end{Bmatrix}\alpha_J$$



m=6,n=11

过渡单元的应力分析及局限性

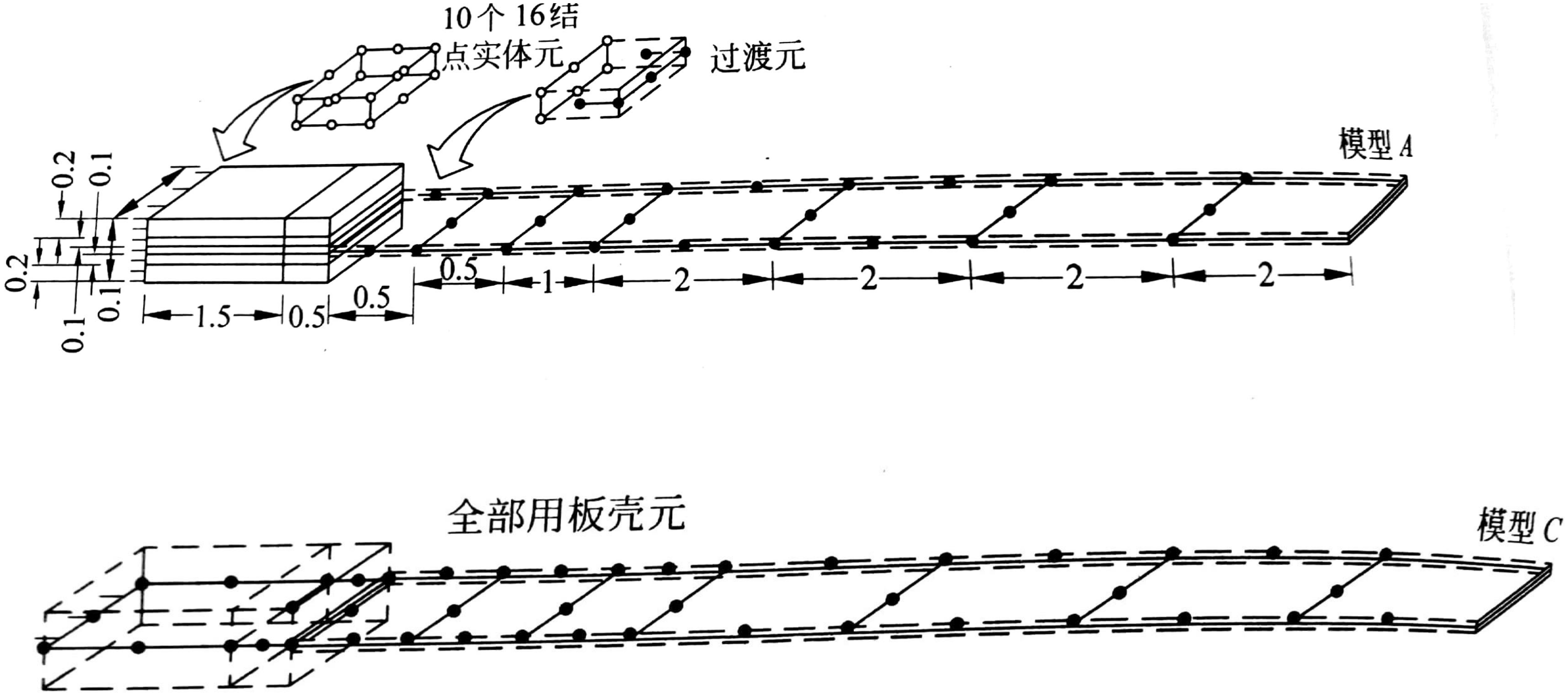
$$w' = w'(x, y)$$

$$\varepsilon_{z'} = 0$$

$$\varepsilon_{z'} = \upsilon(\varepsilon_{x'} + \varepsilon_{y'})$$

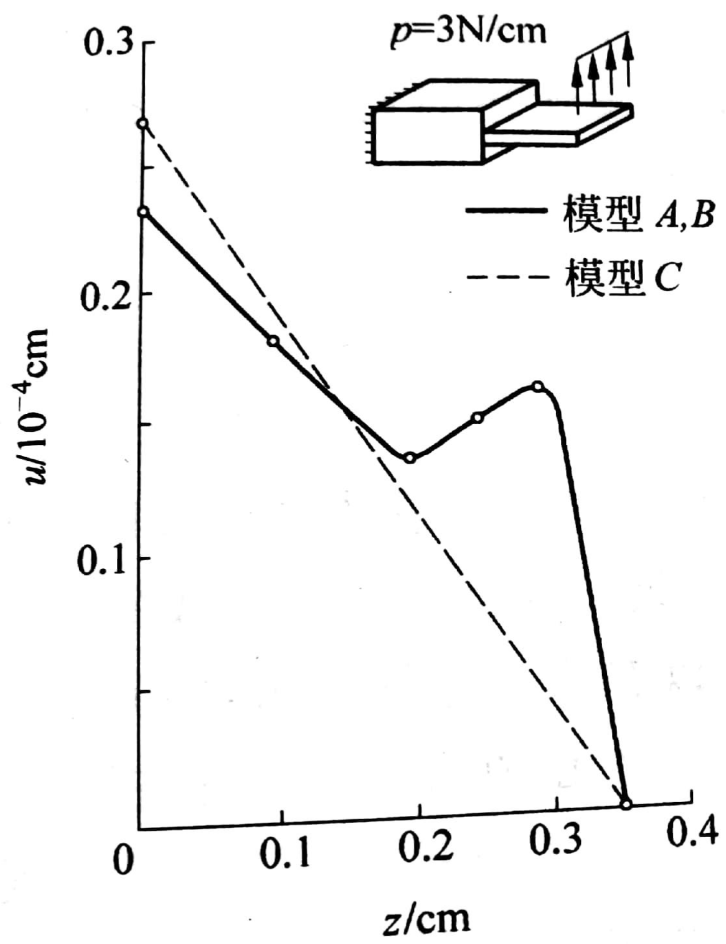
$$\nu = 0$$

实例分析

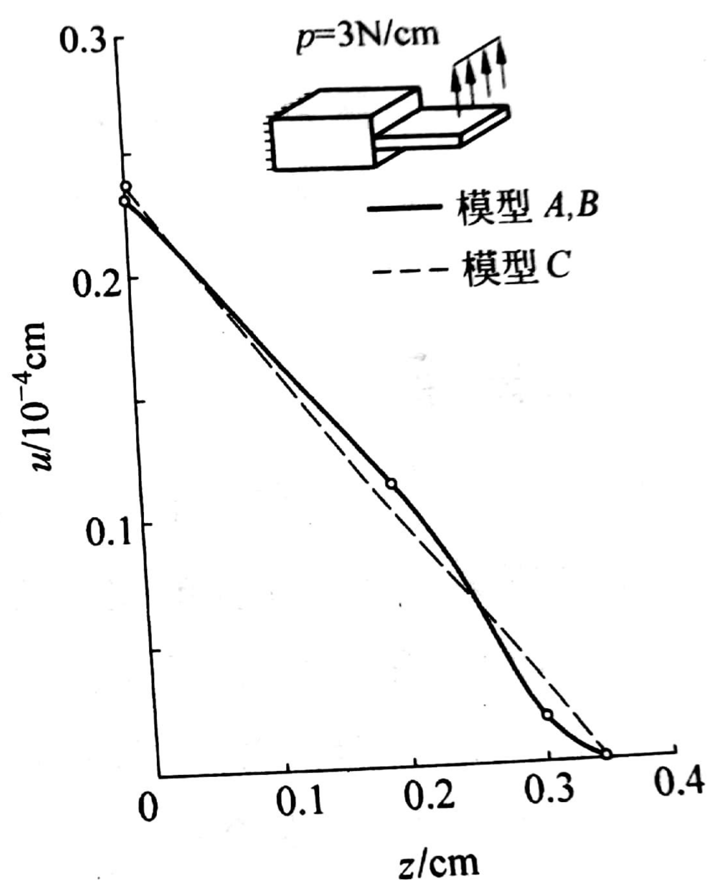


10个 16结
点实体元
过渡元
模型A
0.2
0.1
0.2
0.1
0.1
0.1
1.5
0.5
0.5
0.5
1
2
2
2
2
全部用板壳元
模型C

(d)



(c) 位移 u 沿截面高度的变化(x=2cm)



(d) 位移 u 沿截面高度的变化(x=1.75cm)