12.4 Example: a square Mindlin plate in bending

We consider a simply-supported and clamped square plate (side $a = 1$) under uniform transverse pressure ($P = 1$), and thickness h. The modulus of elasticity is taken $E = 10{,}920$[1] and the Poisson's ratio is taken as $\nu = 0.3$. The non-dimensional transverse displacement is set as

$$\bar{w} = w\frac{D}{Pl^4} \tag{12.26}$$

where the bending stiffness D is taken as

$$D = \frac{Eh^3}{12(1-\nu^2)} \tag{12.27}$$

In table 12.1 we present non-dimensional transverse displacement results obtained by the code problem19.m for various thickness values and boundary conditions. In figure 12.2 we show the deformed shape of a simply-supported plate, using a 20×20 Q4 mesh.

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%.....................................................................

% MATLAB codes for Finite Element Analysis
% problem19.m
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Table 12.1 Non-dimensional transverse displacement of a square plate, under uniform pressure – simply-supported (SSSS) and clamped (CCCC) boundary conditions

a/h	Mesh	SSSS	CCCC
10	2×2	0.003545	0.000357
	6×6	0.004245	0.001486
	10×10	0.004263	0.001498
	20×20	0.004270	0.001503
	30×30	0.004271	0.001503
	Exact solution	0.004270	
10,000	2×2	0.003188	3.5e^{-10}
	6×6	0.004024	0.001239
	10×10	0.004049	0.001255
	20×20	0.004059	0.001262
	30×30	0.004060	0.001264
	Exact solution	0.004060	0.001260

[1] The reader may be curious about the reason for this particular value of E. With $a = 1$, thickness $h = 0.1$ and the mentioned values for E and ν we obtain a flexural stiffness of 1. This is only a practical convenience for non-dimensional results, not really a meaningful value.