

A deformed (commonly referred to as warped) furniture shelf often suggests the weight it has had to bear in use, but this is a half-truth. Panels can warp before use and these deformations are also taken into account by technical standards. In fact, the “UNI EN 14322:2021 Wood-based panels - Melamine boards for interior uses - Definition, requirements and classification” states that for wood-based panels with balanced faces and having thicknesses of more than 15 mm, the warping must be  $\leq 2$  mm/m, as shown in the table:

Feature	Test method	Unit of Measurement	Requirement		
			Nominal thicknesses (mm)		
			< 15	$\geq 15$ e fino a 20	> 20
Flatness	EN 14323	mm/m	/	$\leq 2$ (only for balanced surfaces)	

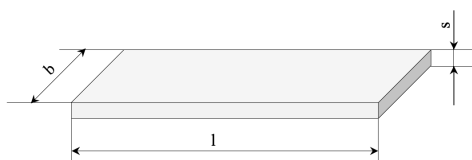
However, this parameter must also be compared with the requirements placed on the finished product.

For example, if we were to consider the case of the shelves of a storage furniture unit, the flexural test is described in paragraph 6.1.4 of “EN 16122 Domestic and non-domestic storage furniture - Test methods for the determination of strength, durability and stability” and requires that the final measurement of the deformation also takes into account the initial warping of the panel. The test procedure does not set a requirement for acceptability, but other specifications or standards do, and the experimental result must compare with those.

If the shelf deflection requirement were 0.5 per cent of the shelf span (as required by most technical specifications), assuming the test were to be performed on a shelf with a width of 760 mm, the maximum permissible deflection under load would be 3.8 mm.

The **question** raised by this article is: **will a panel with an initial warping of 2 mm/m (i.e. 1.52 mm in the case of the 760 mm shelf taken as an example) pass the bending test described in EN 16122?**

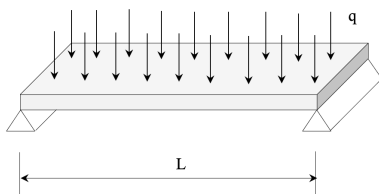
As an example, to estimate the order of magnitude of shelf deflection, we schematise the shelf (Fig. 1) as a plane simply propped at the extremes of its width, with a load ( $q$ ) uniformly distributed over its entire surface (Fig. 2)



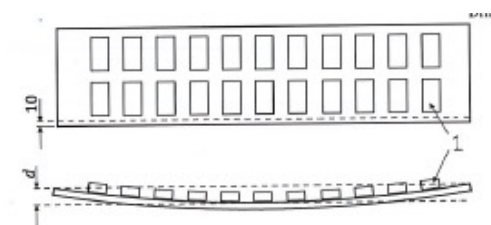
- Fig. 1 -

# Warped furniture and shelves: some considerations

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- Fig. 2 -



The various requirement standards for storage furniture provide for different load indices depending on the intended use of the furniture, as shown in the following table:

Standard	Load index
UNI 11663 Level 1 (Domestic storage furniture- Requirements for strength and durability)	1,0 kg/dm <sup>2</sup>
UNI 11663 Level 2 (Domestic storage furniture- Requirements for strength and durability)	1,5 kg/dm <sup>2</sup>
EN 16121 Level 1 (Non domestic storage furniture - Requirements for safety, strength, durability and stability)	1,5 kg/dm <sup>2</sup>
EN 16121 Level 2 (Non domestic storage furniture - Requirements for safety, strength, durability and stability)	2,0 kg/dm <sup>2</sup>
ISO 7170:2021 Domestic use/Other (Furniture - Storage units -Test methods for the determination of strength, durability and stability))	1,0 kg/dm <sup>2</sup>
ISO 7170:2021 Domestic use/Kitchen (Furniture - Storage units -Test methods for the determination of strength, durability and stability)	1,5 kg/dm <sup>2</sup>
ISO 7170:2021 Non domestic use (Furniture - Storage units -Test methods for the determination of strength, durability and stability)	2,0 kg/dm <sup>2</sup>

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Assuming we choose a panel with the following characteristics:

b = Panel depth  $\approx$  380 mm

L = Span between supports, which in this case corresponds with the width of the panel  $\approx$  760 mm

s = Panel thickness  $\approx$  18 mm

E = Elastic modulus of the panel (index of its stiffness)  $\approx$  3000 N/mm<sup>2</sup>

Note: indicative value that can be obtained from a particle board coated with paper

and the option of 1.0 kg/dm<sup>2</sup> (the minimum required by the standards), which corresponds to q  $\approx$  28.9 kg uniformly distributed over the surface of the board, a shelf deflection (f<sub>max</sub>) of approximately 2.9 mm can be calculated within the range of linear panel behavior.

Note: The calculated value represents a rough estimate of the order of magnitude of the expected deflection.

The test method described in **EN 16122** requires that the deflection is measured from a hypothetical horizontal zero line (the so-called 'ideal plane' perfectly straight), then **any initial warping of the panel is added to the deformation under load**.

Theoretically, the panel tested in this particular case should not show an initial warping of more than 0.9 mm (f<sub>max</sub> = 3.8; f<sub>max</sub> = 2.9 mm).

It is very likely, therefore, that a panel with an initial deflection of 2 mm/m will fail the test.

Note: In all these evaluations, it has been assumed that the material's own characteristics (e.g. elastic modulus of the panel, index of its stiffness) are sufficient for the intended use

Shelf size	Load index	Load applied	Unloading board deflection	Estimated flexion	Permissible deflection	Final deflection (unloaded plane deflection + estimated deflection)
760 x 380 mm	1,0 kg/dm <sup>2</sup>	28,9 kg	1,5 mm	2,9 mm	3,8 mm	4,4 mm

In conclusion, for this particular type of application, it would seem plausible to think that the limit set out in EN 14322 for the warping of wood-based panels covered with melamine papers for indoor use is too high.

This leads to the thought that perhaps, in the near future, **it would be opportune to compare the two standard worlds: the one of finished products** (e.g. storage furniture) **and the other of semi-finished wood products** (e.g. particleboard and wood fibreboard) for a critical discussion of the reciprocal requirements and to give clearer indications to this industrial sector, which could make more conscious purchases in the future.

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