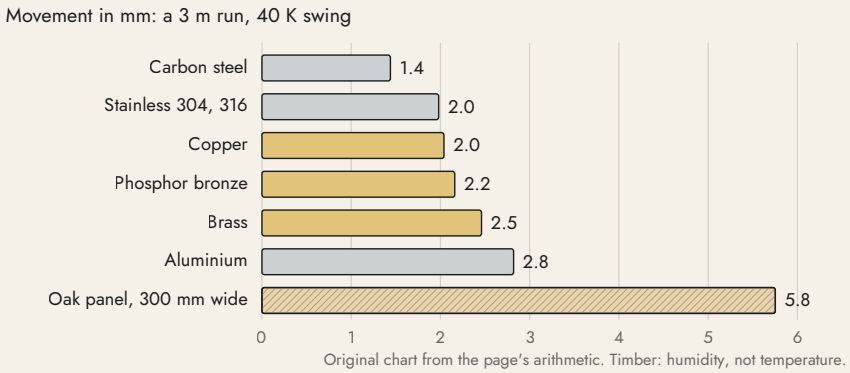
Thermal expansion of metals: *movement allowances*

Movement is the coefficient times the length times the temperature change. Set the temperature range on the drawing, give each long run one fixed point, and remember that beside timber the humidity is the bigger number.

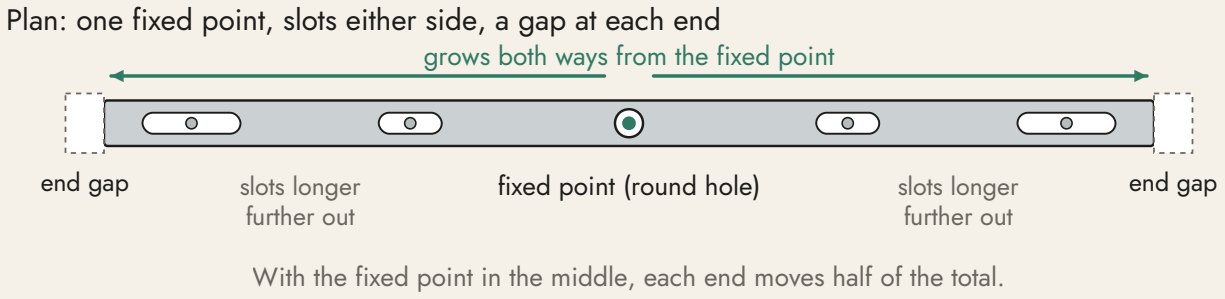
AT A GLANCE

Metal	Coefficient used (millionths per K)	Values read, and their temperature range	3 m run, 20 K (mm)	6 m run, 40 K (mm)
Carbon steel	12	12 (ambient range)	0.72	2.88
Stainless 304 and 316	16.5	16.5 (20 to 200 °C); 17.5 (to 400 °C)	0.99	3.96
Copper	17	16.8 (20 to 100 °C), 17.3 (to 200), 17.7 (to 300); 17	1.02	4.08
Phosphor bronze	18	CuSn8: 18 and 18.2, both 20 to 300 °C	1.08	4.32
Brass	20.5	CuZn37: 20.4 and 21, both 20 to 300 °C	1.23	4.92
Aluminium	23.5	23.1 to 23.8 (seven alloys); 23.6 and 24.2 (20 to 100 °C)	1.41	5.64

One round figure per family, to the nearest 0.5 of the values read, is used for the arithmetic. Free movement only: a fixing that restrains the metal changes the picture. Sources: SCI (steel), Euro Inox (stainless), stockholders' data sheets (the rest). The product standards were not read. Zinc is left out because the figures we met conflict.



Free movement of a 3 m run in a 40 K swing, by metal, with a 300 mm oak panel on the same scale. The timber moves because of humidity, not temperature (see below). Original chart by Make Bespoke Studio from the arithmetic on this page.



One fixed point, slotted fixings either side, a gap at each end. Principle only, not to scale. Original drawing by Make Bespoke Studio.

SPECIFICATION WORDING

MOVEMENT ALLOWANCE

Metal runs over [1.5] m long, and metal fixed to timber, stone or another metal, are to be detailed for free thermal and moisture movement, calculated from the coefficient for [alloy], the run length and a temperature range of [__ K] stated on the drawing. No run is to be held rigidly at both ends. One fixed point per run at [ ]; other fixings slotted or oversize with washers set to slide; end gaps [ ] mm minimum.

CALCULATION TO BE SUBMITTED

For each run over [1.5] m the fabricator is to show on the shop drawings the coefficient used with its source and temperature range, the temperature range assumed, the fixed point and the end gaps. [The engineer approves external and structural runs.] The temperature at fixing is to be recorded.

METAL INLAY IN TIMBER

Metal inlay strips longer than [100] mm and running across the grain are to be [fixed at one point only], with clearance of [ ] mm at each end and in the groove, and are not to be glued rigidly along their length unless approved by sample. Assumed room humidity [ ] to [ ]% RH; timber moisture content at fixing [ ]%.

DISSIMILAR METALS

Where metals of different expansion are fixed together, the shop drawing is to show how the difference in movement is taken up and how galvanic contact is avoided.

TERMS USED

Coefficient of thermal expansion

How much a material grows per metre for each kelvin of warming, usually quoted in millionths per kelvin. It rises a little with the temperature range it is measured over.

Fixed point

The one place a long run is held rigidly, so that the movement is taken up on either side of it by slotted fixings and end gaps.

Movement joint

A deliberate gap or sliding detail that lets a run, panel or strip change size without being held back.

STANDARDS AND SOURCES

- Steel Construction Institute and BCSA, steelconstruction.info, Steel material properties: carbon steel.
- Euro Inox, Stainless Steel: Tables of Technical Properties (2nd ed. 2007) and Stainless Steel Facades (Vol. 2, 2002): stainless coefficients; one-end fixing case study.
- USDA Forest Products Laboratory, Wood Handbook, FPL-GTR-282 (2021): p. 4-17; Eq. 13-3; Tables 4-2, 4-3, 13-5.
- Stockholders' published data sheets: brass, bronze, copper, aluminium: not the product standards.

Full guide: https://makebespoke.com/trade/technical/thermal-expansion-of-metals. Make Bespoke Studio coordinates manufacture through its partner workshops. Figures are guidance only and your specification governs; some may be superseded, so contact the studio to verify.