By Jürgen Hasenauer, Dieter Küper, Jost E. Laumeyer and Ian Welsh

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4. Ribbing

Optimum rib design

Ribs – To overcome the problems that can arise with thick walls, ribs are an effective means of increasing rigidity while allowing wall thickness to be reduced.

Generally, the rigidity of a component can be increased the following ways:
– increasing the wall thickness
– increasing the elastic modulus (e.g. by increasing reinforcing fibre content)
– incorporating ribs into the design.
If the required rigidity cannot be achieved in a design, the recommended next step is to choose a material with a higher elastic modulus than the original material. A simple way to increase the elastic modulus is to increase the content of reinforcing fibre in a polymer. However, given the same wall thickness, this measure produces only a linear increase in rigidity. A much more efficient solution is to increase rigidity by providing optimally designed ribs. Component rigidity is improved as a result of the increase in the moment of inertia. For optimum dimensioning of ribs, it is generally necessary to take into account not only engineering design considerations as such but also technical factors relating to production and aesthetic aspects.

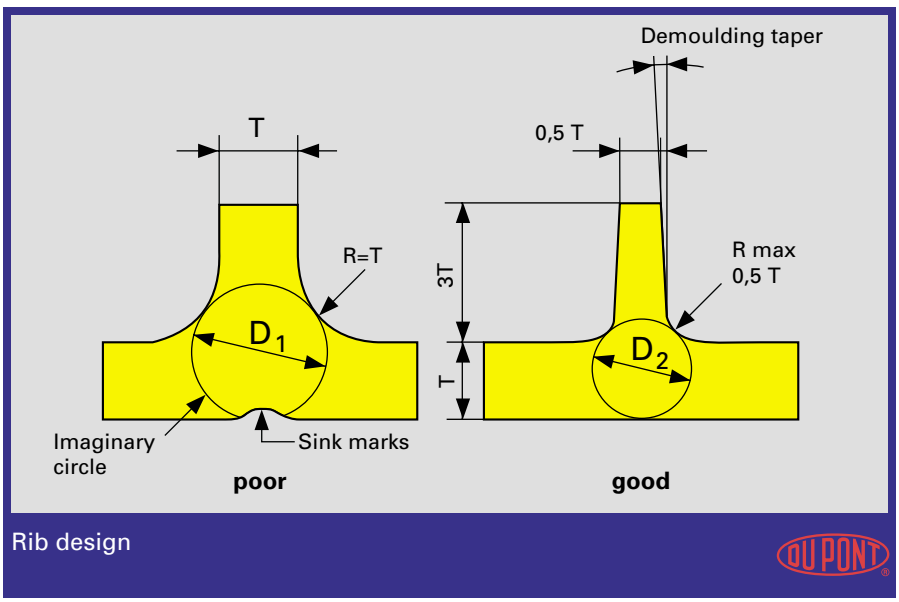

Fig. 1

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Optimum rib dimensions

In rib design, a large moment of inertia can most easily be achieved by providing high, thick ribs. However, with engineering thermoplastics, this approach usually creates serious problems such as sink marks, voids and warpage. Furthermore, if rib height is too great, there is a risk that the rib structure will bulge under load. For this reason, it is absolutely necessary to keep rib dimensions within reasonable proportions (Fig. 1).
To ensure trouble-free ejection of the ribbed component, it is essential to provide a demoulding taper (Fig. 2).

Restricting material accumulation

For components requiring a very high quality surface finish, such as hub caps, rib dimensioning is important. Correct rib design reduces the tendency to form sink marks and thereby increases component quality.
Material accumulation at the rib base is defined by the imaginary circle drawn in Fig. 1. By adhering to the dimensional proportions recommended there, this “circle” can be made as small as possible and sink marks can be avoided or reduced.
If the imaginary circle is too large in this area of material accumulation, voids can be formed and mechanical properties drastically lowered as a result.

	Shallow taper (less than 25 mm deep)	Steep taper (more than 25 mm deep)
POM	0 - 1/4°	1/2°
PA (unreinforced)	0 - 1/8°	1/4° - 1/2°
PA (GR)	0 - 1/2°	1/4° - 1°
PET / PBT (GR)	1/2°	1/2° - 1°

Demoulding tapers

Fig. 2

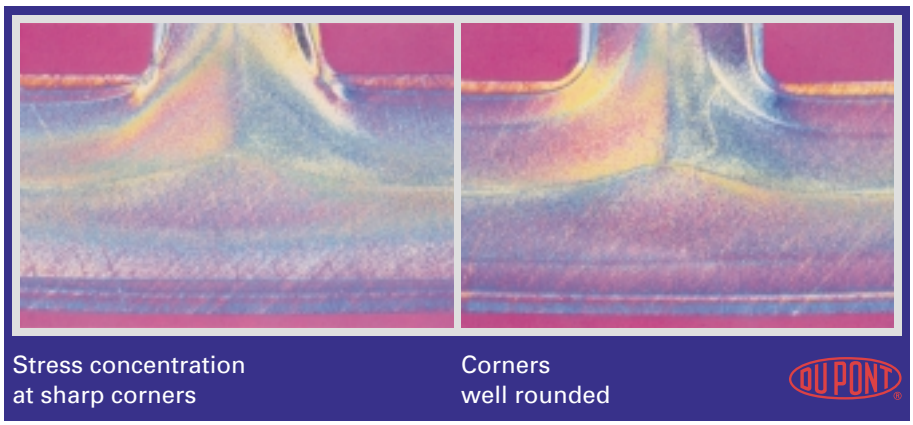

Fig. 3

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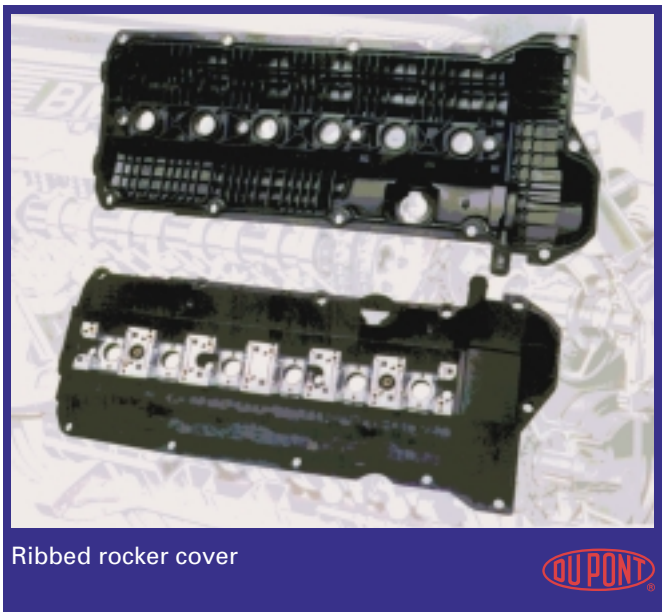
Stress reduction at the rib base

If a ribbed component is exposed to applied loads, stresses may be created at the rib base. If no fillet radii are provided in this area of the component, very high stress concentration peaks will build up (Fig. 3), which not infrequently lead to cracking and failure of the component. The remedy is to provide a sufficiently large fillet radius (Fig. 1) that will permit better stress distribution at the rib base. Radii which are too large, on the other hand, will also increase the diameter of the imaginary circle, which in turn can lead to the problems already mentioned.

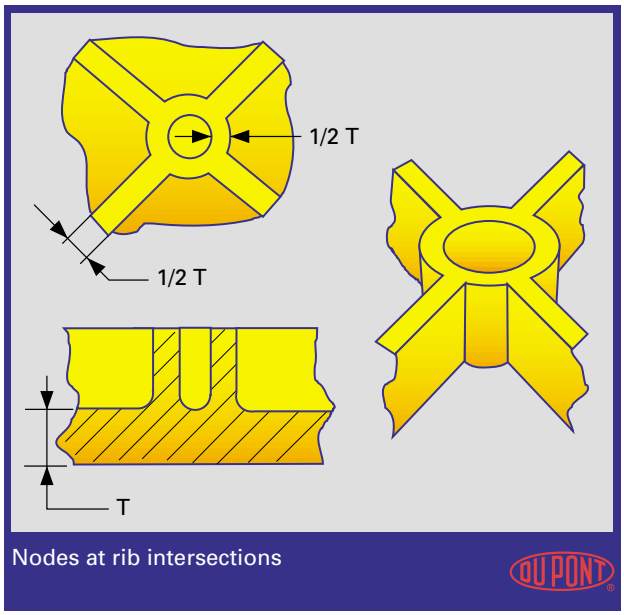
Choice of rib structure

In plastics design, a cross-ribbed structure has proved successful because it can handle many different loading permutations (Fig. 4). A cross-ribbed structure correctly designed for the anticipated stresses ensures uniform stress distribution throughout the moulding. The nodes formed at the rib intersections (Fig. 5) represent material accumulations but can be cored to prevent any problems. Care should also be taken to ensure that undue material accumulation is avoided at the point where the rib joins the edge of the component (Fig. 6)



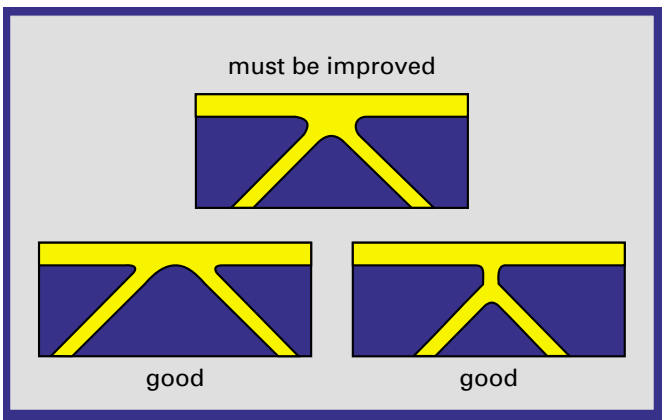
Ribbed rocker cover

Fig. 4



Nodes at rib intersections

Fig. 5



Rib junction with edge of component

Fig. 6

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