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Residual Stresses Measured Before and After Stress Relief in Rolled Aluminum Plate

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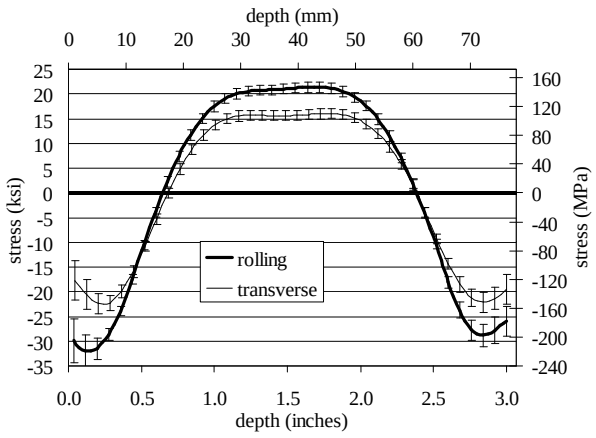
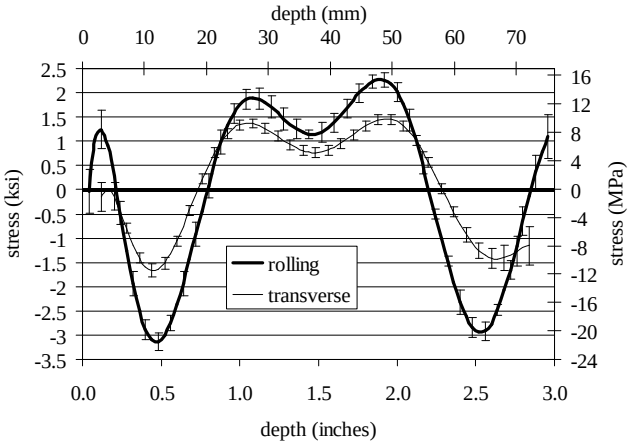
Residual stresses in rolled 7050-T74 aluminum plate were measured before and after (-T7451) stress relief. The residual stresses left even after the stress relief are sufficient to cause distortion in aircraft components machined from this material. The resulting re-work and scrap costs manufacturers tens of millions of dollars annually.

The stress relief process involves stretching the plate in the rolling direction to 1.5% to 3% strain. This process tends to equalize the stresses in the plate, resulting in much lower residual stresses after unloading.

The residual stress profile through the thickness of the plate was measured using the crack compliance method. 150 mm square sections of the 76-78 mm thick plate were removed from the central region of the manufactured plates. A finite element analysis indicated that this was sufficient size for measuring the original residual stress distribution. Wire electric discharge machining (EDM) was used to machine a slot in approximately 1 mm increments through the thickness of the block. Several strain gauges gave the released strains at each increment, which were used to determine the residual stress profile. The first cut was used to determine the rolling direction stresses. A second cut on half of the original block gave the stress profile in the transverse direction.



Residual stress distribution through the thickness of plate before stress relief. Full thickness: 77.9mm.



Residual stresses in stress relieved plate. Full thickness: 75.8mm.

The measured stress profiles agree well with published results that were taken using the layer removal method. The crack compliance measurements can be experimentally performed much quicker than the layer removal measurements. In addition, a smaller block can be used.

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