MANUFACTURING & AUTOMATION RESEARCH CENTER

KOÇ UNIVERSITY

Residual Stress Prediction in Machining

In collaboration with

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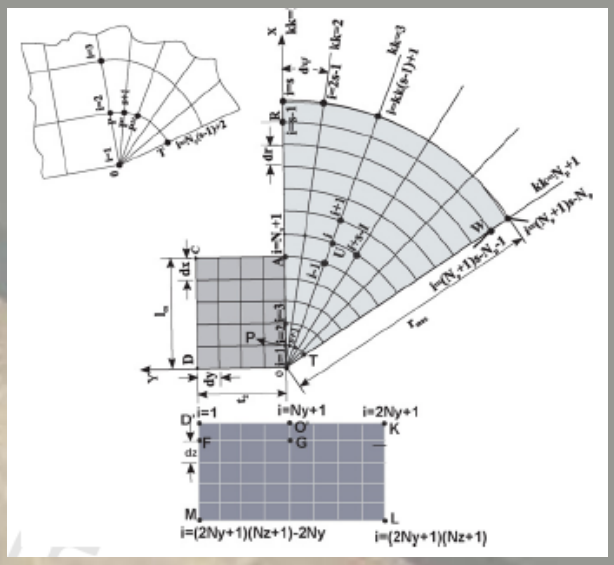
Motivation:

It is well known that machining processes such as turning, milling and drilling, create undesirable tensile residual stresses on the surface of workpieces leading to a reduction in the fatigue life of parts. Residual stresses raise the need for over-tolerant specifications on the parts or require post-processing in order to remove tensile residual stresses. It is very critical to find a fast and precise solution to predict residual stresses in a machined component given the process parameters and material properties. Having a reliable simulation tool for residual stresses allows production engineers to select appropriate cutting conditions in advance. This facilitates the elimination of residual stresses or even altering the state of residual stresses to increase fatigue life using optimum machining conditions.



Research:

An analytical model is developed for prediction of residual stresses in machining. In the thermo-mechanical model of residual stresses both the thermal field of the workpiece and mechanical cutting forces are coupled. The shear energy created in the primary shear zone, the friction energy produced at the rake face–chip contact zone, the heat balance between the chip, tool and workpiece are considered based on the first law of thermodynamics. The temperature distributions on the workpiece, tool and chip are solved by using finite difference method. The calculated workpiece temperature field is used in thermal load calculations. Stresses resulting from thermal and mechanical loading are computed using an analytical elasto-plastic model and a relaxation procedure. The model is verified with experimental measurements of residual stresses on bearing steel 100Cr6 (JIS SUJ2) in the literature. With the analytical model presented, substantial reduction in computational time is achieved in the predictions of residual stresses.