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Improved estimates of the plastic zones ahead of crack tips based on elastic and elastic-plastic analysis

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The traditional estimates of the size and shape of the plastic zones (*pz*) which always follow any real crack tip, based in Linear Elastic Fracture Mechanics (LEFM) concepts, suppose that the stress intensity factor (SIF) is the sole parameter required to describe them. However, such traditional estimates can significantly underestimate the position of the *pz* elastic-plastic border, because other parameters such as the nominal stress σ_n can have an important influence on the stress field around of the crack tip, which should not be ignored in many if not most practical cases. Indeed, since most structural designs allow nominal stresses of up to 80% of the yielding strength, neglecting the σ_n effect in such cases can lead to very unrealistic *pz* estimates. This affirmative is supported by more accurate analytical estimates obtained by using a complete Westergaard stress function to locate the *pz* border on Irwin plates, and by detailed elastic-plastic finite element calculations which corroborate them. This procedure demonstrate that, unlike what is usually accepted and taught in the traditional LEFM literature, the *pz* size and shape do not depend only on the magnitude of the SIF, a fact which has quite important consequences, because it can be used to question the similarity principle, one of the pillars of the mechanical design methods against fracture.

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