# Scaling Phenomena in Fatigue and Fracture

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ABSTRACT

Studies in structural strength and turbulence were originated by great Italians: Leonardo da Vinci and Galileo Galilei. There exist parallels in studies of strength and turbulence, and they will be briefly discussed. In particular, in both fields similarity and scaling considerations played, and continue to play, a basic role.

In the first part of the lecture some classic scaling phenomena in fracture will be presented and discussed briefly. It will be emphasized that, in addition to the standard procedure of dimensional analysis, the scaling laws in these phenomena rely on certain substantial hypotheses assumed as a rule tacitly. The validity of these hypotheses should be carefully examined because, in seemingly analogous phenomena, these hypotheses often became invalid and the scaling laws assume different form and sometimes even disappear.

The general classification of scaling laws will be presented and the basic concepts of modern similarity analysis – intermediate asymptotics, complete and incomplete similarity, will be introduced and briefly discussed. The link with the concepts widely used in modern theoretical physics, like Mandelbrot fractals, renormalization group, anomalous dimensions, etc., will be outlined.

The examples from fatigue and fracture will be presented where there exists incomplete similarity, and the scaling laws cannot be obtained by the dimensional analysis alone. The determination of `anomalous dimensions' – powers in such cases require more complicated analysis. In particular, the Paris scaling law in fatigue will be discussed as an instructive example. It will be emphasized, in particular, that in the Paris law the powers are not the material constants, contrary to the general belief. Therefore, the evaluation of the structural strength (the lifetime of structures) using the data obtained from standard fatigue tests should be done with some precautions.