Effect of size in design of structure

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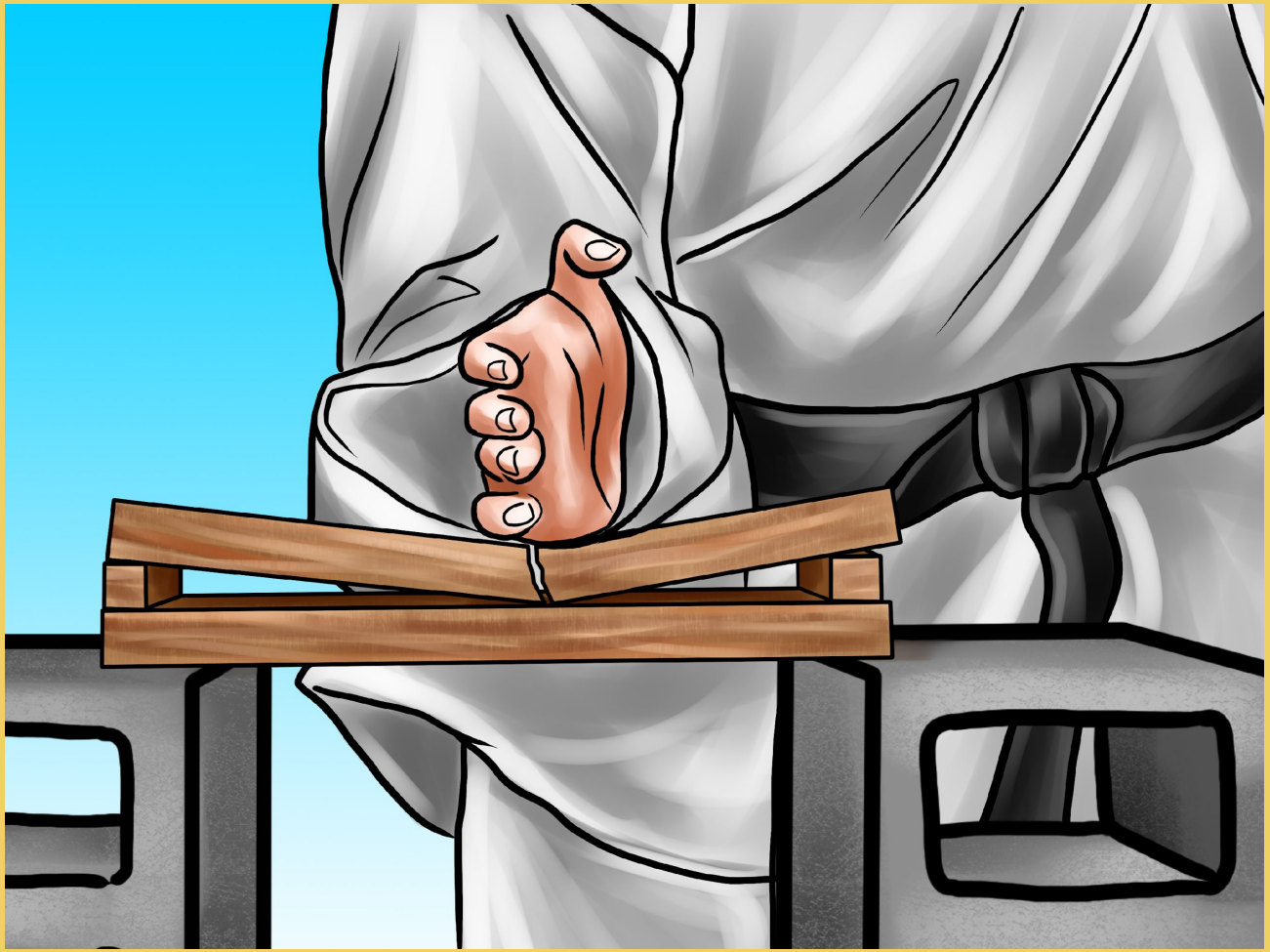
What is the «size effect»?

In statistics, an **effect size** is a quantitative measure of the magnitude of a phenomenon.

Examples of effect sizes are the correlation between two variables, the regression coefficient in a regression, the mean difference, or even the risk with which something happens, such as how many people survive after a heart attack for every one person that does not survive.



How it works?

For example,
conventional strength of
materials predicts that a
large beam and a tiny beam will
fail at the same stress if they are
made of the same material. In the
real world, because of size effects,
a larger beam will fail at a lower
stress than a smaller beam.

The **S.E.** (standart error) of the effect size is used to weigh effect sizes when combining studies, so that large studies are considered more important than small studies in the analysis.

According to the classical theories of elastic or plastic structures made from a material with non-random strength (f_t), the nominal strength ($\boldsymbol{\sigma}_N$) of a structure is independent of the structure size (D) when geometrically similar structures are **considered**. Any deviation from this property is called the **size effect**.

The size effect can have two causes:

statistical, due to material strength randomness

energetic (and non-statistical), due to energy release when a large crack or a large fracture process zone (FPZ) containing damaged material develops before the maximum load is reached

Where is it used in construction?

These properties must be extrapolated to sizes greater by one or two orders of magnitude. Even if an expensive full-scale failure test, for example a failure test of the rudder of a very large aircraft, can be carried out, it is financially prohibitive to repeat it thousand times to obtain the statistical distribution of load capacity. Such statistical information, underlying the safety factors, is obtainable only by proper extrapolation of laboratory tests.

The size effect is gaining in importance as larger and larger structures, of more and more slender forms, are being built. The safety factors, of course, give large safety margins - so large that even for the largest civil engineering structures the classical deterministic analysis based on the mean material properties normally yields failure loads smaller than the maximum design loads. For this reasons, the size effect on the strength in brittle failures of concrete structures and structural laminates has long been ignored.

In fact, the historical experience shows that very large structures have been failing at a frequency several orders of magnitude higher than smaller ones. The reason it has not led to public outcry is that the large structures are few. But for the locals, who must use the structures daily, the risk is not acceptable.

Questions

1) What is the «size effect»?

2) How it works?

3) What are the causes for the reasons for the size effect?

4) Where is it used in construction?

5) How to check the failure of materials?

1) Measure of the magnitude of a phenomenon.

2) Because of size effects, a larger beam will fail at a lower stress than a smaller beam.

3) Statical and energetic causes.

4) Nuclear containments, roof shells, tall buildings, tunnel linings, ets.

5) Its check on laboratory tests

Thanks for watching!

https://www.youtube.com/watch?v=6uYNVCy-8NA

https://en.wikipedia.org/wiki/Effect_size

https://en.wikipedia.org/wiki/Size_effect_on_structural_strength

https://www.leeds.ac.uk/educol/documents/00002182.htm

https://link.springer.com/article/10.1007/s004190050252