Size effects in shear force design of concrete beams

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If the strength of the material was the only factor affecting concrete beams they would all fail at the same stress, as long as the same quality concrete is used. Why is it then that a larger concrete beam generally fails at a lower stress than a smaller beam? Due to a phenomenon known as the size effect.

It goes a little against common intuition that a larger beam would end up failing at a lower stress than the smaller beam, but it is the case when looking at shear failures of reinforced concrete beams. The phenomenon was studied in the thesis, with focus on smaller reinforced concrete beams. What makes this subject so interesting is that there are factors, aside from the quality of concrete, that affect the strength of the beam in regards to shear failure. This in-turn affects how concrete beams are designed in different codes, such as the Eurocode[1]. Effects due to specimen size in structural material have been examined during the last couple of decades and there is still not a well defined size effect, especially for smaller reinforced concrete members.

Shear force is a force that occurs in a structure causing stresses and making it to want to ”shear” apart. Shear failure in structural concrete members is hard to predict and a complex problem that has been investigated during the last century. What makes the problem even more relevant is the fact that the failures are often brittle in nature, which can cause big consequences. A typical shear failure can be seen in figure 1.

[1]The European standard for designing structural members

To examine the effect of structural size in reinforced concrete beams, 16 test beams of different cross sectional sizes were cast and tested in the laboratory. The beams were tested to failure, then analyzed and compared to the theoretical values, calculated according to the shear resistance formulas in the Eurocode. The nominal shear stress in the cross sections was determined for the different beam tests.

All of the tested beams carried more load than calculated and showed a trend of decreasing stress at failure when the height increased. This shows that a size effect is present for the smaller reinforced concrete beams and that the Eurocode formulas are designed on the safe side. This is most likely due to the uncertainty when predicting shear failures, in order to keep the design values on the conservative side.

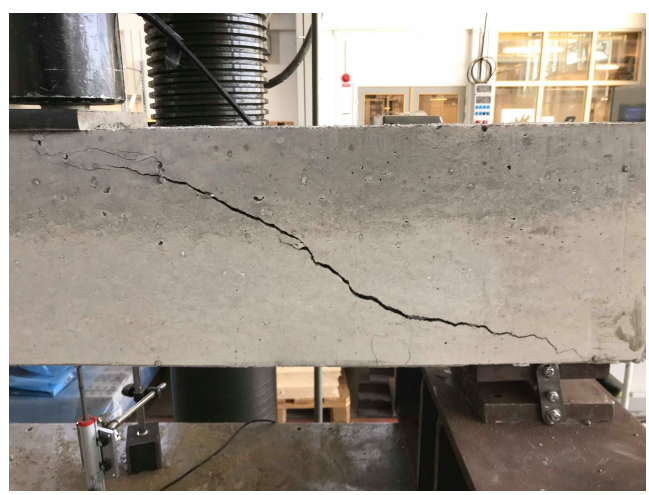

Figure 1: Shear crack in a concrete beam without shear reinforcement