What to do when the cubes fail!!

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IN TERMS OF the SANS 10100:2000 Parts 1 and 2, designers of reinforced concrete structures must base their designs on the cube strength of concrete, and SANS 5863:2006 specifies how this must be tested. The cube strength is known as the characteristic strength of the concrete and is the strength given in the material specification for the structure. It is further defined as the strength below which only 5% of the cube results may fall, i.e. it must give the designer a 95% confidence level that the strength will be achieved. Statistically, a 100% confidence level requires making concrete so much stronger than specified that it becomes economically unacceptable.

The characteristic strength of concrete is given the symbols f_{cu} in the design code, and in the derivation of the design formulae for reinforced concrete design it is reduced by dividing it by relevant factors, so that only 45% of the cube strength is used in the design. This strength is obtained from a pampered little cube of concrete which is perfectly transported, placed, compacted and cured; it is NOT defined as the compressive strength of the concrete in the structure nor is it ever intended to be!

Should the strength of the concrete in the cubes fail to satisfy the acceptance criteria given in the code (which allow a certain proportion of failures) then the code allows certain options to guide the designer or supervisor on the actions to be taken. It is also probable that in most cases cube failures represent poor cube making and may well not represent the concrete in the structure in any way. The actions given in the code are as follows (in the sequence given):

1. The design calculations for the structure should be reassessed to see whether the cube strength as measured is adequate to support the load to be carried on the element concerned, bearing in mind that similar structural elements are frequently designed to have similar dimensions and reinforcement, and seldom carry the same load.
2. Non-destructive testing, such as a rebound hammer or sonic tests may be tried, but seldom give a definitive answer and are generally inconclusive.
3. Drilling and assessment of core strengths taken from t structure.
4. Load testing which is not always practicable.

The action of drilling of cores is the usual recourse when cube is experienced, but it must be recognised that the concrete taken from a structure will not usually equal the strength of the pampered concrete measured from a cube. The code recognises this by reducing the required core strength of concrete below that of the characteristic strength by the application of factors which are less than one.

The test method for testing cores also requires factors to be applied to the measured core strength to adjust for the presence of reinforcing steel cut during drilling, the shape of the core and the proportion of entrapped air visible in the core. These factors are all greater than one and increase the strength of the concrete as measured in the core crushing test.

The methods for acceptance or rejection of the compressive strength of concrete given above must be used with caution and the following must be taken into account:

1. An engineer specifies and a constructor contracts to produce a certain strength of concrete as measured by cubes.
2. Cubes are frequently poorly made and do not represent concrete in the structure, as the handling of the material is very different in the laboratory and in situ. No malpractice in cube making can, however, increase the apparent strength of the concrete.
3. Drilling and crushing of cores is the most common course of action taken when cubes fail. The strength of a core does not have to equal the strength of a cube and is based on a reduced characteristic strength to allow for the difference between in situ and laboratory handling of the concrete. Core strengths, as measured by crushing, are enhanced to allow for variations in testing procedure.
4. The actual strength of the concrete in the structure, as measured by crushing of cores, is irrelevant if the core strength satisfies the acceptance requirements given in the code. The purpose of drilling cores is to estimate whether the characteristic strength, as measured by cubes, had been achieved by the contractor.

Very inaccurate cube moulds

Core showing lack of coarse aggregate at the top

Source:
http://www.saice.org.za/downloads/monthly_publications/2013/2013-Civil-Engineering-August/#/0