

Simple guide to Concrete Cube Testing

Concrete is one of the most widely used building materials in the world, yet people still find it difficult to take samples correctly and manage the testing & certification process. Failure to do this can result in the need to spend even more money undertaking complicated calculations to prove compliance with British Standards or even drilling and crushing cores to prove design and reliability! Why waste so much time and money when it's so easy!? What we have here is a sure fast way of doing it properly and getting it right first time. Enjoy!

Why do we do it?

Concrete is used mostly for structural purposes such as foundations, columns, beams and floors and therefore must be capable in taking the loads that will be applied (unless you're just after a large paperweight!). One of the methods of checking its fit for purpose is to carry out a concrete cube test which measures the compressible cube strength of the concrete and relates directly to the required design strength specified by the designer.

Also is it is usually a minimum requirement from the client to provide evidence of cube test results to ensure compliance with the designers requirements.

First things first! Safety.

Make sure all people involved are trained and competent to carry out the task at hand and make sure you read and understand the risk assessment and method statement, because if you don't, it'll only come back to bite you later. If you're not sure how to do it, ASK!

Wear Personal Protective Equipment (PPE) – as prescribed by the COSHH Assessments. Concrete is hazardous to your health so check with your employer what is required to undertake the task.

Taking a Sample (Sampling)

This is what you'll need;

- A bucket or wheel barrow
- Wooden board / Polythene sheet or similar
- Cube moulds
- Tamping rod or vibrating poker
- Slump cone
- Pen or marker to identify the samples
- Mould releasing agent and brush
- Scoop
- Trowel/Concrete float
- Tape Measure/Steel Rule
- Damp cloth
- Concrete curing tank



Never take a sample from the first or last section of the pour, it won't be a true representation of the batch. The concrete is usually sampled after the 1st metre of concrete has been poured to ensure a good sample is taken. As said in BS EN 12350-1, take a few samples throughout the pour for the best representation of the batch and make sure you take 150% of what you think you'll need. The sample is taken and used to make the cubes. The sample must be a good cohesive mix, it may require some mixing once taken from the concrete batch to be suitable for a slump test and cubes.

Site Testing

Slump Test – always do your slump test before making your cubes to ensure the concrete is usable. If the slump test fails to meet the range limit as dictated by the British Standard (shown in the table below) then the load should be rejected.



Place the damp slump cone on a flat, hard surface. Fill the cone with the concrete sample in three stages. Once each stage is filled, tamp the mix with the tamping rod 25 times. After the third tamping the excess concrete shall be struck off flush to the top of the cone. Lift the mould carefully upwards, to minimise disturbance of the concrete inside. The concrete will slump. Place the cone next to the concrete slump and measure the difference in height in mm between the top of the cone and the top of the highest point of the concrete.

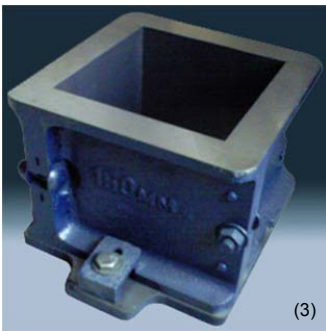
EN 206-1:2000 identifies five classes of slump identified in the table right.

Also note what the slump looks like; true (similar shape to the cone), shear (the slump has sheared in some way), collapse (no resemblance to the original cone). The slump is normally specified by the designer or may be a specific mix to aid in placement, i.e. a high slump for a pump mix. Record the slump on the appropriate paperwork.

Now for the cubes

Usually a minimum of 3 cubes are taken from each sample, so make sure you taken enough from the pour before it finishes. Do check the specification you are working to, as sometimes the quantity of cubes you have to take may vary. The frequency of sampling should be identified in client specifications or by the designer. This could be per batch / load or even per volume poured. Check before you start.

Cube moulds are usually 150mm x 150mm x 15 mm (or 100mm x100mm x100mm) and can be made from steel or polyurethane. The



cube moulds must be manufactured to the specifications / standards of the relevant body, in the UK it is the British Standards Institute to this specification BS EN 12390-1:2000.



Before the concrete is scooped into the moulds, the moulds must be lightly coated in a mould release agent. This ensures that the concrete does not stick to the mould and makes it easier to remove the cube. When using a 150mm mould, the concrete sample is scooped into the mould in 3 equal layers (50mm) and compacted between each layer. There are various methods to compact the concrete into the moulds.

Hand compaction – using a compacting rod / bar to BS EN 12390-2:2009

When using a 150mm mould, each layer compacted is tampered using a certified compacting rod /bar, 35 tamps per layer is required. Once the 3 layers have been tampered, tap the side of the mould with a hammer. Tampering and tapping removes trapped air in the concrete and allows compaction of the sample.

Once complete, the concrete is levelled off using a concrete float or trowel to give a smooth surface flush with the top of the mould.

Mechanical compaction - internal poker vibrator / vibrating table to BS EN 12390-2:2009.

Each layer is filled and vibrated till no more bubbles are on the surface of the layer, this is repeated for the 3 layers. It is very important not to over vibrate the layers as it may lead to segregation / disruption of the concrete mix.

Labelling

It's very important to uniquely identify each of the cubes (and moulds) and to record where they have come from. Usually companies will have a process of labelling or tracking the cubes so make sure you ask first and record it properly.

EN 206-1:2000	
Slump class	Slump in mm
S1	10 - 40
S2	50 - 90
S3	100 -
S4	160-210
S5	≥220



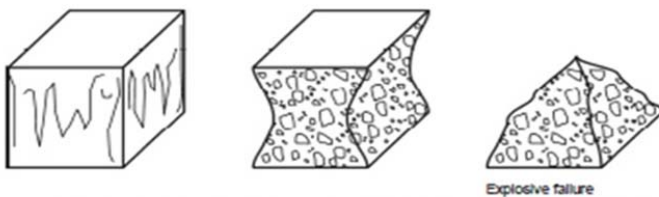
Storage

The cubes should be covered with a damp cloth and a plastic sheet and stored in dry environment at a temperature range of 20 ± 5 degrees. The concrete cubes are removed from the moulds between 16 to 72 hours, usually this done after 24 hours. Make sure the cube ID is transferred from the mould to the cube before placing into a curing tank. The curing tank needs to operate at a temperature between 20 ± 2 degrees and provides a moist environment that allows the cubes to hydrate properly. Ensure the cubes are fully submersed at all times and record the tank water temperature at least daily.

Cube Testing

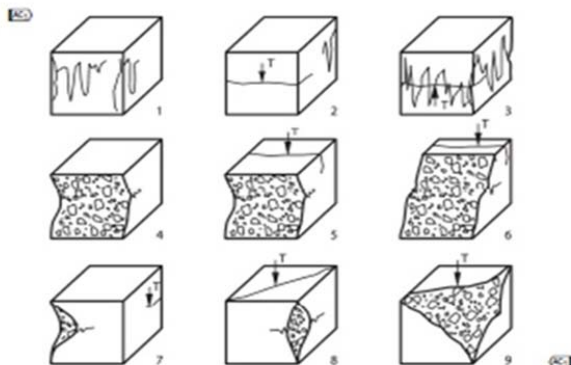
The cubes are generally tested at 7 & 28 days unless specific early tests are required, for example to remove a concrete shutter safely prior to 7 days. Usually 1 cube will be tested at 7 days and 2 cubes at 28 days, however this may vary depending of the requirements, check the design first. The cubes are removed from the curing tank, dried and grit removed. The cubes are tested using a calibrated compression machine. This can be carried out internally by competent personnel or by a certified test house.

The cubes are tested on the face perpendicular to the casting face. The compression machine exerts a constant progressing force on the cubes till they fail, the rate of loading is 0.6 ± 0.2 M/Pas ($N/mm^2/s$). The reading at failure is the maximum compressive strength of the concrete. BS EN 12390-2: 2009 / BS EN 12390-3:2009.



NOTE All four exposed faces are cracked approximately equally, generally with little damage to faces in contact with the platens.

Figure 1 – Satisfactory failures of cube specimens



NOTE T = tensile crack

(5) Figure 2 – Some unsatisfactory failures of cube specimens

The concrete minimum compressive strength will be specified by the client/designer in a specific format. An example of this is given below:

C40/50

The 40 is the compressive requirement of 40 N/mm^2 of a crushed 100mm concrete core and the 50 is a compressive requirement of 50 N/mm^2 for a crushed concrete cube. Therefore using the method of testing using concrete cubes, the tested compressive strength should be compared to the second number.

Once the cubes have reached failure, the shape of the cube has been altered due to the compression. The failure shape can indicate whether it's a satisfactory / unsatisfactory failure. The image left shows the various failures of a cube as show in BS EN 12390-3:2009.

Specifications

Concrete cube testing as with all methods of testing, fresh / hard concrete are governed by standards set by the British Standards Institute and or the client in-house specifications. These standards specify all aspects involved in the process of carrying out tests, from the equipment to the method of testing.





Bringing projects together

A list of the National Concrete Standards relevant to Cube Testing are:

Fresh Concrete:

- BS EN 12350-1:2009 – Sampling
- BS EN 12350-2:2009 – Testing Fresh Concrete, Slump Test
- BS EN 206-1:2000 – Concrete. Specification, performance, production and conformity

Hard Concrete:

- BS EN 12390-1:2000 – Shape, dimensions and other requirements for specimens and moulds
- BS EN 12390-2:2009 – Making and Curing Specimens for Strength Test
- BS EN 12390-3:2009 – Compression Strength of Test Specimens
- BS EN 12390-4:2009 – Compression Strength – Specification of Test Machines

Conclusion

We can't stress enough the value of carrying out cubes tests on concrete within the construction industry. Not only does it verify compliance with design soon after construction but also can save time and costly investigations later if things go wrong.

References

- (1) Concrete being sampled from ready mix truck (http://www.martineztesting.com/services.html#Laboratory_Evaluation_Design_and_Testing_Services)
- (2) Polyurethane mould (<http://www.meritautomotive.com/concrete-test-moulds>)
- (3) Steel mould (<https://www.speedcrete.co.uk/item.do?item=968>)
- (4) 3 cubes that were cured for min 16 hours & no more than 72 hours (<http://geo.uk.com/site-services/concrete-sampling>)
- (5) Extract Diagram from BS EN 12390-3:2009

From the editor: We have tried to make sure the above article is as accurate and up-to-date as possible. If you think we have something wrong, or you feel we need to update it, please get in touch [here](#).

