NDTitans in action

Case 4.2 Production control with CAPO-test on an abutment, Great Belt Link, example, Denmark

For production control at the Great Belt Link project in Denmark the pullout systems, LOK-test and CAPO-test were specified for in-situ strength.

The strength specifications are shown below and a case from testing of one of the abutments of the projects West Bridge is given

Requirement, cf ref.1, page 170 ***Potential strength*** ***In-situ strength***

Table 5.3-1 Requirements to 28 days characteristic strength

	Mix type	Cylinder tests	LOK/CAPO tests
East Tunnel	A1	50MPa	40MPa
	B	45MPa	36MPa
East Bridge &	A	45MPa	36MPa
West Bridge	B	45MPa	36MPa

The compressive strength of the concrete obtained in a real structure is always less than the strength of the same concrete measured in standard specimens in the laboratory. This is because of the workmanship during the constructions, e.g. the effects of transportation, pumping, consolidation and curing

The reduced value of strength, the design strength, is obtained by applying safety factors to the characteristic strength obtained by standard specimens in lab conditions.

In the Great Berlin project, the ratio between the minimum accepted characteristic strengths of standard cylinders and in-situ tests was 1.25.

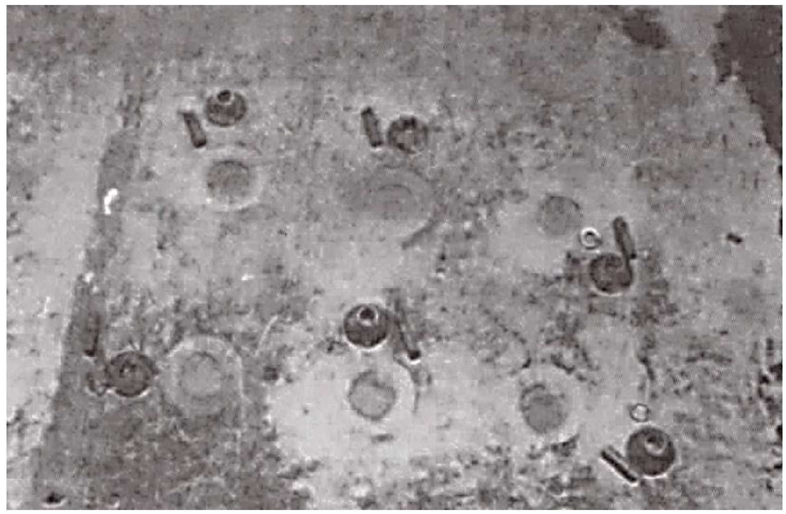
The LOK-test and CAPO-test methods were selected for this purpose, testing strength in-place.

Example: For the structure of the West Bridge where the concrete mix type B was used, the minimum accepted characteristic strength in cylinders was 45 MPa and therefore, the concrete in the structure would comply with the requirements if the characteristic strength from in situ tests made with the LOK /CAPO methods was at least 36 MPa (45/1.25 = 36)

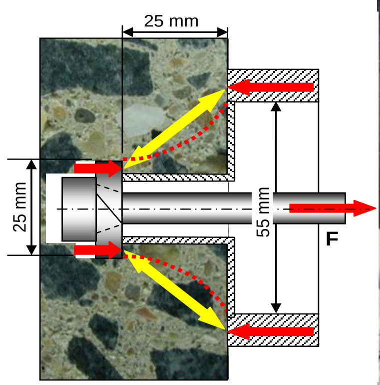
Testing In the control section selected, six CAPO-tests were performed, cf ref 2, page 69-71.

Testing

In the control section of the abutment tested with six CAPO-tests.



The six CAPO-test performed, all with acceptable failures, cf ref 2, page 24.



CAPO-test

Right: The testing in progress, supervised by the GBL inspectors.

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Test Results:

The pullout forces, F in kN, and transformation to strengths f_{cyl} in MPa, using the general correlation $f_{cyl} = 0.69\ F^{1.12}$, cf ref. 3:

CAPO-force F	strength f_{cyl}
41.0 kN	44.2 MPa
36.0 kN	38.2 MPa
40.0 kN	43.0 MPa
42.0 kN	45.4 MPa
40.0 kN	43.0 MPa
41.0 kN	44.2 MPa

Mean value:

F_m = 40.0 kN ⇨ f_m = 43.0 MPa

And, calculating the lower tenth-percentile characteristic strength using the formula

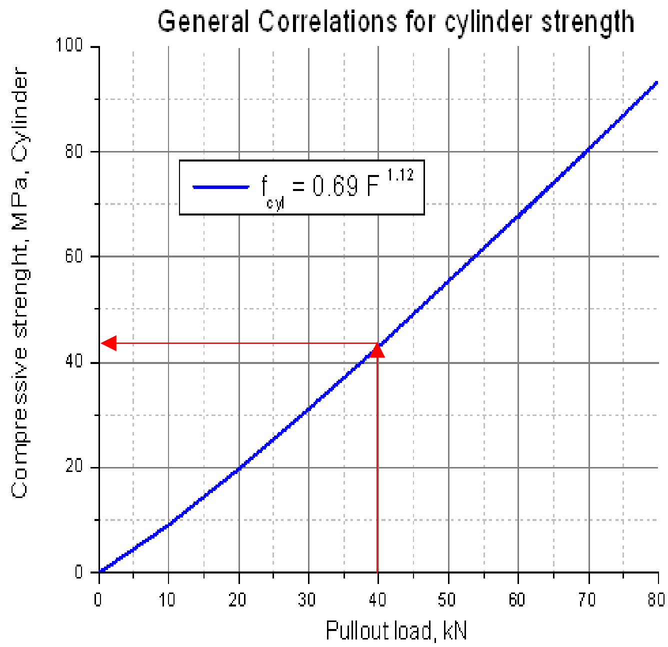
$f_{ck} = f_m - K\ sd$

f_m = 43.00 MPa k = 2.49 sd = 2.48 MPa (CV=5.8%)

⇨ f_{ck} = 36.9 MPa > Required 36 MPa

THE CONTROL SECTION IS ACCEPTED

Notice: The CAPO-tests were performed in the top of the abutment, representing the weakest part of the structure. In this manner not only the cover layer, but also the "interior" was accepted according to the requirements.



Ref. 3 Case 4.1: "Correlation between Pullout force and Compressive Strength", Copenhagen. 2022

Reported by **NDTitan Claus Germann Petersen**

References

1. The Storebælt Publications. "Concrete Technology" Edited by Niels J. Gimsing, København 1999

2. Petersen, C.G. & Poulsen, E.: "Pullout testing by Lok-Test and Capo-Test with particular reference to the in-place concrete of the Great Belt Link", Dansk Betoninstitut A/S, Birkerød, Denmark, 1991

3. NDTitans: Case 4.1 "Correlation between Pullout force and Compressive Strength", NDTitan Case Collection, Copenhagen, 2022