fischer

Application Manual.

Execution of Concrete Pull-off Tests.

EN

Safety Instructions
Please read the Safety Data Sheets (SDS) and Technical Data Sheets (TDS) before using the products! When working with chemical products, use suitable protective clothing, protective gloves and safety glasses. IMPORTANT: Please follow the application instructions, which are included in every package.

 These application instructions were created with care. However, fischerwerke GmbH & Co.KG does not take over any liability for any errors in these application instructions and their consequences. There is also no liability for direct or consequential damage taken from incorrect use of the products.

Performance of construction materials (Epoxy resins) vary with external conditions (e.g. project site conditions such as temperature or humidity).

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Content

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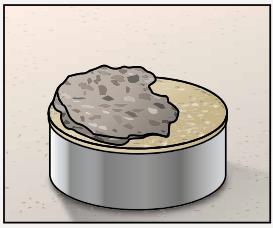
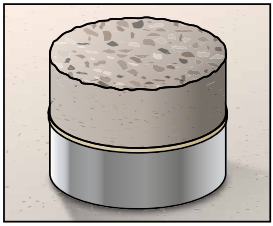
1 Introduction

In order to determine the concrete surface tensile strength, pull-off tests are performed. These tests help to assess the concrete surface quality and to verify the suitability of the concrete surface prior to or after concrete repair and/or structural strengthening applications. It can be applied to horizontal, vertical and slanted surfaces.

The concrete surface tensile strength must be measured by means of a suitable and calibrated concrete pull-off adhesion testing device after surface preparation. In this manual, the necessary steps to perform these tests as well as the evaluation of results are described.

2 Definitions

Term	Description
Concrete surface tensile strength	Determination of the surface tensile strength of concrete: A bending resistant, cylindrical test disk glued to the surface is pulled off at a controlled loading rate. The ultimate pull-of force divided by the area of the testing disk results in the concrete surface tensile strength. The failure modes obtained in this process and the calculated concrete surface tensile strength can provide information about the quality of the tested surface. The detailed description of the different failure modes are described in Section 5.6.
Adhesive failure	60 % Failure type "A": cohesion failure of the concrete substrate, 40 % Failure type "A/B": Adhesion failure between substrate and adhesive 
Cohesion failure (concrete failure)	Failure within a layer 

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3 Recommended equipment

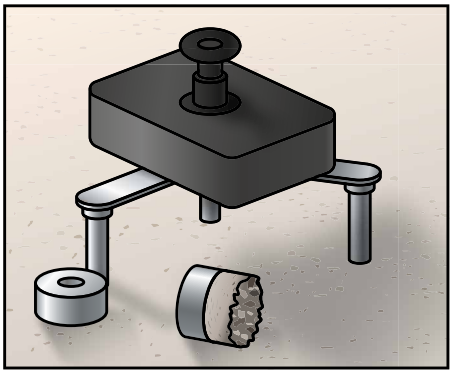
3.1 Equipment, devices, tools and accessories

For adequate testing it is recommended to have the following equipment on site:

- Thermometer for air and surface temperatures
- Concrete pull-off tester including steel disks with a diameter of 50 mm disc to determine the concrete tensile strength, adequate adhesive for installation
- Diamond Core drilling machine and accessories (for concrete pull-off tests)
- Equipment for substrate preparation (by caulking, blasting, grinding and for cleaning work)
- Application equipment (steel brushes, adhesive application device, cleaning cloth, etc.)
- Cleaning of tools and accessories

All tools and processing accessories must be cleaned immediately after use. Cured materials can only be removed mechanically.

3.2 Test device



A portable tensile tester according to EN ISO 4624:2016-08 or ASTM C1583/C1583M must be used.

The concrete pull-off device shall include the force control for a linear load increase, and must be able to save the reading of the maximum exerted force.

3.3 Choice of adhesive

In the field, adhesives based on epoxy resin (EP), polymethylmetacrylate resin (PMMA) and polyurethane resin (PU) are frequently used.

We recommend the use of FIS V Plus, FIS EM Plus or FRS-CS.

FIS EM Plus

FIS V Plus

FRS-CS 585 S

Depending on the specific conditions of the environment different adhesives might be preferable.

In warmer climates, an adhesive with longer dry time might be chosen, like the FIS EM Plus.

Preferably an adhesive without long curing time is to be used. Else it needs to be ensured that the glued-on testing disk is fixed to the surface with a holding fixture while curing.

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4 Health and safety

4.1 Risk assessment

All health and safety risks must be assessed and adequate countermeasures shall be defined. This includes the very condition of the structure and the resulting risks thereof, the processing of all materials used on site as well as working methods.

All work and working procedures must be carried out in full compliance with the relevant local safety and environmental regulations in force on site.

4.2 Personal safety

During the installation, safety shoes, safety gloves and other suitable skin protection must be always worn. It is strongly recommended to use adequate disposable safety equipment during the processing and application of the materials. Since epoxy adhesives or impregnating resins can cause skin irritation, always wear protective gloves e.g. nitrile-based hand gloves when working with them. Unprotected skin must always be covered with protective cream before starting work.

Always wear suitable eye protection during processing, mixing and installation of the products. It is recommended to carry eye wash with you at all times. Always wash hands with suitable soap and clean water after processing the materials.

The work area must be well ventilated, and workers should take regular breaks in the fresh air, to avoid health problems. The developing dust and quartz sand during drilling, grinding or sandblasting the concrete can be hazardous. Avoid to inhalation of concrete or CFRP dust. To protect yourself and others, use e.g. vacuum cleaner or other adequate suction techniques. Always wear a dust mask or respirator when grinding concrete or cutting the CFRP Laminate. For detailed health and safety information, see the relevant SDS.

4.3 First aid

If epoxy-based chemicals come into contact with the eyes or mucous membranes, contact lenses must be removed and the eyes must be rinsed immediately with clean, warm water for 10–15 min. and a medical doctor should be consulted.

If chemicals come into contact with the skin, it must be cleaned immediately and carefully rinsed with clean warm water.

In case an accident happens, despite all of the preventive measures, the corresponding SDS must be immediately handed over to the emergency services. This helps the emergency services to select the appropriate medical treatment(s). For detailed health and safety information, refer to the relevant SDS of the individual products.

4.4 Waste disposal

Excess materials must not be poured down in drains or into water supplies. Waste and packaging must be disposed by specialized waste management companies or partners in accordance with local legislation and official requirements. Furthermore, chemical materials must not enter the soil, watercourses, drains or sewers. Chemical waste in uncured form or leaking adhesive must be disposed as hazardous waste.

Waste in the form of cured adhesive can be safely disposed of as normal construction waste in accordance with local legislation. For detailed environmental and safety information, refer to the relevant SDS.

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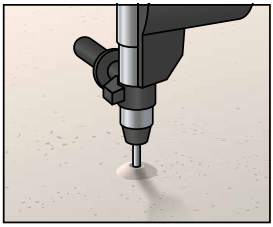
5 Preparation works

5.1 Preparation of the core drilling

Installing the support bracket

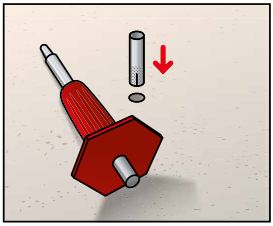


Drilling into the concrete surfaces free-hand is not permitted.

In order to ensure vibration-free pressure without canting effects, a support bracket with dowels must be used on all surfaces, whether horizontal, vertical or overhead surfaces.

To attach this support bracket, as a first step, a hole for the drill core anchoring is drilled.

Depending on the kind of anchor, the drill hole is cleaned.

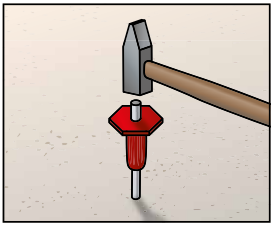


For the fixing of the support bracket, a suitable anchor system needs to be used.

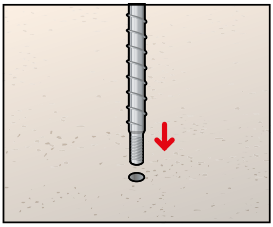
In the following manual, the installation of a sleeve anchor is described. Alternatively an expansion plug could also be used.

We recommend the use of the sleeve anchor fischer ZYKON FZEA II, bolt anchor fischer FAZ II Plus or high performance anchor fischer FH-II.

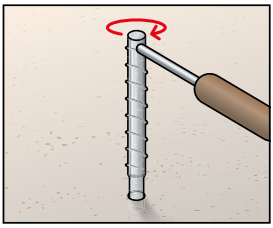
The anchor is inserted into the drill hole.



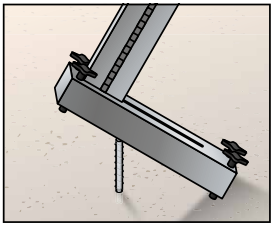
Fixing the anchor according to its manual.



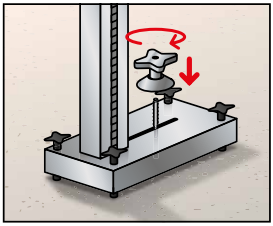
Inserting the drill core anchoring.



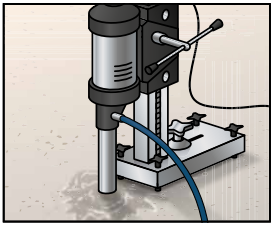
Tightening of the drill core anchorage.



Setting up the support frame.



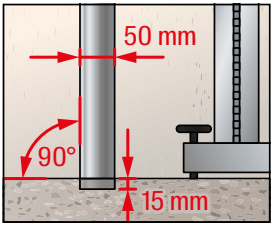
Attaching the support frame.



Spot drilling the inspection area.

5.2 Core drilling

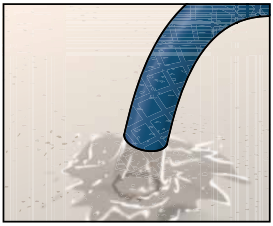
Core drilling



The drill rig should not generate significant vibrations and should prevent lateral movements of the drill bit. For the drilling, a diamond core bit cylinder with 50 mm ø (± 1 mm) inner diameter is to be used, with an axis angle 90° (± 1°) to the surface.

The groove must be cut 15 mm (± 5 mm) deep into the concrete surface. The diamond core bit is then carefully removed without damaging the specimen.

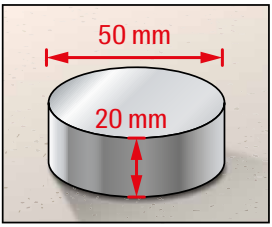
It is recommended to wet drill. Particularly in the case of thermoplastic surface protection coatings, dry drilling is unsuitable due to the expected peak temperatures.



After the drilling process, the drilling sludge that has accumulated must be thoroughly removed with water.

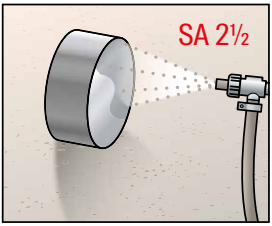
5.3 Test disk application on the concrete

Preparing the test disk



For the concrete surface tensile tests, circular test disks with a diameter of 50 mm (± 0.5 mm) made of steel (2 cm thick) are used.

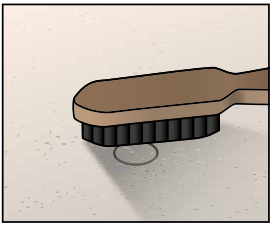
The test disks must be equipped with a fixture for the attachment of the test device for the pull-off test, which ensures that the load is applied perpendicularly to the test surface and that no bending or shearing forces act on the test area.



To prepare the test disks, they are sanded with a grinder or sand paper and then cleaned with a lint-free cloth. To minimise the risk of adhesion failure between the steel disk and the adhesive, it is recommended to roughen up the steel disk surface to achieve SA 2½ surface grade by e.g. sand-blasting.

The test disks must be grease-free and dry and should be cleaned by using e.g. fischer FRS-CA Universal Cleaning Agent.

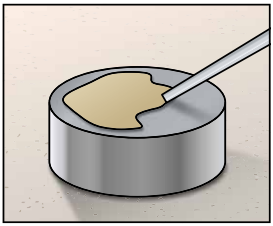
Cleaning of the test area



Concrete surfaces must be roughened up e.g. by sand-blasting.
Coating systems are roughened with coarse sandpaper or a wire brush.

The sanding dust is removed with a lint-free cloth or oil-free compressed air.

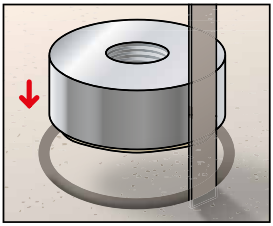
Attaching the test disk



On the surface of the test disk a thin layer of adhesive (approx. 1 mm) is applied, in a way that the adhesive forms an even, homogeneous layer between the test disk and the concrete surface.

In order to determine meaningful values, the adhesive layer between the test disk substrate is crucial.

The processing information for adhesive e.g. pot-life, installation temperature, hardening time of the adhesive used for the test needs to be followed.



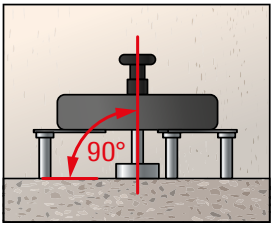
Sufficient pressure must be applied to the test disk, so that the air between the contact surfaces and the adhesive is expelled.

The test disks are to be glued centrically, protrusions into the groove are not permissible.

Important: No adhesive should penetrate into the drilled groove.

5.4 Testing procedure

Setting up the testing device



The test device for the pull-off test is placed concentrically above the disk, angled 90° (± 1°) to the drilled surface. The test device shall be positioned in such a way that its position can't change during the test.

5.5 Applying the load

Recommended loading rate:

- for concrete bases and hard layers: 100 N/s.
- for elastic and hard thermo-plastic layers: 300 N/s

Important:
The load shall be increased continuously and uniformly at a rate of (0.05 ± 0.01) MPa/s until failure.

5.6 Determination of the failure type/evaluation

The type of failure of the test specimen is to be determined by visual evidence.
There are the following types of failure:

Type	Description
A	Cohesion failure of the concrete substrate
A/B	Adhesion failure between the substrate and the first layer (e.g. primer, bonding agents or repair mortar)
B	Cohesion failure in the first layer
B/C	Adhesion failure between the first and the second layer
C	Cohesion failure in the second layer (as defined by the product or system under test)
-/Y	Adhesion failure between the last layer and the adhesive layer (e.g. C/Y in a two-layer repair system)
Y	Cohesion failure in the adhesive layer
Y/Z	Adhesion failure between adhesive layer and test disk (which is Z)

5.7 Number of pull-off tests

The required number of concrete pull-off tests, as well as the choice of the position of the tests to obtain a representative evaluation of the concrete depends on the corresponding standards, regulations and national guidelines and/or it is determined by experienced professionals.

The exact regulations can be found e.g. in ASTCM C1583/C1583M, with additional guidance on the number of tests as well as interpretation of the test results in ICRI 210.3, or in EN ISO 4624, with additional national guidelines like ZTV-Ing Part 3.

5.8 Documentation

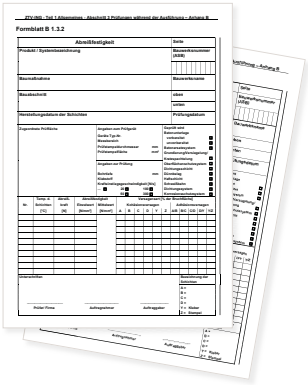
In case of a combination of these failure modes, a visual verification of the failure surface should be carried out in order to determine the percentage of the surface area for each failure mode and to express it as a ratio, e.g.:

A : A/B : B = 40 % : 10 % : 50 %.

Each pull-off test should be documented in a report.

The report should include all materials used in the test, the test conditions like location, weather, surface temperature, and the failure modes as well as the resulting tensile strength.

Exact templates for documentation can be found e.g. in form B 1.3.2 of the ZTV-ING or described in EN 1542-08 or ASTM-C1583-12.



5.9 Statistic evaluation of the results

The breaking strength f_h (N/mm² = MPa) results by diving the breaking force F_h (Newtons) by the area A of the test disk (mm²):

$$F_h = \frac{F_h}{A} = \frac{4 \cdot F_h}{\pi \cdot D^2}$$

Example of single test results, and subsequent calculations:

2.2 1.8 2.8 2.6 2.4

Average $\bar{\chi}$	2.36 N/mm² = MPa
Standard deviation σ	0.344 N/mm² = MPa
5%-fractile; characteristic resistance $f_{c,k}$	1.88 N/mm² = MPa

We recommend using the fischer REINFORCE-FIX software to evaluate the test results and directly calculate all relevant data.

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6 Legal notes

The above information, in particular the suggestions for processing and use of our products, are based on our knowledge and experience under normal conditions, provided the products have been stored and used properly. Due to the different materials, substrates and deviating working conditions, a guarantee of a work result or liability, from whatever legal relationship, can neither be justified from these instructions nor from verbal advice, unless we are charged with intent or gross negligence in this respect. In this context, the user must prove that he has in writing all knowledge required for a proper and reasonable assessment by fischer, has been communicated to fischer thoroughly and on time. The user must test the products regarding their suitability for the intended use.

The product specifications are subject to change without notice. Third party property rights must be observed. In all other respects, our respective terms and conditions of sale and delivery apply. Always the latest product data sheet (TDS) applies, which should be requested from us.

fischer stands for

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Consulting
Electronic Solutions

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