

The Pull-Off Adhesion Series

8. Measuring the Pull-Off Adhesion of Coatings on Concrete

Testing coating adhesion on concrete substrates using a pull-off adhesion gauge is similar to testing coatings on metal substrates. There are, however, a number of differences in the test procedures and equipment used.

Firstly, as the coating adhesion values on a concrete substrate tend to be considerably lower than those on metal substrates, a 50mm diameter dolly is most commonly used. This allows for consistent and more reliable results at low pull-off values.

Secondly, as the dolly diameter is two-and-a-half times larger than a standard 20mm dolly (or pull stub) used for other substrates, either the gauge used or the actuator skirt will be different.

Gauges such as the Elcometer 106 Scale 6 are designed specifically for testing coatings on concrete, as are the Elcometer 506 and Elcometer 510, which have specially designed dolly skirts for use with 50mm dollies.

Thirdly, as coatings on concrete have a lateral bond strength that can produce misleadingly high values, if the coating is thicker than 500 microns (or 20 mils), the coating must be cut down to the substrate, and it must be cut before adhering the dolly to the substrate.

It is also worth noting that coatings less than 500 microns (or 20 mils) thick may also require cutting, but this would be at the request of the client or contractor.

Either way, whether you cut or don't cut, it is important to report what you have done, and then ensure all adhesion tests are carried out in the same way.

When selecting a position to perform the pull test, the dolly should be placed away from any bumps or edges, and there should be enough space around it for the gauge or actuator head to be attached - so that a uniform, perpendicular, tensile pull can be achieved.

Don't forget to leave space for the support ring, which is required for some adhesion gauges.

To minimise the risk of an adhesive glue failure, lightly pass sandpaper back and forth across the area to be tested. This should be done before cutting the coating, as abrading after the cut risks damaging the edges of the coating you are about to test.

When abrading, take care not to damage the coating or cause a significant loss of coating thickness.

Once the coating has been lightly abraded, unless directed to do otherwise, the coating is now ready to be cut all the way down to the surface of the substrate.

Now you could use a knife to do this, but as the dolly is not adhered to the coating, this can be dangerous. It is much safer to use the dolly cutter which is supplied with the gauge, and as you will be cutting quite a large circle, the cutters are designed to be attached to an electric drill.

Whilst an electric drill will make it easier to cut cleanly through the coating, it is often not as easy as it looks, as the cutter can have a tendency to skip across the coating. To avoid this, it is often wise to use a guide template made of plywood or other suitable material, which has been securely clamped down. Alternatively use a drill stand.

In some cases, and depending on your standard or test method, you may also be required to cut into the substrate itself, typically to a depth of around 15mm ±5mm.

Once the coating is cut, abrade the dolly on a flat surface. Do not do this in your hand as this may damage or round the edges of the dolly, reducing the surface area and affecting the test result.

To avoid an adhesive glue failure, clean both the dolly and the coating of any dust or grease using a suitable solvent.

Mix the adhesive according to the manufacturer's instructions, and apply a thin film of adhesive over the entire dolly face.

Press the dolly carefully down onto the prepared test surface, applying an even pressure to the dolly, to ensure that the dolly face is parallel to the test surface. Remove any excess adhesive from around the dolly, making sure that no adhesive has flowed into the groove made from cutting.

To keep the dolly secure during the curing process, tape the dolly in place with masking tape, and allow the adhesive to cure for the manufacturer's recommended duration.

Once fully cured, remove the masking tape, reset or rewind the gauge or actuator head to its start position, and attach it to the dolly.

Apply a uniform increase in force in accordance with your test method or standard - typically this would be a rate of pull of 0.2 MPa/s or 30 psi/s for coatings on concrete.

Whilst the rate of pull is controlled manually for most pull-off adhesion testers, the Elcometer 510 Automatic Pull-Off Adhesion tester allows the rate of pull to be selected, and when the start button is pressed, the gauge applies the pre-selected rate of pull automatically.

Pull-off adhesion tests usually require the dolly to be completely pulled off the surface, and in addition to the pull-off force, the failure mode is also recorded.

To determine the failure mode, you will need to inspect both the dolly face and the substrate's surface, where the result could be:

- A glue failure, where the glue fails before the coating or substrate;
- An adhesive failure, where there is a failure between two layers of coating, or between the coating and the substrate;
- Or a cohesive failure, where the coating fails within a single layer, or the substrate fails.

Since concrete has a very low tensile strength, the substrate typically fails before the coating. However it is possible for both adhesive and cohesive failures to occur during one test.

Many National and International Standards require the user to record both the pull-off force and the nature of the failure as an estimated percentage to the nearest 10%.

Codes are used to denote the layer or layers in which the failure occurred.

For example, if the pull-off force was 2.3 MPa, and upon reviewing the dolly and surface, there is an 80% cohesive failure of the substrate, and a 20% adhesive failure between the substrate and the first layer of coating, usually defined by the colours and conditions of the dolly and the coating system; then the result is recorded as 2.3MPa, 80% A, 20% A/B.

Whilst most concrete adhesion gauges will require the test data to be recorded manually, the Elcometer 510 Automatic Pull-Off Adhesion gauge allows the user to store both the pull-off force and the failure mode against each reading, into memory. This can all be transferred via USB or

Bluetooth to your PC or mobile device running Elcometer's ElcoMaster Application, where you can generate inspection reports in seconds.

For more information and training on the pull-off adhesion method, or Elcometer's range of pull-off adhesion testers, please click on one of the links on-screen or visit our website.