

# Wet adhesion testing.

## Two devices under comparison

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### *The test method*

A technical test method has been under development for some years at the CEN TC 139 (technical committee 139, Paint and varnishes of the European Committee for standardization.) for assessing the adhesion of wood paints for exterior use in a condition of humidity.

That document describes a testing method to measure the force necessary to pull-off certain circular based objects made on aluminium called "dollies" (from their shape that is similar to a little dolly) previously glued to the surface to be tested. A circular hole of 20 mm internal diameter and 1 to 2 mm deep is sawn on the surface. Then 0,5 ml of distilled water is put inside the hole.

After two hours (during this period the hole is maintained wet) the dollies are pulled off perpendicularly from the surface of the panel under testing.

At Catas we use an Universal electromagnetic dynamometer at a movement speed of 1 mm/min.

The force necessary to detach the dollies from the panel is registered as test result.

### *The wooden substrate*

A particular attention has to be given to the choice of the wood panel to be used as substrate, considering that wood is not homogeneous by definition.

Scots Pine (*Pinus sylvestris*) is commonly used to test paints for outdoor use. The choice and the characteristics of the panel are described in the EN 927-3, the standard method for the natural weathering test.

We made several pull-off in wet condition tests to evaluate the adhesion of paints for windows, in the last few years. We observed that waterborne paints applied on Scot Pine substrate give particularly low results if compared to the same test made at the dry condition (that is without water in the sawn circular hole). The pull-off test is a well known method and it has been largely used for long, as a matter of fact there exist many standards for different kind of products (e.g. paints for metal, wood and/or other kind of coatings).

### *Difficulty*

As consequence of the crucial matter of the test, some paint producer companies have been provided of manual or semi-automatic disposals called "Pull-off tester". The results they obtained are usually higher than those find by Catas using the dynamometer.

Many inter-laboratory tests have been carried out, some of them using different kind of wood substrate, trying to make the test on the same panel in adjacent zones, but the results appeared in any case different.

Consulting some reference standards about this subject, it seems that this matter was already known and debated by the authors.

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*In the EN ISO 16276-1 standard, the calibration of the instrument is mentioned. At paragraph 6.1.4 we can read: "the measurement equipment shall be calibrated. If a calibration certificate is required, it shall be checked to ensure that it is current and relates to the instrument in use, i.e. has the same serial number."*

*The ISO 4624 mention the possibility of great difference of results among different instrument: "instead of a tensile tester, other types of pull-off adhesion testers (mechanically, pneumatically, hydraulically or hand driven) may be used provided that they give similar results. The type of instrument shall be reported in the test report, because hand-driven/mechanical/hydraulic instruments are reported to produce widely different results."*

### The experiment

Even though we are aware of the reliability of our instrument, periodically calibrated, and conscious that the matter was already taken in account by the standard, we would like to give a more mindful answer to our customers. This is the reason why we decided to make an experiment and thanks to Sirca company and its collaborators who lent their pull-off tester to us, we tried to make a contemporaneous comparison between instruments.

Two dollies have been glued together and in the same time subjected to traction. One dolly connected to our dynamometer and the other one connected to the pull-off tester; the results were visually read on both instruments. The values were collected while the test was in progress in order to have more data instead of the only final result obtained in the moment when the dollies were detached.

### Observation

By the experiment the evidence that the results read on the dynamometer were higher than those read on the pull-off tester. Anyway the variance between data was so big to persuade us to considered the test unreliable (in some cases the difference between the values read on the two instruments at that very moment was higher than the 100%).

An evaluation more in deep permitted to understand something more and find a conclusion.

The first test with the pull-off tester was carried out without taking in account the instructions reported in the operating handbook, that provides two important information:

- a. The instrument need a preliminary set up at 0,7 MPa before testing;
- b. The testing range is 0,7 MPa - 20 MPa.

There's the evidence that the pull-off tester is not useful to assess the wet adhesion of water borne paints for outdoors because the results, as told before, are commonly low and lower than the minimum value in the range of usability of this instrument. Furthermore, on the base of the experience that a low load is needed to detach the dollies in this circumstance, it is impossible to set up the instrument at 0,7 MPa before starting the test, the dolly should be detached during the set up itself.

The experiment was brought to a conclusion by the repetition of the test on the dollies setting up the pull-off tester at 0,7 MPa before starting (as the test was carried out on two dollies glued together the resistance should have been higher than 0,7 MPa).

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Now the difference between the values read at the same time on the two instruments was reduced at mean percentage values of 10%. Anyway, the tendency of the dynamometer is to give lower values than the other instrument used for the experiment.

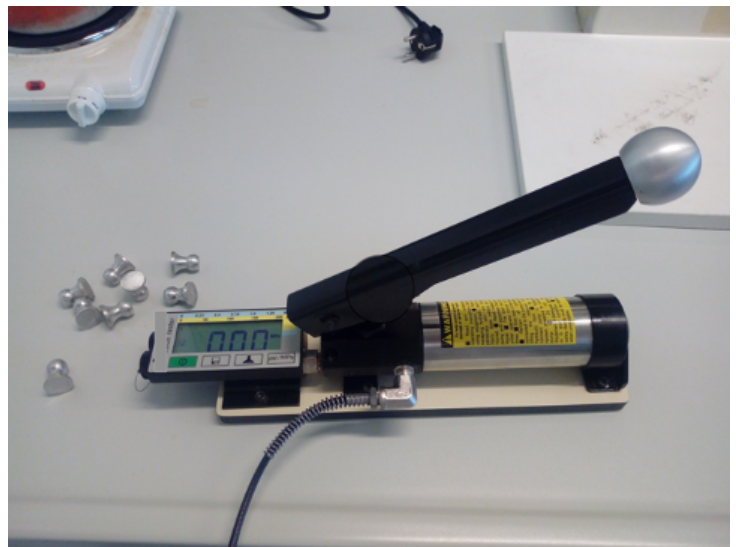
### Conclusions

In light of the experience done we can suggest the use of the pull-off tester to assess the adhesion at dry conditions as the results are usually higher than 0,7 MPa.

Moreover, if an initial set up of the pull-off tester at 0,7 MPa is possible without causing the detachment of the dolly, it means that the test is in line with the range of operativity of the instrument.



*Picture #1. The instant of the experiment. Two dollies, glued together, are connected to the dynamometer and the pull-off tester at the same moment.*



*Picture #2. The pull-off tester used for the experiment.*

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