# Limpet

**// LIMPET PULL-OFF TEST for the measurement of the strength of concrete and the bond strength of concrete repairs**

**Developed by Structural Materials Research Group, Queen's University Belfast, Northern Ireland, UK (Included in BS 1881: Part 207)**

**LIMPET** measures the **pull-off strength** of the surface zone of concrete and the **bond strength** of patch repairs with minimal damage. It is an exceptionally good tool for assessing the progressive deterioration in these cases when exposed to normal or aggressive environments.

**LIMPET** is equally suitable for on site and laboratory use.

**LIMPET**

- is particularly suited when a **strength result** is required **quickly** and with minimal damage
- measures the strength of concrete *in situ* and of materials used to repair them
- is an **internationally approved test for** assessing the bond strength of **patch repairs**
- works equally well on vertical, inclined and horizontal surfaces
- is very light, easy to handle and so is very suitable for site use
- is supported by internationally accepted research

**BACKGROUND**

In most countries, the strength properties of the concrete in a structure are assessed indirectly by measuring the strength of cubes or cylinders which are made in a standard manner from the concrete supplied to the site. Whilst this is well accepted by the industry, it has its limitations in that problems are not detected until it is too late as testing is generally carried out at 7 and 28 days. In addition, and fortunately infrequently, it can be the subject of abuse either by making cubes prior to the addition of more water to the mix or, in extreme cases, by the contractor supplying cubes from a specially prepared mix which will meet the specifications. Furthermore, cubes or cylinders manufactured in a standard manner do not represent the quality of concrete in the structure.

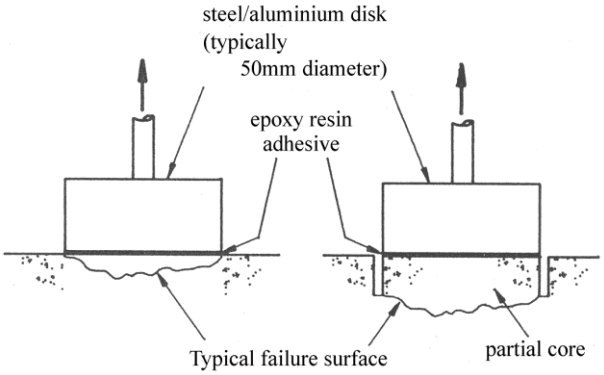
One way of dealing with these issues is to measure the strength of cores or cubes cut from the structure. Not only this is quite a laborious procedure, but also is not possible in all cases and especially in slender members. More over it leaves behind part of the structure to be filled with an appropriate material. These shortcomings could be eliminated by **measuring the properties of the concrete *in situ***. This also permits the effectiveness of the compaction and curing processes to be incorporated in providing a reliable indication of the condition of the finished product. Another advantage to be gained from *in situ* strength testing is that the speed of the overall construction programme could be increased if an accurate assessment of the *in situ* strength was made because this would allow a much faster .turn-around for formwork and back-propping.

## LIMPET APPLICATION AREAS

- Determination of concrete strength *in situ*
- Assessment of the extent of damage to concrete due to deterioration mechanisms acting on concrete structures
- Monitoring the effect of microcracking on strength of building materials
- Assessment of the bond strength of patch repairs
- Measurement of the effect of curing of concrete
- Measurement of the influence of special formworks, such as controlled permeability formwork, on strength
- Determination of the effect of shrinkage and settlement cracking on strength of concrete
- Quality assurance of building materials
- Compliance testing of strength specification

## METHODS OF TESTING

Two basic approaches can be used. One is where the metal disc is attached directly to the concrete surface. This approach is used to make an assessment of the strength of a body of concrete where there is no reason to believe that its surface is materially different to the rest of the mass. Typically, it might be used to judge when it is safe to strike formwork.




The second approach is where partial coring of the surface is adopted. If the concrete surface is carbonated or altered and, therefore, having different physical properties compared with the interior, a much more valid strength value is obtained by coring to a depth below the affected layer thereby causing the failure surface to occur in the unaffected mass. This second approach has particular value in assessing and assuring the strength of the interface between base concrete and surface repair material. If the partial core is continued below the interface and the failure is on the interface, a direct measure of the bond strength of the interface is obtained.

## Functional purpose of the Limpet

The **Limpet** is a simple, sturdy, lightweight, portable device to measure the strength of concrete and concrete repair materials on site or in the laboratory. The device is manually powered, precisely manufactured and has an accurate electronic load measuring sensor to record the concrete failure load.

## The components of the Limpet

The **Limpet** is supplied in a portable carrying case and consists of a number of parts. The main body of the instrument contains the gear driving system and the tensile force measuring and recording system (Fig. 1a). The steel loading rod which is anchored at the top to minimise eccentric loading is screwed into the loading disc in order to carry out the test. To ensure uniformity of loading with minimal eccentricity, the hard rubber base of the instrument rests firmly on the concrete surface during testing (Fig. 1b). In this figure, shown also is the disc that is used to carry out the pull-off test and that with concrete attached at the end of a test. Fig 1c shows display panel, switches, top of loading rod underneath safety strap and the battery compartment.

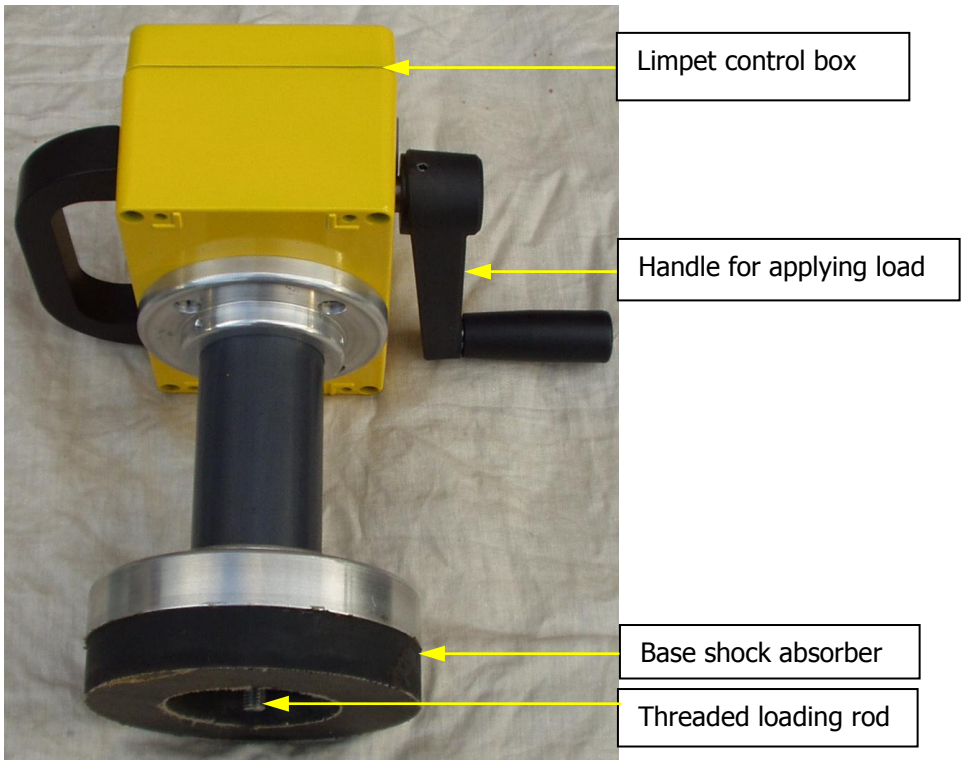



**Fig. 1a** **Limpet** Pull-off Test System

**Fig. 1b** Concrete being tested

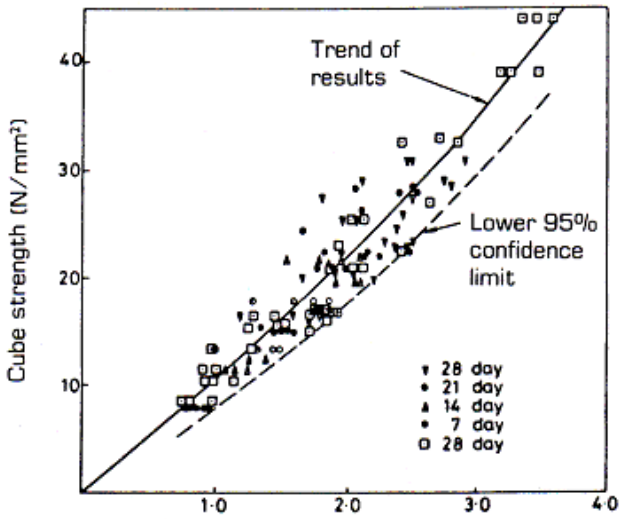
**Fig. 1c** Top panel showing features

## Advantages of the Limpet

- Consistently accurate and reliable results can be achieved by an unskilled operator.
- An inspection of the fracture surface allows unsatisfactory failures to be instantly discounted and gives useful information on the quality of the concrete.
- Does not require planning in advance of placing the concrete.
- Provides a check on safety in relation to when shuttering can be stripped, shoring can be removed, prestress can be applied, or check *in situ* strength if cubes do not achieve the design strength.
- Low cost and speed of testing.
- Is very light, easy to handle and so is very suitable for site use, even overhead testing.

## Interpretation of pull-off strength

To convert the pull off tensile strength into a cube compressive strength an empirical correlation chart, such as shown opposite, can be used. It is a fairly simple matter to produce a correlation chart for the specific aggregates and cement being used, thereby improving accuracy and consistency of testing.



Typical correlation curve for concrete of different ages

## Technical details of the Limpet

### Brief Specification

| | |
|---|---|
| Load range: | 0-10 kN (1 tonne) |
| Resolution: | 0.001 kN |
| Accuracy: | ± 1% of full range |
| Load indicator: | liquid crystal display with peak hold |
| Supply: | 9V – PP3 battery or equivalent, consuming 50mA |
| Reset facility: | This resets to zero the reading on the LCD and compensates for any drift |
| Size: | Height 290 mm |
| | Width 200 mm |
| | Length 160 mm |
| Weight: | 4.30 kg |

## Supplier Information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