



*40th Anniversary
of the
Commercial
Production
of the
Clegg Impact Soil
Tester
1977 to 2017*



The Clegg Impact Test was developed under the guidance of lecturer Dr Baden Clegg between 1971 and 1976 in the Civil Engineering Department at the University of Western Australia from an original idea of his for testing compacted and in situ soils



The first Clegg Hammers produced by the UWA, with a 4.5 kg hammer



The University established a company called Univention for manufacturing and marketing the Clegg Impact Soil Tester, also known as the Clegg Hammer



Dr Clegg's idea was that by adding instrumentation to the laboratory compaction hammer, the result could be a portable, easy to use device for rapid testing of soil strength/stiffness properties in both the laboratory and the field

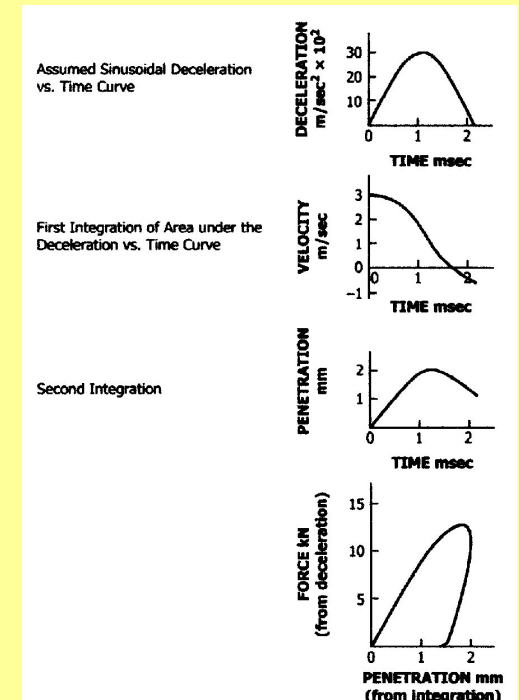


4.5 kg Laboratory Compaction Hammer and Soil Test Mould

After various trials, it was worked out that an output based on gravity units peak deceleration upon impact could be taken as a parameter directly related to the strength/stiffness of soils



A Piezo-Electric Accelerometer Provides the Signal



Development of Force-Penetration From Deceleration-Time

Clegg Impact Test foreseen as a quick and cost effective alternative to CBR (unsoaked, no surcharge)

In the lab or field, from this:



Clegg Impact Test foreseen as a quick and cost effective alternative to CBR (unsoaked, no surcharge)

To this:



The Clegg Impact Test method was conceived and shown to be useful for:

- *Compaction control*
- *Monitoring strength changes with moisture changes and the effects of stabilisers*
- *Classifying materials used in roadworks based on their strength/stiffness*
- *Evaluating existing roads*

The Clegg Impact Test was conceived as a test method that could be carried out by:

- *Engineers*
- *Work Supervisors*
- *The Man on the Job*
- *Researchers*

By 1980, the analogue display had been replaced with a digital display and single button operation



The digital display version provided a meter that was easier to operate and read



1985: Dr Clegg retires from the UWA after 30 years there as a lecturer.

The rights to the Clegg Hammer form a part of his retirement package.

By 1987, he has agreements in place for three manufacturers under license around the world.

Dr Clegg demonstrating the Clegg Hammer



These manufacturers were:

T.A. Brown Electronics, W.A.

Lafayette Instrument Co., U.S.A.

Trevor Deakin Consultants, U.K.

*Dr Clegg demonstrating
the Clegg Hammer*

Trevor Deakin Consultants and the British Gas Story 1987-1990



Trevor Deakin was aware that British Gas was looking for a test device to provide to their workers and sub-contractors in the field for testing trench reinstatement work. This was because as of 1990 they would be legally liable for any claims of damage or injury as a result of failure in their reinstatements under footpaths or roads. British Gas included the Clegg Impact Soil Tester in their trials and selected it to be the device to use as part of a method specification for control of reinstatement work. As a result of what is known as the British Gas Specification, more Clegg Hammers have been produced in England than anywhere else in the last 30 years.



*Trench
reinstatement
testing
in the U.K.*



Dr Baden Clegg Pty Ltd

Founded 1993 by:

Dr Clegg

(b.1925 - d.1999)

Jim Crandell

Tuarn Brown

ABN 85 060 575 608

*1995 saw the acceptance and first
publishing of ASTM D 5874:*

*Determination of the Impact Value (IV) of a Soil
(which covers all masses of Clegg Hammers)*



1996 saw the acceptance and first publishing of ASTM F 1702:

Measuring Impact-Attenuation Characteristics of Natural Playing Surface Systems Using a Lightweight Portable Apparatus

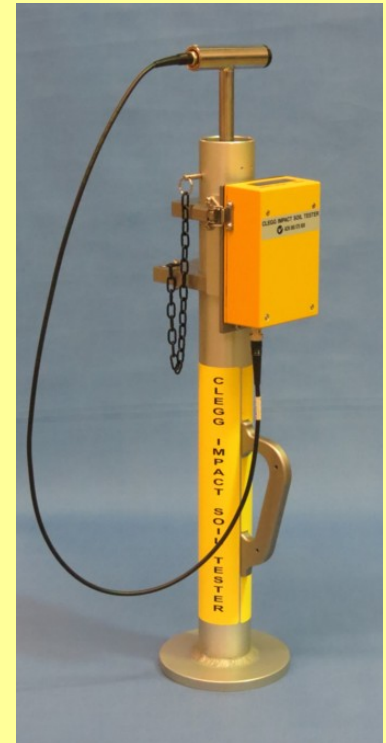
(written specifically for the 2.25 kg Clegg Hammer)





*20th Anniversary
of the
Production
of the
Clegg Impact Soil
Tester
by
Dr Baden Clegg
Pty Ltd*

1997 to 2017



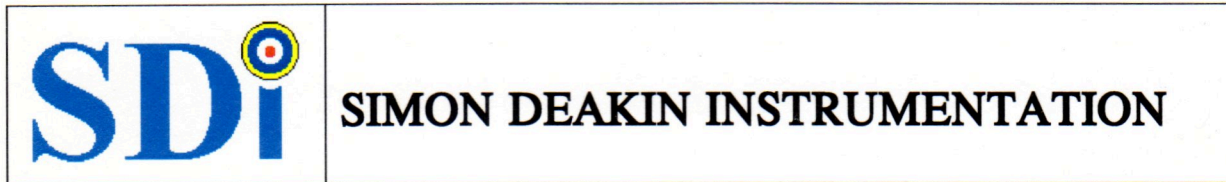


Dr Baden Clegg Pty Ltd was formed to provide information, support, marketing and R&D in relation to the Clegg Impact Soil Tester. In 1997, our company took over manufacture in Australia of the Clegg Hammer from T.A. Brown Electronics, though their principal, Tuarn Brown, involved from the very early days at the UWA with the Clegg Hammer mechanical and electronic design, was already a company director and advisor

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Clegg Impact Soil Tester
(The Clegg Hammer)
INFORMATION SERVICE
www.clegg.com.au
ABN: 85 060 575 608

*Simon Deakin, son of Trevor, takes over
manufacture in the U.K. around the same time*



Now simply known as



2000 saw the acceptance and first publishing of AS1289.6.9.1:

*Determination of stiffness of soil –
Clegg impact value (CIV)*

(written specifically for the 4.5 kg Clegg Hammer)



The Family of Clegg Hammers



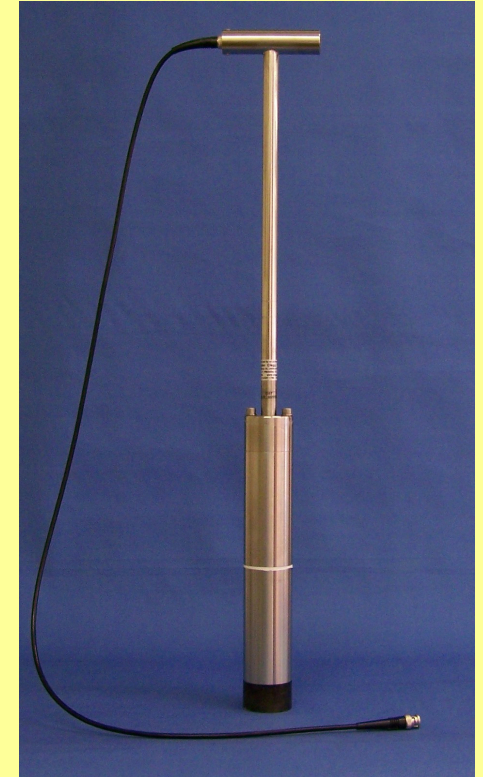
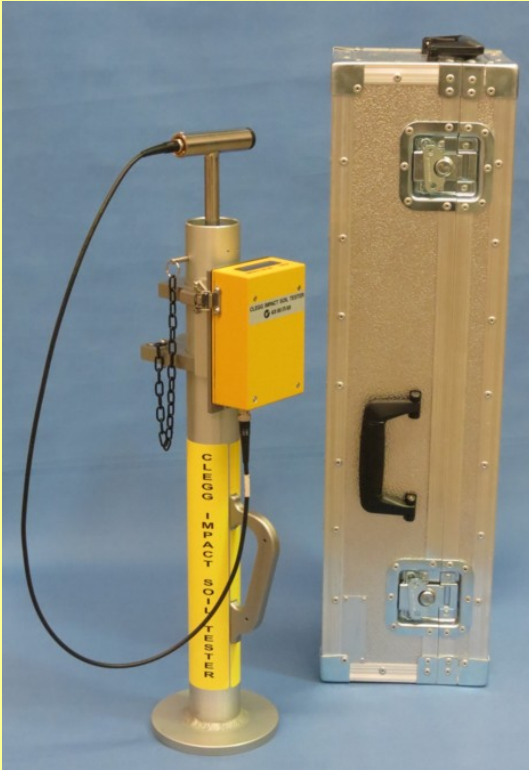
Left to right: 0.5 kg, 2.25 kg, 4.5 kg , 10 kg, 20 kg

The International Brood



How the 2.25 kg and 4.5 kg Clegg Hammers made by the various manufacturers appeared in the year 2000, left to right: Oz, US, UK

How the Australian version appears today



Model GTM-SS-E2

Supplied with a rugged case and aluminum guide tube, with the display fitted to the guide tube with its circuitry on a timer so that the meter doesn't need to be hand-held like the original and other models.

Construction of the Oz 4.5 kg drop-hammer is stainless steel, with a hardened steel end.

Applications beyond roadworks with the 4.5 kg mass also include:



*Clockwise from above: testing unsealed airstrips after rain, pads for dongas and other light structures, railway foundations
- and from Main Roads WA*

Specification 501 for Characteristic CIV:

CIV_c = to or > 55 prior to sealing

where CIV_c = CIV – 0.59SD (for 9 tests/lot)

Uses of the lighter versions include:



*Clockwise from left: tennis, horse tracks, football (various codes), golf
(not pictured: cricket pitches and baseball diamonds)*

Clegg Impact Test as Alternative to CBR

(1) Dr Clegg's Revised General Correlation of 1986 for a 4.5 kg Clegg Impact Soil Tester (to ~700 % CBR), roughly 1/4 of the CIV plus 1, then squaring:-

$$\% \text{ CBR} = [(0.24 \times \text{CIV}) + 1]^2 \quad r = 0.957$$

The equation above was derived from results obtained in Australia, New Zealand and the UK. These tests cover a wide range of soils for both laboratory and in-situ testing, unsoaked, non-surcharge conditions.

(2) Dublin Light Rail Project Correlation for 2.25 kg Clegg Hammer for in-situ material prior to construction (to ~50 % CBR, output in gravity units, Gm):-*

$$\% \text{ CBR} = e^{[(\text{Gm (3rd Drop Result)} - 14.936) / 79.523]} \quad R \text{ Squared} = 0.9317$$

The equation above was derived by engineers working on the Dublin LRT Project, Civil, Track & Building Works C600, Contractor: MVMBNI JV in the period October 2001 to January 2003. Gm represents gravity units peak deceleration upon impact rather than the “tens of gravities units” scale of CIV.

**Gm appears on the display of some Clegg Hammer meters and is short for Gmax. More recently, g-max is used instead of Gmax, e.g. in revised ASTM Standards to correct things, because “big G” stands for the gravitational constant and “little g” stands for the acceleration due to earth's gravity.*

Clegg Hammer Modulus (CHM)

(a quasi Young's or Elastic Modulus)

- *Looking first for Vertical Displacement under the centre of the applied loading (Δ) and then solving for the modulus of elasticity (E), with certain assumptions:*

- $$\Delta = 2 (p) (a) (1 - \mu^2) / E$$

- *Where p = contact pressure, a = the radius of applied circle of loading, E = the modulus of elasticity and μ = Poisson's ratio. Assuming Poisson's ratio is 0.5, then:*

- $$\Delta = 1.5 (p) (a) / E$$

- *For a rigid plate (i.e. Clegg Hammer) rather than a flexible plate then:*

- $$\Delta = 1.18 (p) (a) / E$$

- *Calculating p from force (Clegg Hammer Mass x Acceleration due to gravity) and the acceleration (deceleration, G_m , i.e. value as measured by the Clegg Hammer times 10), where the Clegg Hammer radius (in metres) and drop-height (in metres) factor into it, and applying an additional factor of 0.6 for converting square wave used in maths to $\frac{1}{2}$ sin wave type shape as observed on actual impacts on compacted soils using a CRO and solving now for E (in Pascals), this becomes:*

- $$E = (1.18) (9.81) (0.6) (G_m) (G_m) (\text{Hammer Mass}) / (\pi) (\text{Hammer Radius}) (\text{Drop-Height})$$

Clegg Hammer Modulus (CHM)

(continued from previous slide)

- *From the previous slide, the Clegg Hammer Modulus (CHM) for the 4.5 kg Clegg Hammer (output: CIV) and 20 kg Heavy Clegg Hammer (output: CIV/H) at their set drop-heights are calculated, in MPa and based on certain assumptions, as:*
- *Standard CHM (CHM/S)*
4.5 kg Clegg Hammer:- $CHM/S \text{ (in MPa)} = 0.088 [(CIV)(CIV)]$
5 cm Φ Hammer, 0.45 m Drop-Height
- *Heavy CHM (CHM/H)*
20 kg Clegg Hammer:- $CHM/H \text{ (in MPa)} = 0.23 [(CIV/H)(CIV/H)]$
13 cm Φ Hammer, 0.3 m Drop-Height
- *Qualifying remarks:- the coefficients in these equations have been derived using double integration of time vs. deceleration to determine the deflection and using this in elastic plate bearing theory to arrive at an elastic modulus. They depend to some extent on the technique used for the integration and the theoretical assumptions. The use of Clegg Hammer Modulus (CHM) as a “seed” modulus for iterative analysis comparing calculated deflections with field observations should enable the coefficients to be refined from time to time. (Additional note: the larger diameter and mass of the 20 kg Clegg Hammer means that this is the Clegg Hammer that should be used if comparing to the Falling Weight Deflectometer, not the smaller and lighter 4.5 kg version. The 10 kg version of the Clegg Hammer is likely more suitable for comparison to Portable or Light FWDs.)*

Article in Transportation Geotechnics May 2016:

“Estimation of resilient modulus of unbound granular materials using Clegg impact value and field stress levels”

by

Abbas Mohajerani, Bao Thach Nguyen, Lovro Glavacevic

School of Engineering, Civil Engineering, RMIT University

Extracts from Summary:

- This study examines the correlation between the Clegg impact value (CIV) and the M_r of unbound granular materials (UGM) of pavements*
- The results indicate that there exists a good to strong correlation between the resilient modulus M_r and Clegg impact hammer value, CIV, with the highest R^2 value of 0.82 and the average R^2 value of 0.76, from 48 stress levels used in the M_r tests*



Current Directors

Jim Crandell

Stephanie Clegg

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For more information:
www.clegg.com.au