Ref Clegg info sheet

Non Destructive Impact Testing

With compliments to Dr. Baden Clegg Pty Ltd for providing information on the different types Clegg Impact Hammers

The **Standard 4.5 kg (10 lb) Clegg Impact Soil Tester (CIST)**, also known as the Standard 4.5 kg Clegg Hammer, was conceived originally to relatively quickly, easily and cost-effectively test the strength/stiffness characteristics of soil materials (including soft rocks and lightly stabilised materials) as used in road construction, for standard lift thicknesses. Its applications have grown beyond this basic concept. Some further examples are compaction control and/or use in design and/or evaluation of earthworks, roadwork's, trench reinstatement and unsealed air strips. Because of the rapid nature of the test, a sense of the uniformity over an area can be ascertained in a relatively short time. Significant correlations with percent CBR have been developed for values from one to several hundred percent CBR (for unsoaked, no surcharge conditions). The Standard CIST has also been found useful to monitor the increase in strength after compaction as a result of the degree of moisture, necessary for achieving the specified density, reducing, e.g. through evaporation and/or drainage, such that a minimum necessary strength is achieved for the design or anticipated traffic loads prior to sealing/opening to traffic. Suggested notation for results with the Standard Clegg Hammer dropped four times on the exact same test spot from a prescribed drop-height of 0.45 m, with the highest value in the series taken as the test output is as the **CIV** (Clegg Impact Value). The test equipment and procedure for CIV using the 4.5 kg Clegg Hammer is given in Australian Standard AS1289.6.9.1 and in US ASTM Standard D5874 (which covers the other Clegg Hammers described below as well, as long as it is clearly reported which Clegg Hammer is being used). The prescribed drop-height of the 4.5 kg Clegg Hammer in Australia is now set at 455 mm, with the mass set between 4.5 kg and 4.6 kg (though the Standard Clegg Hammer is still referred to as the 4.5 kg Clegg Hammer).

The **Light 0.5 kg (1.1 lb) Clegg Hammer** is used primarily for testing natural and artificial playing surfaces. It is more sensitive in output and makes less penetration into the surface in comparison to the 4.5 kg Hammer (to the point of barely perceivable on these surfaces in many cases). The Light Clegg Hammer has been found useful for determining the stiffness - or 'hardness' - of recreational turf as related to ball bounce and possibly also for player response or safety. For example, it may be used to test cricket pitches to monitor stiffness changes due to moisture changes, grass growth, and wear, as the game proceeds. The Light Clegg Hammer may be used as an aid in the watering regime and to help determine the weight of the roller to be applied. Other examples of the Light Clegg Hammer's applications include golf and bowling greens, grass tennis courts, horse race tracks and football fields. The Light Clegg Hammer is well suited to testing of sand from the surface down to a depth of roughly 150 mm (6 inches). Note that many of these applications are now tested (in Australia anyway) using the later developed 2.25 kg Clegg Hammer - see below - with the Light Clegg Hammer used mainly at present for testing grass tennis courts and golf putting greens. The suggested notation for results obtained using the Light Clegg Hammer from a prescribed drop-height of 0.3 m with the highest value of four successive drops on the same exact test spot taken as the test result is as **CIV/L** (spoken as the Light Clegg Impact Value).

The **Medium 2.25 kg (5 lb) Clegg Hammer** provides a CIV scale with sensitivity between the Light and Standard Clegg Hammers. An example of its use is for shock attenuation measurements on natural and artificial playing surfaces. It too can be applied as an aid in the watering regime and preparation of a turf surface, e.g. as an aid to selecting roller weight and number of passes. The Medium Clegg Hammer also has application to earthworks, trench reinstatement, compaction control, etc., but on surfaces/materials at lower strengths than those where the Standard Clegg Hammer would be used instead. A significant correlation with percent CBR for lower strength materials has also been developed for the Medium Clegg Hammer (for a range of around under two to fifty percent CBR). Suggested notation for results with the Medium Clegg Hammer when dropped from 0.45 m with the highest value of four drops in a series of drops on a test spot is as **CIV/M** (spoken as the Medium Clegg Impact Value). Note that in Australia (and elsewhere) when testing turf, often it is only three drops of the Medium Clegg Hammer that are made, instead of the four drops of the standard test method. Others suggest dropping the Medium Clegg Hammer only once on natural and artificial turf playing surfaces. It is important to follow the procedure that is specified for the circumstances, as a significant change in the procedure (and the mass and dimensions of the equipment too by the way, as well as the drop-height) results in a significant change in the output. Selecting the output parameter on a drop count different from that used elsewhere results in change

which may be significant. This needs to be clearly understood (and reported accordingly.) The prescribed drop-height in the USA, and now in Australia, for the Medium Clegg Hammer is as 457 mm. Testing of natural turf surfaces using the 2.25 kg Clegg Impact Soil Tester is covered in US ASTM Standard F1702. Note that F1702 calls for only one drop per test and that the output reported not in Clegg units (tens of gravities peak deceleration upon impact), but in gravity units peak deceleration (though allowance is made for multiple drops to be made per same exact test spot, with the number of drops reported accordingly, along with the specifics regarding the drop selected as the test output parameter). Previously, gravity units peak deceleration upon impact was symbolised as *G*max (seen also as Gm), but F1702 now refers to this as *g*-max (though *G*max and Gm are still used in Australia and elsewhere). The output of Clegg Hammers made in Australia (in the main) are in terms of Clegg units (what we might call *C*max or Cm). Multiplying an output (or an average of outputs) that is in *C*max by ten is therefore what is needed for then reporting in terms of *g*-max.

The **Medium Heavy 9.1 kg (20 lb) Clegg Hammer** has a hammer diameter of 13 cm as compared to the 5 cm diameter of the 0.5 kg, 2.25 kg or 4.5 kg Clegg Hammers. As such, it tests through a larger zone, both horizontally and vertically, so is suggested for testing double lift thicknesses when it comes to earthworks, roadworks, unsealed airstrips, trench reinstatement and, in the USA, bell holes. The GTM version (the version made in Australia) has a guide tube on wheels with a pull-handle to ease movement, and is designed so that it can be dropped from up to a height of 0.61 metres so as to meet the apparatus requirements of US ASTM Standard F1936 for measuring shock attenuation of artificial football fields (e.g. American gridiron football). Suggested notation for results from the Medium Heavy Clegg Hammer when dropped from a set drop-height of 0.3 m with the highest value result of four successive drops per test spot taken as the test result is as **CIV/MH** (spoken as the Medium Heavy Clegg Impact Value - if dropped from a prescribed height of 0.61 m, then as CIV/MH-0.61 m).

Note that in the USA there is instead the **10 kg Heavy Medium Heavy Clegg Hammer** (suggested notation for the output at the fourth drop based on the highest value in the series from a set drop-height of 0.3 m is as **CIV/HMH**, spoken as the Heavy Medium Heavy Clegg Impact Value). The Australian 9.1 kg GTM version of the Medium Heavy Clegg Hammer can be supplied with bolt-on weights, at an additional cost, to take the mass to 10 kg, if desired.

The **Heavy 20 kg (44 lb) Clegg Hammer**, like the Medium Heavy and Heavy Medium Heavy CIST, has a hammer diameter of 13 cm and so also tests through a larger zone both horizontally and vertically than the smaller 5 cm diameter Clegg Hammers. The Heavy Clegg Hammer is used for testing of unsealed and lightly sealed gravel road pavements, especially when deeper lift thicknesses are used, but it was conceived originally for testing on the running course of flexible pavements, and is used for this purpose too. Customers in the USA have included the US Forest Service for testing logging roads and NASA for testing the landing strips for the Space Shuttle. The Heavy Clegg Hammer has also been used in earthworks. The GTM version (the version made in Australia) has a guide tube on wheels with a pull-handle to ease movement. (The much heavier mass means less sensitivity than the Standard Hammer and so allows for testing in situations beyond the 100 CIV output of the Standard Hammer). The Heavy Clegg Hammer, like all Clegg Hammers, is manually operated, i.e. the drop-hammer is raised in the guide tube to the prescribed height of drop and allowed to freefall. For the 20 kg Heavy Clegg Hammer, the set drop-height is 0.3 m. While a strong arm and back and due care are needed when using the 20 kg Heavy Clegg Hammer, in particular, it is still sufficiently light to be hand operated and transported on the job site by those in good health and strength (though assistance is helpful when lifting onto a ute tray bed or what-not, as the guide tube adds significantly to the weight of the instrument; otherwise, a method which can be used is to remove the drop-hammer from the guide tube and lift or lower each independently, reassembling afterwards). Suggested notation for results from the Heavy Clegg Hammer when the highest value is selected from four successive drops from the prescribed drop-height is as **CIV/H** (spoken as the Heavy CIV).