

## **PILE HELMET FOR FOUNDATION PILE DYNAMIC LOAD TESTING, AND METHOD OF USE**

The invention relates to a pile helmet for a foundation pile under dynamic load

5 testing. The invention also relates to a foundation pile dynamic load testing apparatus comprising a pile helmet. The invention also relates to a method of performing foundation pile dynamic load testing using a pile helmet. The invention also relates to a method of performing foundation pile dynamic load testing using an apparatus comprising a pile helmet.

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Construction projects generally require installation of foundation piles in the ground. The foundation piles must be tested to ensure they meet their design parameters. Generally speaking there are two main types of tests carried out on foundation piles: static load testing and dynamic load testing.

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The static pile load test had previously been considered in some circles to be the best measure of foundation suitability to resist anticipated design loads. The static load test involves the direct measurement of pile head displacement in the response to a physically applied test load.

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Dynamic load testing is a high strain test method for assessing pile performance. In recent years, it has been perhaps the more commonplace approach for pile load testing worldwide. Dynamic load testing involves impacting a head of a pile with a piling hammer or drop weight and measuring the resultant strain and acceleration  
25 exerted on the foundation pile. These measurements are used to quantify the pile and soil behaviour in response to the applied dynamic force

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Traditionally, dynamic load testing involves utilising a crane having a boom and a pulley line mounted on the boom. A hammer is connected to the pulley line. The crane lifts the hammer to a desired height, and then drops the hammer on the head

of the foundation pile under test. As the hammer hits the foundation pile, it exerts an impact force on the foundation pile, and it is the effect of that force which is measured and analysed.

- 5 A significant problem in this system arises from the fact the hammer remains connected to the pulley line as it drops towards the foundation pile. The friction restrains the vertical falling speed of the hammer, thereby decreasing the amount of impact force transmitted to the pile head. Further, problems can arise when the effect of this requires having to increase the load of the hammer towards the safe  
10 working load of the crane.

One effort to solve this problem is disclosed in Singapore Patent Application No. 201104861-8. However, the system introduces its own problems. The solution presented by this application provides for a U-shaped framework having a pair of  
15 vertical supports to be mounted on the ground across the foundation pile to be tested. A hammer is released (i.e. dropped) from the framework to fall freely towards the foundation pile, the hammer not being restrained in its fall by a pulley line as described above. However, in order to ensure the hammer does not stray from the desired fall path, a steel guide casing is provided for the hammer to fall  
20 within, with the lower end of the steel guide casing being clamped to the foundation pile. Unfortunately, this arrangement is inherently unstable, requiring further mechanical support of the steel guide casing, over and above it being clamped to the foundation pile. Further, vibration stresses caused by hammer recoil may also be transmitted to the framework, potentially compromising the stability of the steel  
25 guide casing and the framework itself. One solution to the problem of inherent instability of the steel guide casing might be somehow to fix the steel guide casing to the framework. However, this would exacerbate the problem of the mechanical stresses arising from recoil of the hammer been transmitted to the frame, and introducing the risk of mechanical failure of the framework.

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Recoil concerning striking of foundation piles is a well-known problem, present for many decades. For instance, United States Patent No. 4,314,613 is directed to a pile-driving recoil damping device. However, this is a complex mechanical device and therefore far from being a perfect solution.

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The invention is defined in the independent claims. Some optional features of the invention are defined in the dependent claims.

Implementation of the techniques disclosed herein provide for significant technical  
10 benefits. For instance, provision of a pile helmet as disclosed herein may reduce significantly the transmission – to a frame of a dynamic load testing apparatus – mechanical stresses caused by falling hammer recoil. Furthermore, the pile helmet may also help to reduce potential danger caused by concrete chips being chipped off the foundation pile from the striking of the hammer dropping onto the pile.

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Further advantages and benefits of the techniques disclosed herein may be understood from the following discussion, in which the invention is described, by way of example only, and with reference to the accompanying drawings in which:

20 Figure 1 is an exploded perspective view of a first pile helmet;  
Figure 2 is a plan view of the pile helmet of Figure 1;  
Figure 3 is a sectional elevational view of the pile helmet of Figure 1 and 2;  
Figure 4 is a sectional elevational view of the second pile helmet; and  
Figure 5 is an elevational view of an apparatus for dynamic load testing of the  
25 foundation pile, implementing a pile helmet in accordance with the techniques disclosed herein.

Turning first to Figure 1, there is illustrated a first pile helmet 100. Pile helmet 100 comprises two principal components: top member 102 and housing 104.

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Top member 102 comprises a main body 106 having an upper surface 108, a lower surface 110 and a thickness defined by edge 112. In the example of Figure 1, main body 106 is of a generally circular cross-sectional area having a diameter 114, therefore giving it a general disc-or plate-like shape. Extending from main body 106 are projections 116 having an upper surface 118, a lower surface 120 and a thickness defined by edge 122. In the example of Figure 1, the thickness 122 of the projections 116 is approximately the same as the thickness 112 of main body 106. Further, and in this example, the projections have a generally planar and/or cuboid shape, although the outer edges – distal the centre of the main body 106 – may be chamfered or otherwise have rounded edges.

The projections are intended for insertion in the apertures 142 of the housing 104, to be discussed in further detail below. Use of projections in its simplest form, requires only a single projection and a corresponding single aperture in the housing. In such circumstances, the top member 102 of pile helmet 100 comprises a main body 106 having a projection 116 extending therefrom, the projection being for extending through an aperture 142 in the housing 104. But, in the example of Figure 1, top member 102 comprises a plurality of projections (four) extending from the main body 106, the reason for which will be described below. In the example of Figure 1, the four projections 116 are spaced generally equidistant around the perimeter/outer edge 112 of the main body 106, spaced apart by approximately 90 degrees.

Top member 102 also comprises fixing points 124 for the fixing of guide rods, not shown in Figure 1, but described in more detail with reference to Figure 3 and Figure 5. In its simplest form, top member 102 does not comprise purpose-built fixing points 124, but the guide rods are simply affixed at these points, perhaps by welding.

Housing 104 comprises a bottom outer surface 126 for resting on a ground area around a foundation pile under test and/or for attachment to a frame of a testing

apparatus (neither the ground area, nor the frame or the pile being shown in Figure 1). Housing 104 further comprises an outer surface/wall 128, and a top opening 130. Housing 104 further comprises an inner surface/wall 132, the inner surface 132 and the outer surface 128 defining the thickness of the wall of the housing illustrated along top surface 134. When attached to the frame of the testing apparatus, it may be advisable to attach the housing 104 at or near the top surface 134 to the frame of the testing apparatus such as by welding or similar. If attached to the frame, the underside 126 of the housing 104 may be raised above ground level; it is not critical it rest on the ground. In the example of Figure 1, housing 104 is generally hollow having an internal volume 138 defined by the inner surface 132 of the wall of the housing 104. Internal volume 138 is accessible via (upper) opening 130. In the example of Figure 1, the bottom surface 126 of housing 104 is defined only by the thickness 134 of the wall of the housing. Otherwise, there is no bottom surface across the diameter 140 at the base of the housing. This arrangement facilitates the placing of the housing around the foundation pile. In the example of Figure 1, housing 104 is of a generally circular cross-sectional with the diameter 140. Thus, housing 104 is of a generally hollow cylindrical shape, but of course other arrangements are envisaged.

When a projection 116 is provided on top member 102, housing 104 may comprise at least one aperture 142, but four apertures 142 are shown in Figure 1 to correspond with the number of projections 116 in Figure 1. . It will be appreciated that the number of apertures in the housing 104 may correspond with the number of projections 116 of the top member 102.

Aperture 142 has a lower section defined by lower edge 144 and the region 146 for a retainer (not shown in Figure 1) to be fixed, thereby restraining the projection 116 from being withdrawn from aperture 142. Aperture 142 may be a slot of generally rectangular cross-section cut out of the wall of the housing 104, extending from the top surface/edge 134 of the housing downwards towards the base 126. In the

example of Figure 1, aperture 142 comprises, and in the direction moving down from the top edge 134, an upper aperture section 146 for the retainer..

When top member 102 comprises a plurality of projections 116 (and housing 104 has  
5 a corresponding plurality of apertures 142) the projections 116 may rest on the lower sections (edges 144) of the aperture 142 main sections when not being used. That is, when the top member 102 comprises a plurality of projections 116 extending from the main body 106, the plurality of projections being for extending through a corresponding plurality of apertures 142 in housing 104, each of the apertures 142  
10 has a lower section (or edge) 144 for the projections 116 to rest thereon in a non-use condition. The discussion of this will become more apparent with reference to Figure 3, below.

In use, housing 104 is placed around the foundation pile to be put under dynamic  
15 load testing, as described above. Housing 104 is arranged such that the foundation pile – or at least a head of the foundation pile – is disposed within the internal volume 138 of housing 104.

Then – or separately, beforehand – top member 102 is lowered towards housing 104  
20 with the projections 116 in registration with the apertures 142, and then lowered towards the lower edges 144 of apertures 142. Thus, top member 102 is disposed, at least in part, within the internal volume 138 of housing 104. In a preferred arrangement, top member 102 is positioned on/in housing 104, with the projection(s) – where provided – positioned in the aperture(s) 142 prior to delivery  
25 to site. The retainer(s) (not shown in Figure 1) is/are then fixed across the first aperture section(s) 146 at the upper part of aperture(s) 142 to retain the projection(s) 116 within the aperture(s) 142. These retainers may comprise of pieces of metal being welded or otherwise fixed across upper aperture section 146.

In this arrangement, the projections 116 may not come into contact with lower edges 144 in the use condition. Housing 104 may be sized such that the head of the foundation pile extends upwards within internal volume 138 almost towards the top of the housing 104, say within about 100 mm or 200 mm of the top of the housing.

5 Thus, under force of gravity, and as projections 116 are free to move vertically within apertures 142, top member 102 rests on the head of the foundation pile. And the housing may be sized accordingly that it does not rest on the ground, being held in an elevated position above the ground by virtue of the top side 118 of the projection(s) coming in to contact with the lower edge of the retainer(s). Note that it

10 is not necessary for the top member 102 to rest directly on, and in contact with, the head of the foundation pile; it can also rest indirectly on the head of the foundation pile; that is, there might be an intermediary – such as a wooden block – disposed between the underside 110 of the top member 102 and the top surface of the foundation pile head (not shown). A further alternative arrangement where the top

15 member does not rest directly on the foundation pile head is discussed below with reference to Figure 4.

When in a non-use condition – for example, the pile helmet is being transported to a construction site – the projections, when provided, will simply rest on the lower

20 section 144 of the aperture 142. The underside 120 of the projection 116 will rest on the edge 144. This arrangement facilitates installation at site, obviating the requirement of having to install top section 102 in/on housing 104 at site.

It will also be realised that it is not essential that the housing completely encircle or

25 enclose the foundation pile head.

For the top member 102 to be able to be disposed, at least in part, within the internal volume 138 of housing 104, the cross-sectional area of the main body 106 is less than the cross-sectional area of the part of the internal volume within which the

30 top member is disposed. Thus, and while resting on the foundation pile head, top

member 102 has a degree of freedom of lateral movement in the directions 148 within the internal volume 138 of housing 104. The advantage of this will be discussed in further detail below with reference to Figure 3.

5 It is to be noted that various configurations for the precise geometry of the plan-view shapes of the main body 106 of top member 102 and the cross-section of the part of the internal volume 138 – within which the main body sits – are envisaged. That is, it is not essential that the main body 106 and cross-sectional area of the housing 104 be circular or generally circular. For instance, other, regular shapes such  
10 as square or rectangular are also envisaged, but it will also be appreciated that irregular shapes are also encompassed. However it is to be noted that regular shapes may be preferred for manufacturing reasons. It may also be preferred that the respective shapes of the main body 106 and the cross-section of the internal volume 138 complement one another – for example both may be generally circular–.

15 In examples where the projections 116 are not provided in top member 102 – for example, top member 102 comprises simply of a generally-circular plate-shaped disc – top member 102 simply sits inside the internal volume 138 of the housing on the foundation pile head, directly or indirectly, the installation been carried out at site. It  
20 is not necessary for housing 104 to have apertures 142 in such arrangements. Top member 102 is simply free to move laterally in the directions 148, the restriction on the amount of movement being dependent on the difference in the dimensions of the top member 102 and the internal surface 132 of the housing 104. It will be understood that provision of the projections, the apertures and the retainers serves  
25 to inhibit excessive movement of the top member 102 relative the housing 104. For example, this serves to inhibit top member being separated from the housing when struck by a hammer of a dynamic load testing apparatus.

Use of the term "top" for the top member 102 is used to signify only that, when  
30 installed, member 102 sits above the head of the foundation pile and it may also be

installed generally towards the top of the internal volume of the housing. No other spatial or dimensional limitations or implications are intended.

Thus, it will be appreciated that Figure 1 illustrates a pile helmet 100 for a  
5 foundation pile under dynamic load testing, the pile helmet 100 comprising a top member 102 having a body 106 with a first cross-sectional area. A housing 104 has an internal volume 138 of a second cross-sectional area, the second cross-sectional area being greater than the first cross-sectional area. The top member is arranged to be disposed, at least in part, within the internal volume of the housing and also to  
10 rest – whether directly or indirectly – on a head of the foundation pile.

Figure 2 and figure 3 illustrate the pile helmet 100 installed in situ around a head of the foundation pile, respectively, in plan and elevation view. Thus, and referring first to Figure 2, the generally circular arrangements of the top member 102 and the  
15 housing 104 are readily apparent. Projections 116 extend outside of housing 104, through the apertures 142, although these are not clearly visible in the plan view of Figure 2. Top member 102 is free to move laterally in the directions 148 within the housing 104 by virtue of the fact the cross-sectional area of top member 102 is less than the internal volume of the housing, or at least the section of the volume within  
20 which the top member is disposed. The fixing points 124 for the guide rods – to be discussed below – are also illustrated.

Figure 3 illustrates the pile helmet 100 in elevational view. Thus, pile helmet 100 is installed around the head 302 of foundation pile 300, as described above. The  
25 underside 110 of top member 102 sits on top surface 304 of the foundation pile head 302, being in direct contact with a top surface of foundation pile head 302. It will be recalled from above that intermediaries may be disposed between the top member and the foundation pile head.

Visible in Figure 3 are the projection retainers 308 for fixing across the upper aperture section 146 of housing 104. A lower surface or edge 308 of the projection retainer 306 is in contact with the upper surface 118 of the projection 116. As mentioned above, projection 116 does not come into contact with the lower section/edge 144 of aperture 142 in the use condition, thus meaning there is a window 310 in aperture 142 defining a gap between the underside 120 of projection 116 and the section/edge 144.

In the example of Figure 3, guide rods 312 are installed, being fixed to the upper surface 108 of main body 106 as described above.

Housing 104 comprises another aperture 314 allowing an on-site technician to access the foundation pile head 302 therethrough, and the accelerometer 316 and strain transducer 318 installed thereon.

During operation, the hammer (not shown in Figure 3) for the dynamic load testing of the foundation pile is installed above the pile helmet 100, with the guide rods 312 (where provided) running through a channel in the hammer. While the current example is given with there being two guide rods, it will be appreciated that, where provided, other numbers, including one guide rod, may also be used. The guide rods are used to guide the hammer towards the pile helmet. Thus, when the hammer is released, it falls towards the pile helmet, under guidance from the guide rods 312, striking the top member 102 – in this example on the upper surface 108 of main body 106 – and the impact force is transmitted through the top member 102, to the foundation pile head, and the effect of the impact force thus transmitted being measured by the strain gauge and the accelerometer.

As noted, top member 102 may not rest directly on foundation pile head 302, but there may be intermediaries – for example wooden blocks and the like – which allow

the transmission of the impact force, but which further minimise the risk of any damage to the foundation pile itself from the impact force.

In at least one implementation, the pile helmet 100 may be provided with hammer  
5 cushions 320 – in the form of, for example, timber planks and/or tightly coiled ropes  
– placed on the top member 102, minimising the risk of damage to the top member.

Therefore, it will be appreciated that Figure 5 illustrates a pile helmet 100 where the  
top member 102 comprises a guide 312 fixed thereto, the guide 312 being arranged  
10 to pass through a channel in a body of a hammer of the dynamic load testing  
apparatus, the guide being for guiding the hammer towards the top member 102  
during dynamic load testing.

When impact force is transmitted from the hammer to the foundation pile, the  
15 hammer will recoil, transmitting stress vibrations through the ground and/or the  
guide rods 312. Either or both of these transmitted stress vibration components may  
be transmitted to the frame of the dynamic load testing apparatus (shown in Figure  
5) which is a highly undesirable situation. Provision of the pile helmet may mitigate  
this undesirable effect at least in part. By providing a pile helmet with the top  
20 member having a degree of freedom of movement in one or all of the directions 148  
within the internal volume 138 of the housing 104, this helps to dissipate the effect  
of the transmitted shock vibrations. Furthermore, the enclosure (at least partially) of  
the foundation pile with the pile helmet helps to mitigate the risk of any chippings  
being dislodged from the foundation pile head because of the impact force of the  
25 striking of the hammer.

Figure 4 illustrates a second exemplary pile helmet 400. Note that in this  
arrangement, top member 402 is provided without projections (such as the  
projections 116 of Figure 1), and housing 404 does not require any apertures  
30 corresponding to apertures 142 of Figure 1.

Top member 402 is not, in this example, of disk-or plate-like construction, but instead comprises a solid block, preferably of a regular geometrical shape such as square, rectangular or circular cross section. Top member 402 has a top surface 406, a lower surface 408 and an edge 410 defining the thickness of the top member. Top member 402 has a width 412. As with the arrangement of Figure 1, guides may (or may not) be fixed at fixing points 414 on the top surface 406.

Housing 404 comprises the bottom outer surface 416, and outer surface/wall 418 and an upper opening 420. The inner surface/wall of the housing 422 defines the internal volume 428. In this example, the internal volume is not a single internal volume space, but it is partitioned by partition 430. In this example, the underside of the partition 430 rests on the foundation pile, and the top member 402 rests on the upper surface of the partition. This essentially creates two sections of the internal volume, one above and one below the partition. The internal volume has an internal width 432.

It can be seen that the top member 402, sitting on top of the partition 430, sits at least partially within (the upper section) of the internal volume 428. Note that it is not essential for the top member to be disposed completely within the internal volume; the arrangement of Figure 4 may be sufficient for the upper sections of the wall of the housing to restrain the top member 402 as it moves in the directions 434, responsive to being struck by the hammer of the dynamic load testing apparatus (not illustrated in Figure 4).

It will be appreciated that other, exemplary pile helmet arrangements are also envisaged.

Figure 5 illustrates a dynamic load testing apparatus 500 which works particularly well with the pile helmet 100, 400.

Apparatus 500 comprises:

- a main frame 502
- 504 plunger beam
- 506 support device
- 5 • 508 hydraulic clamp
- 510 hammer body
- 512 channel in the hammer body for the guide rods to pass through
- 514 casing guide
- 516 screws preventing lateral movement of the hammer
- 10 • 312 guide rod
- 518 guardrail
- 520 vertical lifting points
- 522 horizontal lifting points
- 524 ladder
- 15 • 526 support wedge block.

In the example of Figure 5, these components may be described as follows.

Main Frame Structure is primarily made up of 4- vertical steel columns with horizontal steel beams welded at two ends along intervals of the shaft of the vertical columns. The whole structure or setup which houses various components as shown is to be mounted on top of the pile that is subjected to dynamic testing.

The Plunger Beam is a steel structural beam which may have pairs of holes drilled at intervals of 500mm and 1000mm throughout its length. Both ends of the beam may be attached with shackles as lifting point for a crane's hook and for holding onto the hydraulic clamp.

The hydraulic clamp is a clamp with a pair of movable jaws capable of holding an object of a certain weight when its jaws are closed. It may run on hydraulic system

with hydraulic fluid feeding it through a hydraulic hose attached to it from a Hydraulic Pump.

The hydraulic hose connects the hydraulic clamp and the hydraulic pump.

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The hammer has a design weight, and is to be used to drop freely from a calculated/ design drop height onto the pile subjected to dynamic testing.

10 The pile helmet 100, as described above, may operate as a protection cover which is to be placed on top the pile subjected to dynamic testing to minimise the stress transmitted to the frame and to prevent concrete chippings, which may result from the impact of the hammer dropping on the pile, from flying outwards.

15 The hydraulic pump comprises of an electric motor and a hydraulic fluid reservoir. It runs on electricity current from a generator to drive hydraulic fluid into the hydraulic clamp through the hydraulic hose which controls the opening and closing of the jaws of the hydraulic clamp.

20 The support device is a device fitted on the top portion of the main frame structure. It is designed to hold and suspend the combine loads of the plunger beam, the hydraulic clamp and the hammer. In one example, it is held with 2 nos. of pins and locks inserting through the aligned holes of both the support device and the plunger beam.

25 The guide casing is a guide to contain the hammer and prevent it from moving out of the main frame Structure when dropped. It may also be equipped with 4 heavy duty screws which when tighten shall securely hold the hammer from moving sideways.

In this example, the guide rods are a pair of steel rods that run from the top of the pile helmet through the hammer to the underside of the support device. These rods

serve as a drop-path for the hammer to ensure it hits on the correct point and creates maximum impact on the pile when dropped.

- 5 The hammer cushions maybe one or both of timber and a tight coil of rope. These are used as a cushion to reduce noise generated from the impact of the hammer and the pile helmet and also may contribute to the knitting the recoil of the hammer.

- 10 A ladder may be located at the side of the main frame structure to facilitate technician from gaining access to the top of frame.

2 nos. of pins may be inserted through the aligned holes of the support device and plunger beam and locked at their tips to prevent slippage.

- 15 The Shackle may be a U-shaped piece of metal secured with a bolt across the opening to hold 2 or more objects together or use as lifting point.

- 20 The apparatus 500 can be set up in "transport mode", hoisted horizontally at the lifting points by, say, a minimum 50 ton capacity mobile crane. The apparatus may then be conveniently loaded onto a flat-bed trailer and transported to site.

- A step-by-step sequence for the foundation pile dynamic load testing using the apparatus of Figure 5 – which in itself will implement one or more of the pile helmet arrangements described above – is now described.

- 25 1. The subject PILE is selected by Project Qualified Person (QP) or his/her representative for Dynamic Load Testing.

2. The PILE shall be exposed and ensure that the top surface is relatively flat.

3. A square dug-out of, for example, L=4m x B= 4m x D= 1.5m is prepared next by an excavator with the subject exposed PILE at the central position.
4. The surface of the dug-out base has to be relatively flat and horizontal. A check using a spirit level is carried out.
5. Once the dug-out base is satisfactorily checked, the apparatus 500 shall then be positioned vertically into the dug-out by a mobile crane where the Pile Helmet 100 covers the exposed PILE head and the Top Plate of the Pile Helmet contacts fully with the PILE head.
6. The verticality and horizontality of the apparatus 500 is checked at the vertical column and horizontal beam using a spirit level.
7. Gauges consisting 1x Accelerometer and 1x Strain Transducer are fixed onto the PILE shaft through the window opening 314 of the Pile Helmet by the Specialist Tester. These gauges are connected by cables to a readout computer unit or Pile Driving Analyzer (PDA) or CAPWAP placed some distance away.
8. A designated Technician with Safety Personal Protection Equipment in-placed shall make his way to the top of the structure by the ladder access.
9. The Technician will then latch the Crane's hook into the shackle connected to the tip of the Plunger Beam.
10. The Plunger Beam together with the Hydraulic Clamp and Hammer shall then be lifted at one go to a pre-determined drop height approved by the Project QP beforehand. The drop height is checked by a dumpy level staff (large retractable ruler used by surveyor).

11. 2 nos. of pins are then inserted through the aligned holes of the Plunger Beam and the Support Device and capped at each end of the pins with locks by the designated technician.
- 5     12. The Crane shall slack its hoisting cable so that the entire Plunger Beam together with Hydraulic Clamp and Hammer now rest on the Support Device.
13. For reasons of safety, the Crane's hook shall still be connected to the tip of the Plunger Beam. This is also to facilitate the setup process and cut down on the time  
10     taken should the test is required to be re-executed on the same pile.
14. Hammer cushions in the form of timber planks or tightly coiled rope shall be placed on the top of Pile Helmet.
15. The height between the bottom of the Hammer and the top surface of the Pile  
15     Helmet is then checked using a dumpy level staff against the pre-determined approved drop height before actual test execution.
16. All personnel shall stay approximately 5m out of bound of the setup.
- 20     17. The designated Technician will standby at the Hydraulic Pump which controls the release of the hammer, placed some distance away.
18. Upon getting the final safety check done and clearance from the designated Technician and the Specialist Tester as well as the approval of the Project QP/ QP  
25     Rep, the Test Supervisor shall give a signal to release the Hammer.
19. The designated Technician shall press a button on the Hydraulic Pump to release the Hammer.

20. The Hammer will then drop freely and vertically onto the Pile Helmet where the impact force will travel to the PILE and send signals to the gauges attached and recorded by the readout computer unit or Pile Driving Analyzer (PDA) or CAPWAP.

- 5     21. If the impact force is inconclusive, the Crane will lower the Plunger Beam and Hydraulic Clamp to pick up the Hammer and redo the test by going through Step 10 to 20.

22. Otherwise the test is considered complete.

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#### Dismantling and Demobilisation

1. The Plunger Beam together with Hydraulic Clamp shall be lowered to pick up the Hammer.
2. After which, the Plunger Beam, Hydraulic Clamp and the Hammer shall then be
- 15     lifted together to a “Transport Mode” and secured with Pins and locks at the Support Device as well as clamping the shaft of the Hammer to the Casing Guide by tightening 4x heavy duty screws to prevent any Hammer movement.
3. Next, the setup is lifted off the dug-out vertically and place on the open flat
- 20     ground.
4. The Crane shall tip the setup slowly so that it lays horizontally on the ground.
5. The Setup can then be lifted off the ground horizontally by a Crane and loaded
- 25     onto a flat-bed trailer.

In one implementation, the equipment and tools which may be required are as in Table 1.

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| <b><u>S/n</u></b> | <b><u>Equipment/ Tools</u></b>                 | <b><u>Qty</u></b> | <b><u>Purpose</u></b>                               |
|-------------------|------------------------------------------------|-------------------|-----------------------------------------------------|
| 1)                | DYNAMIC PILE TESTING SYSTEM                    | 1                 | For execution of pile dynamic testing               |
| 2)                | Mobile Crane – Min. 50T Capacity with 70' Boom | 1                 | Lifting and hoisting works                          |
| 3)                | Excavator – Min. 0.3m3 Bucket Capacity         | 1                 | Preparation of dug-out and levelling of ground      |
| 4)                | Dumpy Level & Staff                            | 1                 | Measurement of ground levels and Hammer drop-height |
| 5)                | Spirit level                                   | 1                 | Measurement of surface for horizontal level         |

TABLE 1

In one implementation, the personnel required are as set out in Table 2.

| <b><u>S/n</u></b> | <b><u>Equipment/ Tools</u></b>         | <b><u>Qty</u></b> | <b><u>Purpose</u></b>                                                                                                                                                                                                                                                      |
|-------------------|----------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1)                | Test cum lifting and safety supervisor | 1                 | Overall in-charge of safety, test & supervise all lifting works                                                                                                                                                                                                            |
| 2)                | Test technicians cum lifting team      | 2                 | Check flatness of ground & measurement of Hammer Dropheight. Perform rigging & signalling for lifting activities. Designated operator for hydraulic clamp for grabbing/ releasing of hammer & engaging/ dis-engaging the Support Device at the top of Main Frame Structure |
| 3)                | Crane operator                         | 1                 | Operate mobile crane                                                                                                                                                                                                                                                       |
| 4)                | Excavator operator                     | 1                 | Operate excavator                                                                                                                                                                                                                                                          |
| 5)                | Specialist tester                      | 1                 | Installing gauges (Accelerometer & Strain Transducer) on pile shaft, receiving signals from data logger/ computer, interpreting results and provide fully analyzed report                                                                                                  |
| 6)                | Project qualified Person/rep           | 1                 | Approving authority                                                                                                                                                                                                                                                        |

TABLE 2

It will be appreciated that the invention has been described by way of example only. Various modifications may be made to the techniques described herein without departing from the spirit and scope of the appended claims. The disclosed techniques comprise techniques which may be provided in a stand-alone manner, or  
5 in combination with one another. Therefore, features described with respect to one technique may also be presented in combination with another technique.

## CLAIMS

1. A pile helmet for a foundation pile under dynamic load testing, the pile helmet comprising:
  - 5 a top member having a body having a first cross-sectional area;  
a housing having an internal volume of a second cross-sectional area, the second cross-sectional area being greater than the first cross-sectional area; wherein  
the top member is arranged to be disposed, at least in part, within the internal volume of the housing and also to rest on a head of the foundation pile.
- 10 2. The pile helmet of claim 1, wherein the top member comprises a main body having a projection extending therefrom, the projection being for extending through an aperture in the housing.
- 15 3. The pile helmet of claim 2, wherein the top member comprises a plurality of projections extending from the main body, the plurality of projections being for extending through a corresponding plurality of apertures in the housing, each of the apertures having a lower section for the projections to rest thereon in a non-use condition.
- 20 4. The pile helmet of any preceding claim, wherein the top member and the internal volume of the housing are each of a generally circular cross-section.
5. The pile helmet of any preceding claim, wherein the top member further  
25 comprises a guide affixed thereto, the guide being arranged to pass through a channel in a body of a hammer of a dynamic load testing apparatus, the guide being for guiding the hammer towards the top member during dynamic load testing.
6. A foundation pile dynamic load testing apparatus comprising the pile helmet  
30 of any of claims 1 to 5.

7. A method of performing foundation pile dynamic load testing using the pile helmet of any of claims 1 to 5.
- 5 8. A method of foundation pile dynamic load testing using the apparatus of claim 7.