

STRUT LOCKING JACK FOR SUPPORT BEAM

FIELD

[0001] The present invention relates to a locking jack apparatus for installing support strut beams against the walls of an excavation site.

BACKGROUND

[0002] It is common in the construction industry, in particular, deep underground excavation construction projects, to find struts installed across the width of an excavated site to ensure that the walls hold up sufficiently when performing deeper excavation commonly known as braced excavation. It is also industrial practice to remove the strut beams once the construction project comes to an end.

[0003] Cross lot or internal bracing to reduce wall movement transfers the lateral earth between opposing walls through compressive struts. Adjacent strut beams are placed according to industrial practice, typically 7 meters apart horizontally and 4 meters apart vertically. In a typical civil engineering project, as many as 1000 struts can be used for such supporting purposes. Examples of the strut beam are the yamadome support beam, the I-beam or rigid pipes simply.

[0004] Installation of the strut beams is done by excavating soil locally around the strut and only continuing the excavation once pre-loading is complete. A typical sequence of excavation in cross-lot braced excavations is shown in Figure 3(a) – (d). The strut beams rest on a series of waler beams that distribute the strut load to the diaphragm wall in Figure 3(b) – (d).

[0005] There are 2 well-known techniques to install the strut beams in place across the excavated hole. The first method is the 'pure hydraulic jack' method and the second method is the 'shim' plate' method. Each of the 2 methods involve the common

process steps of preloading, retaining the position of the strut beams after preloading, and finally dismantling.

[0006] The term 'pre-loading' refers to closing the gaps between the support beam/bolt joints and to put tensions/compressions to the support beams. Typically in pre-loading, 30 to 70 percent of the design load is pre-loaded to check the soil condition.

[0007] In the 'pure hydraulic jack' method, or any other equivalent method defined by different parlance, each strut is held against the walls of an excavated hole using a single hydraulic jack, which remains with the strut throughout the entire duration of the construction project, i.e from pre-loading to dismantling. The cost of each hydraulic jack is about SGD\$10,000.00 each. Thus, in mega scale civil engineering projects, the cost could be exorbitant and prohibitive because multiple hydraulic jacks are necessary .

[0008] Owing to the high cost of hydraulic jacks, a less costlier method has been adopted by the construction industry in recent years. In the 'shim plate' method, firstly, as with the 'pure hydraulic jack' method, hydraulic jacks will be used to first install the strut beams against the walls, putting pressure on the walls and strut beams in the pre-loading process. However, in the 'shim plate' method, the hydraulic jacks will be removed once the pre-loading is done. After the removal of the hydraulic jacks, there will be some back pressure from the walls to the strut beam, resulting in some shrinkage or compression of the strut beams, leading to slack and gaps forming. To push back the walls, an extra step is necessary to insert shim plates to fill up the slack and gaps between the strut beam and the walls before the hydraulic jacks are removed.

[0009] The 'shim plate' method is a cheaper method compared to the 'pure hydraulic jack' method. However the 'shim plate' method is less safe because there is an inherent difficulty and danger encountered when with trying to match the 'gaps' or 'slacks' formed from the shrinkage/compression of the strut beams. For instance, to fill in a gap/slack of 11mm, a skilled technician has to use a plate with thickness less than

11mm, say 10mm. Otherwise there will be difficulty in inserting the plate. In this case when the hydraulic jack has been removed the initial tension put into the strut beam will decrease by 50%. Hence from this it can be seen that the method is neither as accurate nor is it able to provide accurate tolerances, as compared to the 'pure hydraulic jack' method. Arising from this lack of accurate tolerance, is the problem of safety issue since the strut beams are now more likely to give way to collapsing walls.

[0010] In both the 'pure hydraulic jack' and 'shim plate' methods, a waler beam is found between the wall and the strut beam. Additional plates may be added to the set up when required. Further, in both methods, it is likely that the strut beams would have to be cut in order to have them dismantled. This is mainly because of the high pressure found in the strut beams as a result from the initial pre-loading of the strut. The cut strut beams may dislodge and crash dangerously to the ground below causing a safety hazard. The cutting of the strut beams could also result in a sudden release of pressure from the walls, which could result in the waler beam recoiling from the wall, adversely affecting the structural support of the waler beam to the wall.

[0011] Therefore, the 2 methods are cost prohibitive because strut beams have to be cut at the end of the construction project, expensive hydraulic jacks have to be used etc. The shim plate method also lacks in terms of safety, because the tolerances are not accurate enough, which may lead to wall collapsing.

SUMMARY OF INVENTION

[0012] It is therefore an object of the invention to provide a locking jack apparatus for securing strut beams against the walls of an excavated site in a manner, which is low in cost and high in safety.

[0013] According to an aspect of the current invention, it is provided a locking jack apparatus comprising a piston configured to exert pressure on one or more surfaces, an operator configured to retain the tension of said locking jack relative to the wall and

the strut beam; and a cylinder configured to contain an amount of granular material such as sand, gravel, soil, silica and mineral grains.

[0014] According to another aspect of the invention, it is provided a method of pre-loading a strut beam against a surface, said method comprising: mounting a locking jack apparatus to an end of the strut beam and against the surface; having means to apply pressure to said end of the strut beam and to said surface; retaining a tension of said apparatus relative to the surface and the strut beam; and removing the means to apply pressure.

[0015] According to another aspect of the invention, it is provided a method of dismantling a strut beam installed against a wall, said method comprising discharging granular material from a locking jack apparatus, applying external pressure against the surface of the wall; reducing the tension of said locking jack relative to the wall and the strut beam and removing the strut beam.

BRIEF DESCRIPTION OF DRAWINGS

[0016] Figure 1 depicts a locking jack apparatus according to an embodiment of the invention;

[0017] Figure 2 depicts, in cross-section, a locking jack apparatus in accordance with an embodiment of the invention for use between a waler beam and a strut;

[0018] Figure 3 depicts an overview of the working of the invention.

[0019] Figure 4 depicts a conventional excavation sequence

DETAILED DESCRIPTION

[0020] Figure 1 schematically depicts a locking jack apparatus 15 according to one embodiment of the invention. The apparatus comprises:

- a piston 100 configured to exert pressure on one or more surfaces;
- a top plate 900 which acts as an interface between the waler beam and the piston;
- an operator 400 such as a screw lock nut configured to retain the tension of said locking jack relative to the wall and the strut beam; and
- a cylinder 300 configured to contain an amount of granular materials such as sand gravel, soil, silica and mineral grains.

[0021] Figure 2 depicts, in cross-section, a locking jack apparatus 15 in accordance with an embodiment of the invention for use between a waler beam 110 and a strut beam 10.

[0022] The piston 100 acts as the main body mass and bulk of the locking jack apparatus, providing structural strength to the jack. The piston 100 is attached to the strut beam 10 via an attachment block (as shown in Figure 3). Such an attachment block may have means to ensconce one or more hydraulic jacks, preferably about 4 hydraulic jacks. The piston 100 may be mounted on the attachment block with a base plate 800 as interface. It is recommended that the attachment block, base plate be made of grade G50B material.

[0023] The piston 100 may have piston rod protrusions 200 which may be biased against the side wall of the excavation with a waler beam 110 in between them. A top plate 900 acts as an interface between the waler beam and the piston.

[0024] The screw lock nut acts as an operator or means 400 to close and lock down any remaining gap between the locking jack apparatus and the wall/waler beam

110 that may be caused by, for example after the dislodgment of the 4 hydraulic jacks off the attachment on the strut beam 10 which allows back pressure from the waler beam 110 to act against the locking jack apparatus 15 mounted at the end of the strut beam 10. When the 4 hydraulic jacks are dislodged, there will be some loss in tension. The screw lock nut 400 serves to advance the gap that would have been formed thereto by 1 – 10mm and locks in the initial tension. By fastening the screw lock nut 400, the present invention ensures that the locking jack apparatus stays in its position as though the hydraulic jacks have never been removed. Thus, the screw lock nut 400 permits non-hydraulic support of loading.

[0025] In an embodiment of the present invention, 4 hydraulic jacks each with a jacking capacity of about 100 tons can be mounted on the attachment and used for pre-loading and installation of the strut beams. These 4 jacks with an aggregate jacking capacity of 400 tons are then removed from the pre-loaded and installed strut and moved elsewhere for pre-loading and installation of other strut beams, resulting in significant cost savings. Each of these hydraulic jacks costs an estimate SGD\$4000.00, which is a significant savings over the conventional regular hydraulic jacks because they are short stroke type jacks.

[0026] The cylinder 300 acts as a receptacle for granular material such as sand 500. Before the pre-loading process, a sufficient amount of sand 500 is loaded and compressed into the cylinder 300. During the pre-loading process the sand 500 is subjected to high pressure within the confines of the cylinder 300 because the locking jack is exerting pressure against the waler beam 110 and walls of the excavated site. The sand 500 may be highly compacted as a result.

[0027] As shown in Figure 2, cylinder 300 may be coupled to the piston 100 body via some fastening means such as but not limited to bolts 120. In a preferred embodiment, the sand to be used for such applications should be gravel grade or type.

[0028] During conventional dismantling of the strut beams 10, the strut beams 10 are cut up so that they can be easily removed. Such practice leads to high wastages of the metallic strut beams 10 and safety issues as previously mentioned. The present invention seeks to mitigate such problems by allowing the locking jack to retreat away from the waler beam 110 or wall so that the pressure between the waler beam 110 and jack 15 is relieved and the strut beam 10 may be removed without having to cutting it up. Such pressure relieving and retreat of the locking jack from the wall may be performed in a safe and slow manner.

[0029] In an embodiment of the present invention, the method of dismantling the strut beams 10 from the walls of an excavated side comprises the steps of opening up the connector plugs 600 that seal one or more openings found on cylinder 300. Once the plugs 600 are opened, some sand will be released from the openings via gravity. However, only a small amount of sand is exited from the cylinder in this manner. As mentioned, the sand is highly compacted. A skilled technician is expected to use a tool to discharge/expel the sand from within the confines of the cylinder 300.

[0030] When the sand is expelled from the cylinder, the cylinder collapses in a direction towards the strut beam 10. A clearance develops as a result of this retreat of the jack 15 away from the wall. Nonetheless, the screw lock nut retains the positional integrity of the jack 15 vis-à-vis the waler beam 110 and wall despite the clearance. However the pressure acting on the wall and jack 15 is severely relieved and reduced, leading to easy and safe subsequent dismantling of the strut beam 10 from the excavated site by a person skilled in the art.

[0031] Hence it can be seen that the embodiments of the present invention result in significant cost savings, improved safety and enhanced efficiency of pre-loading and dismantle of strut beams.

[0032] The descriptions above are intended to be illustrative not limiting. It will be apparent to one skilled in the art that modifications may be made to the invention as described without departing from the spirit and scope of the claims set out below.

[0033] A jack apparatus as contemplated herein should be broadly construed. One or more embodiments of the invention may be applied to any other industry where there is a need for lifting or jacking heavy object, such as including but not limited to the marine ship building industry.

CLAIMS

1. A locking jack apparatus for engaging one or more surfaces, comprising a piston configured to exert pressure on one or more surfaces; an operator configured to retain the tension of said locking jack relative to at least one of the surfaces and a strut beam; and a cylinder configured to contain an amount of granular material.
2. An apparatus according to claim 1, wherein said piston and cylinder are coupled together by a plurality of fastening means.
3. An apparatus according to claim 2, wherein said plurality of fastening means is a bolt.
4. An apparatus according to claim 1, wherein said cylinder receives or discharges the granular material through a plurality of openings.
5. The apparatus according to claim 4, wherein said plurality of openings are sealed by a plurality of connector plugs.
6. The apparatus according to claim 1, wherein a first surface of the piston is in contact with a base plate, said base plate being in contact with an end surface of the strut beam.
7. The apparatus according to claim 1, wherein a second surface of the piston is in contact with a top plate, said top plate being in contact with a waler beam.
8. The apparatus of claim 7, wherein the waler beam is in contact with a wall.

9. The apparatus of claim 1, wherein the operator is a screw lock nut or a wedge shaped shim plate.

10. The apparatus of claim 1, wherein the piston is attached to the strut beam via an attachment block.

11. The apparatus of claim 10, wherein said attachment block holds one or more jacks.

12. The apparatus of claim 11, wherein the jacks are hydraulic jacks and have a total load bearing capacity of 400 tons or more.

13. The apparatus of claim 1, wherein the attachment block is mounted to the piston with a base plate interface, said attachment block and base plate are fabricated from G50B material.

14. The apparatus according to any of the preceding claims, wherein the granular material is sand, gravel, soil, silica and mineral grains.

15. The method according to claim 23, wherein said granular material is sand, preferably gravel grade sand.

16. A method of pre-loading a strut beam against a surface, said method comprising:
mounting a locking jack apparatus in accordance with claim 1 to an end of the strut beam and against one of the surfaces;
having means to apply pressure to said end of the strut beam and to one of the said surface;
retaining a tension of said apparatus relative to one of the surfaces and the strut beam;
and
removing the means to apply pressure.

17. The method according to claim 15, wherein one of the surfaces is a surface of a wall or waler beam.

18. The method according to claim 15, wherein said means to apply pressure is one or more hydraulic jacks.

19. The method according to claim 15, wherein 4 hydraulic jacks are used.

20. The method of claim 15, wherein a screw lock nut retains the tension of said apparatus relative to one of the surfaces and strut beam.

21. The method according to claim 15, wherein the locking jack apparatus is mounted to an end of the strut beam via an attachment block.

22. The method according to claim 20, wherein said attachment block holds 1 or more removable hydraulic jacks.

23. The method according to claim 15, wherein one or more plates of material is wedged between the locking jack apparatus and a waler beam.

24. A method of dismantling a strut beam installed according to claim 15, said method comprising
discharging granular material from a locking jack apparatus according to claim 1;
applying external pressure against one of the surfaces of the wall;
reducing the tension of said locking jack relative to the wall and the strut beam and
removing the strut beam.

25. The method according to claim 23, wherein the granular material is sand, gravel, soil, silica and mineral grains.

26. The method according to claim 23, wherein said granular material is sand, preferably gravel grade sand.

27. The method according to claim 23, wherein the granular material is discharged from a member of the locking jack apparatus.

28. The method according to claim 25, wherein said member is a cylinder.

29. The method according to claim 23, wherein the external pressure is provided by hydraulic jacks.

30. The method of claim 23, wherein the screw lock nut is loosened to reduce the tension of said locking jack.