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LEEA

Guidance on Testing of Hand Operated Lifting Machines

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1.0 The requirements
New hand operated lifting machines are within the scope of both the Supply of Machinery (Safety) Regulations 2008 and the Machinery Directive 2006/42/EC, as they are currently aligned. Therefore the harmonised standard EN 13157 Cranes – Safety – Hand powered cranes and the UK designated standard BS EN 13157 Cranes – Safety – Hand powered cranes apply

Section 4 of Annex 1 of the legislation contains the Essential Health and Safety Requirements (EHSRs) specific to lifting operations. Clause 4.1.1 defines two tests: static test and dynamic test.

The static test is defined in a way that permits the force to be applied by external means. That is appropriate for lifting accessories but not for lifting machines as it will not test all the teeth of each gear or ratchet wheel nor will it test the ability of the brake to arrest a descending load. Therefore for lifting machines the load should be applied through the machine's own mechanism. The static test for hand operated lifting machines is 1.5 x WLL.

The dynamic test requires the lifting machine to be operated in all possible configurations and this is explained further in EHSR 4.1.2.3. The test should be made at the nominal speeds and combine all movements which the control system allows to be operated simultaneously. For a complex lifting machine such as a mobile crane, that could mean operating the hoist, slewing, derricking and telescoping motions simultaneously. The dynamic test is 1.1 x WLL.

Hand operated chain blocks have only the hoist motion and the speed is dictated by the operator. Therefore, in effect, the only difference between the two tests is the test coefficient so doing the static test also covers the dynamic test.

The current legislation both have an Essential Health and Safety Requirement (EHSR) 4.1.3 headed 'Fitness for purpose', the second paragraph of which requires the static and dynamic tests to be performed on all lifting machinery ready to be put into service. The previous Directive expressed the static test as a design requirement and EN 13157 was written accordingly. Although the standard was updated editorially to reflect the current legislation, this technical change was missed. A proposal to correct that omission is currently being considered.

In summary, to comply with the Supply of Machinery (Safety) Regulations 2008 and the Machinery Directive 2006/42/EC every new hand operated lifting machine must be subjected to a test of 1.5 x WLL applied through the machine's own mechanism.

2.0 The test equipment
When load testing, it must be assumed that the item under test might fail. Therefore the test facility must be such that the operator can work from a safe position and that any debris arising from failure is contained.

To be meaningful the test equipment must apply the required amount of load within reasonable tolerances. Neither the appropriate legislation nor EN 13157 specifies the tolerances. However the LEEA Technical Requirements for Members (document ref LEEA 042) specifies a maximum tolerance of ± 2%. There are several ways of achieving the required loads within this accuracy, as the following sections will explain.

<u>2.1 Calibrated test weights directly applied.</u>
This is the ideal method. The weights must be such that they can be used singly or combined to achieve the required load(s). Consideration must be given as to how the weights are selected and combined. The weight of any lifting accessories, e.g. a lifting beam, and friction between the weights can be significant.

<u>2.2 Un-calibrated weights used in conjunction with a calibrated load cell.</u>
The load cell must be accurate within ± 2% at the required load. Many load cells are not sold as test equipment and are only calibrated at full scale value. The error may be proportional, variable or fixed but you will not know. A fixed error of 1% at full scale could be 2% at half scale and 4% at quarter scale.

Test equipment should be calibrated at increments throughout the range down to the limit of resolution. The limit of resolution is the smallest increment the display can show. However some digital displays flicker or hunt up and down. The resolution is then the range of flicker. For example, a

10t load cell with a display to 2 decimal places, has a resolution of 10kg. However if it flickers between 0 and 1, the resolution is 20kg. If it flickers up to 1 and down to -1, the resolution is 30kg. Hence the true accuracy of a load cell is a combination of the accuracy with which it senses the load and the resolution of the display.

In use with un-calibrated weights the indicated error must also be included. Indicated error is the difference between the load required and the nearest that can be achieved with the weights available. To illustrate the combination, consider a 5t load test using a 10t load cell with a display to 2 decimal places and calibrated as accurate to ± 0.5% at full scale. If the error is fixed, at 5t it will be 1% = 50kg. If it flickers ± 1 that is another 30kg. If the indicated load is 4980kg that is another 20kg bringing the total possible error to 100kg = 2% of the required load. Each possible error seems small but in total they are significant. Some errors may cancel others out but you will not know.

2.3 Weights in conjunction with a multiplying device e.g. nodding donkey
The device must allow sufficient movement under load so that every gear wheel in the lifting machine rotates at least once. The overall accuracy must be within ± 2% taking account of additional sources of error such as friction. It is important that the multiplying ratio is constant throughout the range of movement. Unfortunately many have a fundamental design fault as illustrated in figure 1 below.

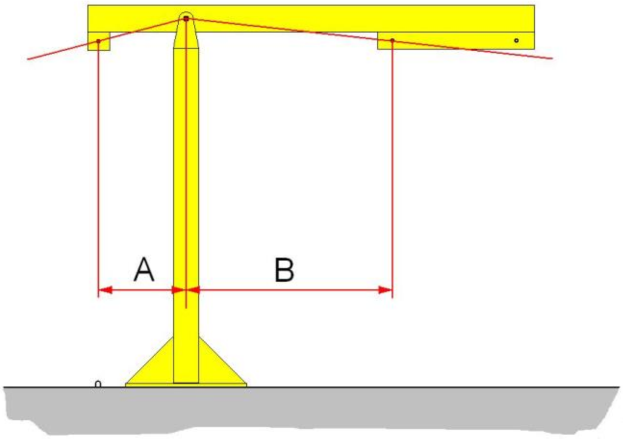

Figure 1

The multiplying ratio is B/A. However the pivot points of the lifting machine, test weights and donkey beam are not in a straight line. As the load is lifted, A will decrease and B will increase. To provide a constant multiplying ratio, the pivot points must be in a straight line as illustrated in figure 2 below.

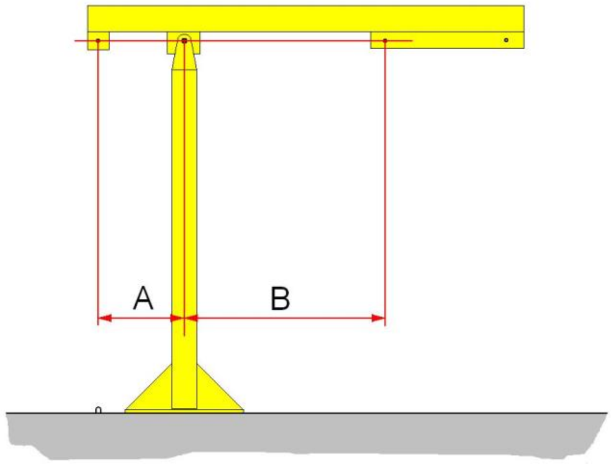

Figure 2

The lifting machine usually pulls against an anchor point in the floor. This causes the lifting machine to make a slight angle to the vertical as the donkey beam rocks. Provided there is sufficient height to the donkey beam (e.g. a minimum of 2m) and the anchor is positioned vertically below the suspension point when the donkey beam is horizontal, the effect is insignificant. However if that is not the case, an error may be introduced.

Some designs have more than one suspension point for the lifting machine. This is intended to give a choice of multiplying ratios. Appropriately positioned anchor points are required for each to ensure correct alignment.

There are generally only two methods of adjusting the load, by altering the amount of load or by changing the position of the load suspension point. In practice most designs will use a combination of the two. For the latter there needs to be a means of repositioning the weights under the appropriate suspension point. Slinging at an angle and allowing the weights to skid into position is not good practice.

There should be a load chart to illustrate the combination of suspension point and weights required for each test load.

Either calibrated or un-calibrated weights can be used. The considerations stated above for directly applied calibrated weights are also relevant here. Un-calibrated weights can be time consuming to adjust for what is usually intended to be a readily available test facility. It is unlikely that they will be correctly adjusted on every occasion. A better option is to use pre-weighed weights. Any suitable material can be used but to ensure the weight doesn't change accidentally it is preferable that each weight is made 'of a piece'. For example a stillage holding scrap could be used but unless sealed in some way, pieces of scrap may be added or lost. Each weight should be clearly identified and related to the load chart.

Whilst individual weights can be pre-weighed, the load chart should be checked with a load cell at the lifting machine suspension point(s) and all intended combinations of weights and suspension points. The accuracy of the load cell must be taken into account as explained above.

2.4 Hydraulic testers

The attraction of hydraulic testers is that they can provide an infinitely variable test force at a lower cost than calibrated test weights, take up less space than a nodding donkey and can also be used to test lifting accessories. However there are several types of hydraulic tester and some will not test lifting machines to our requirements.

One type uses a manually pumped hydraulic cylinder mounted in a loading frame. These do not permit the necessary movement under load so are unsuitable.

Suitable hydraulic testers work on the principle that they exert a pre-set force and allow movement whilst maintaining that force. The amount of movement must be sufficient to allow every gear wheel of the lifting machine under test to rotate at least once. The force is achieved by a continuously running hydraulic pump pressurising a cylinder. The amount of force is set by controlling the pressure. This is usually achieved by a manually controlled valve. Operator skill is therefore required to achieve the correct load.

The force is measured in one of two ways, either by measuring the pressure in the cylinder or by a separate load cell. Those measuring cylinder pressure usually indicate the load with an analogue gauge. The diameter of the gauge and the size of the scale increments is often such that the resolution is not adequate. Also the gauge pointer often oscillates in response to pulses from the pump making it impossible to obtain an accurate reading.

Those using a separate load cell generally have a digital display. The method of determining the limit of resolution is as explain above for load cells used with un-calibrated weights.

Whatever method of force measurement is used, the hydraulic tester must be capable of maintaining the force within the required accuracy whilst permitting the necessary movement. That includes lowering as well as hoisting. Even with the low speeds of hand operated lifting machines, some hydraulic testers do not have adequate pump capacity or pipe sizes to maintain the force during lowering. They are unsuitable.

In use, a lifting machine must accelerate the load up to hoisting speed and arrest a lowering load from full speed. Both actions require a force over and above that required to sustain a stationary load. A hydraulic tester can only exert the force required to sustain a stationary load although many hydraulic testers will show some increase in force during hoisting.

The LEEA requirement for accuracy is -0 +10%. This comes from BS 3243 which is superseded by EN 13157. Nevertheless it is an authoritative source and in the absence of any guidance from the legislation or EN 13157, is the best we have. It ensures that the force is never less than that required to sustain a stationary load but allows for some fluctuation arising from the machine and operator skill. To stay within this accuracy, allowance must be made for the accuracy of the machine. Thus for a class 2 machine (±2%) the indicated load should be in the range of +2% to +8% of the nominal load.

Although the LEEA technical requirements permit this type of hydraulic tester, it should be remembered that it comes from a manufacturing standard and that the actual force applied at the upper limit will be 1.65 x WLL not 1.5 x WLL. Whilst a manufacturer may be happy to apply that force to his products, anyone testing someone else's products should exercise caution and aim to keep the indicated load to the lower limit.