With concern mounting about the exposure of site workers to Vibration White Finger, Nick Johnson discovers how Errut determines the low hand arm vibration levels it quotes on plate compactors.

Shaky figures?

It was very cold out on the exposed test site beside the Belle factory situated within the Peak District National Park. But, by wrapping up well, we were easily able to protect ourselves from the biting wind and the low winter temperature. And our temporary discomfort was nothing compared to much more permanent numbness that can be experienced by construction workers who regularly operate vibrating equipment for long periods.

Regular exposure to harmful vibrations transmitted through machine handles to the hands and arms of the operator can lead to the person suffering permanent injury and disability. The medical condition is known as Hand Arm Vibration Syndrome (HAVS) and one of the common symptoms associated with it is called Vibration White Finger (VWF).

VWF got its name from the fact that the fingers of the person subjected to excessive hand-arm vibration actually do turn white during an attack. This blanching occurs when small blood vessels constrict and reduce the flow of blood to the fingers. Sufferers can experience varying degrees of numbness and tingling together with a loss of sensation and manual dexterity. And prolonged exposure can result in serious damage to the blood vessels, nerves, bones and muscles.

Andy Bell of Errut operates the Errut plate whilst Alan Matthews of AVT records the hand arm vibration figures.

Compensation claims

Clearly some equipment such as handheld breakers, demolition picks and drills are more likely to put their users at risk of suffering VWF and so the makers of these tools have been busy developing low vibration versions. And now, as compensation claims spiral, so considerable attention is being paid to minimising the risks of using plant which has to vibrate to do its job.

Much development work has been carried out by the makers of vibratory rammers and plates to introduce low vibration handles and other arrangements designed to considerably reduce the machine operator's exposure to vibration. But it is a balancing act as, by their very nature, rammers and plates have to vibrate in order to do their job effectively.

For users striving to follow their risk management obligations and identify potentially hazardous equipment, the situation has been complicated by the difficulty of being able to get directly comparable data from competing manufacturers. And indeed there has been confusion over how to carry out tests and which test results to quote.

Low hand arm vibration figures are now a big marketing feature of vibrating plate compactors. And at the Hirex 2001 exhibition in February there was much debate as to which plate maker had actually achieved the plate with the lowest hand arm vibration figure.

One plate maker which has done much to publicize the desirability of selecting plates with low hand arm vibration is the Belle Group member Errut. It used Hirex last year to launch its new PC plate range complete with new style low vibration handles and the claim that they produced "the lowest operator vibration levels in the country." Hand arm vibration is measured in metres per second squared (m/sec^2) and taking its 400mm width plate as an example, Errut then claimed that it had succeeded in dramatically reducing the unit's single axis vibration. It quoted a safe usage time of 243 minutes a day on the new Errut PC400 compared with only 80 minutes on the former EPC400 – thereby extending the safe usage time for operators by over two and a half times.

However some competitors were quick to point out that specifying vibration levels in only one axis is misleading as this can lead to misinterpretation of the actual hand arm vibration levels. They contended that, to calculate the true vector triaxial sum, three axes must be taken into account. Each of the three sums is squared then added together; the square root of the total is the true Weighted Acceleration Level which is measured in m/sec^2.

Errut's Andy Bell now says "we initially quoted single axis in the direction of travel in good faith as it was the accepted way of quoting the vibration of floor saws which we had previously had tested." More debate has followed the maker of another new low vibration plate recently publishing an extremely low hand arm vibration figure for its new machine when tested 'on uncompacted material'. This information caused competitors to point out that a test on uncompacted material is unrealistic.

Independent test

So how should plate compactors be tested? To find out I was invited by Belle to witness an independent test being carried out on one of its machines and this led me to being on the company's windswept test site on a bitterly cold April morning.

The tests were being carried out by Alan Matthews of Stockport-based AV Technology Ltd. His business now does a lot of vibration testing for plant manufacturers and he is clearly well versed in carrying out this work.

Alan Matthews says that, whilst there are standard rig mounted tests for tools such as breakers, there is not a set bench test for vibrating plate compactors. For these machines need to be tested for hand arm vibration whilst actually being used to compact material. As a result, competing plant makers can come up with figures that are not directly comparable as their machines can be tested on varying material and in conditions that are not uniform.

My visit to Derbyshire was made all the more interesting when I discovered that Alan Matthews was testing not just an Errut plate but

also three similar machines made by competitors. The object of this 'group test' was for Belle to help satisfy itself that, despite other claims to the contrary, its plates could still 'be held for longer' – to quote the Belle Group slogan.

The competitive plates had been hired from local hire companies and, whilst one of the three was clearly almost brand new, one of the others was not quite the latest model. As their makers were not present to verify how closely these units matched their original condition and specification, I will not actually name the units concerned – but merely refer to them as Model A, B and C. However what was interesting was that one of these competitors returned a much higher hand arm vibration figure than that stated on its specification sheet.

The Svantek instruments were able to measure and record vibrations in three axes simultaneously.

The tests involved the plates each compacting a 11.0m long strip of 102mm deep MOT class aggregate spread over clay based soil. The plates were used in turn to travel up and down the same strip to complete a total of six passes (each one way along the 11.0m strip). The hand arm vibration level was continuously measured in three axes to provide readings after each pass. And after each plate compactor had completed its six passes the material was raked over using a special 20 tine attachment on a Belle 761 skid steer loader so that each unit started off on the same uncompacted material.

To measure the hand arm vibration levels, Alan Matthews used an accelerometer secured to the handle of each plate compactor in turn by means of a Jubilee Clip. Care was taken to ensure that this accelerometer was securely fitted and that it did work loose during any of the tests.

This accelerometer was able to measure simultaneously in all three axes and automatically give the vector sum of the three axes. It was connected to a Svantek SVAN912AE single channel sound and vibration analyser used with an SV 06A four channel input module.

Each of the test plates was operated by Andy Bell of Errut and the duration of each pass was measured to check that similar compaction times were achieved. The test did not however extend to testing the density of the material after six passes although it appeared that all the plates achieved good compaction.

Before each plate compactor was used I made a physical check to confirm its model number and plate size. This resulted in the discovery that Errut had brought over a 400mm wide PC400 plate from its Staveley factory rather than the PC350 as originally intended. All Errut plates share the same orange coloured impact resistant, moulded front covers and one with a PC350 badge had accidently been fitted to a PC400, the 400mm wide plate compactor.

The accelerometer measured the Axis X as being sideways along the horizontal handle, the Y Axis as being vertical and the Z Axis as being in line with the forward direction of travel. The Vector Sum (or Weighted Acceleration Level) of these three readings is then obtained by squaring each one, adding together the sum of the three figures and then calculating the square root of the total in m/sec^2. I then calculated an average of the six Vector Sum figures and this was used to calculate a Recommended Usage Time in minutes for a working day of eight hours.

The HSE gives a cumulative maximum recommended daily exposure level of 2.5m/sec^2. This means that plates with lower average Vector Sum Vibration figures can be used for a longer proportion of the working day.

The results showed that, on its first test, the Errut PC400 achieved an average Vector Sum Vibration figure of 3.88m/sec^2 which correlates to a Recommended Usage Time of 250.0 minutes. This plate was again tested after the three competitors had been evaluated and it then achieved a Vector Sum Vibration figure of 3.69m/sec^2 which equates to a Recommended Usage Time of 276.4 minutes. By comparison the best of the other three plates recorded a Vector Sum Vibration figure of 8.97m/sec^2 which would give it a theoretical Recommended Usage Time of only 46.8 minutes.

Errut was clearly pleased with the results although by supplying a 400mm plate rather than the 350mm unit as originally intended, its contestant was wider than two of the other plates on test. With a wider base plate the PC400 may produce slightly better test results than the company's PC350 which would have provided a more direct comparison with competitors B and C.

These tests show that the levels of hand arm vibration can vary significantly between different plates used in the same conditions. They also throw into question the figures published by certain manufacturers.

They also indicate the need to appoint a single, completely independent test agency which can be accepted by the HSE, machine makers and users as being able to carry out vibration (and associated compaction) tests to a common standard under very controlled conditions. Users need accurate, properly comparable figures if they are to be able to select the machines which best protect their work force from the debilitating symptoms of VWF. ■

TEST CONTENDERS

Make/Model	Errut PC400	Competitor A	Competitor B	Competitor C
Operating Weight	81kg	78kg	83kg	84kg
Plate Width	400mm	400mm	360mm	350mm

FULL FIRST TEST RESULTS FOR ERRUT PC400

Pass	Frequency Weighted Vibration Level (m/sec^2) Axis X	(m/sec^2) Axis Y	(m/sec^2) Axis Z	(m/sec^2) Vector Sum	Time for Pass (sec)
1	1.97	1.95	2.16	3.51	23
2	1.97	1.93	2.26	3.59	24
3	2.43	1.97	2.51	4.03	24
4	2.24	1.95	2.37	3.80	23
5	2.45	1.95	2.51	4.03	24
6	2.69	2.11	2.63	4.32	27

Average Vector Sum vibration figure = 3.88m/sec^2
Recommended Usage Time = 250.0 minutes

COMPARATIVE TESTS

Make/Model	Average Vector Sum Vibration Figure (m/sec^2)	Recommended Usage Time (mins)
Errut PC400*	3.88	250.0
Competitor A	8.97	46.8
Competitor B	12.15	25.5
Competitor C	9.24	44.1
Errut PC400**	3.69	276.4

* First Test ** Last Test

Note: Competitors A, B & C were used plates which had not been checked over by their manufacturers prior to the test.