The BEST, FASTEST & LOWEST COST Compaction

Belle GROUP

Innovation from the UK that makes a real difference to the cost and quality of compaction.

Belle Group has made a significant improvement to the performance of plate compactors without compromising on cost or practicality.

This booklet explains how a simple, physical principle has been harnessed by Belle Group to give its customers a valuable advantage.

Any innovation of this simplicity and effectiveness will challenge long held beliefs. The advantages become clear when you see the machines in action and test the results. The conclusions from independent testing and 10 years of practical experience has already convinced thousands of buyers, specifiers and operators.

HOW IT WORKS

The conventional way of specifying compaction equipment is to use the machine weight and the force of the vibrator. These are convenient catalogue figures but they don't give the full picture.....

Concentrated weight

Imagine how a woman's stiletto heels make indentations in a wooden floor. Now imagine how a man doesn't sink in to soft snow if he is wearing snow shoes.

Stiletto heels compress a hard timber floor because all the woman's weight is concentrated on to the very small heel area. The heavier man does not compact and sink in to the snow because his weight is spread over the much wider area of the snowshoe.

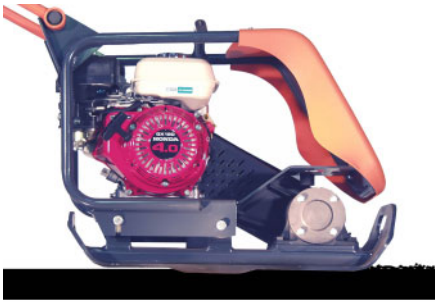
Weight spread

Applying this understanding to compaction equipment makes sense. A lightweight machine will compact more if the area of contact is smaller. This is the simple principle Belle has developed to increase the performance of vibrating plate compactors.

By using two distinct contact areas a plate compactor can exert two different forces. *Dual Force* plate compactors use a low pressure (large area) to stop the machine sinking in soft, un-compacted materials. A second, high pressure (small area) comes in to play as the material is consolidated and needs a high force to complete the compaction.

Dual Force 1st Force

- All of the base area is used (snow shoe)
- The contact area is the same as a standard machine
- Pressure equals the maximum a standard plate can produce
- The material is consolidated and flattened
- This stage is normally completed during the first pass



Dual Force 2nd Force

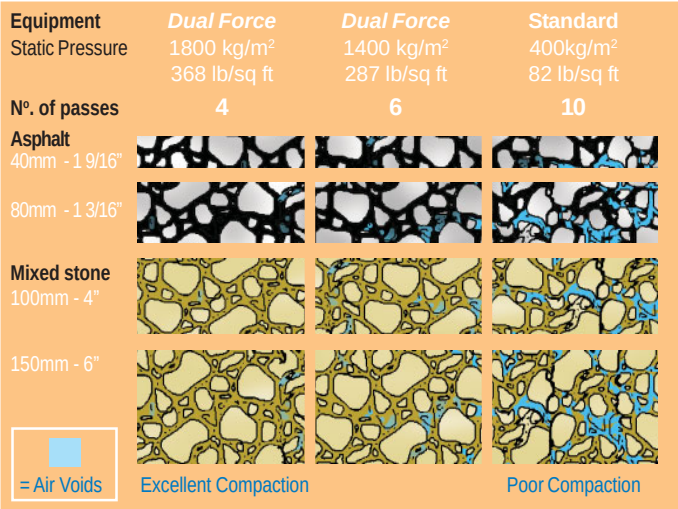
- Only the small base area is used (stiletto)
- The unique *Dual Force* plate reduces the contact area
- The pressure is up to 5 times that of standard machine
- The material is fully compacted
- Full compaction is achieved deeper and faster
- The surface finish is as good as a standard plate or roller but the compaction below the surface really makes a difference

Dual Force is only is only available from Belle, patent number 2261840

WHAT IT DOES

The *Dual Force* claim to faster and superior compaction has been proved time after time during ten years of practical field use. Early users saw the potential benefits and put the technology to the ultimate test. Using *Dual Force* for day-to-day work alongside traditional equipment has supplied the evidence to support the claims.

User groups in the UK have also engaged the most respected research organisations such as TRL (Transport Research Laboratory) and WRC (Water Research Council), to carry out quantifiable and scientific tests that determined the exact difference *Dual Force* can make.



Testing provides the evidence to prove the advantages of *Dual Force*

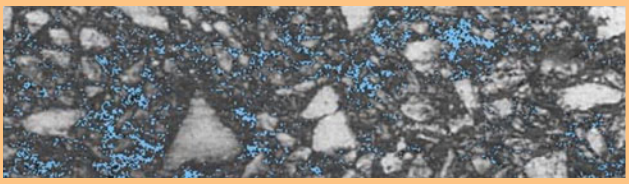
Faster 1. – Materials can be laid down in deeper layers so fewer layers are needed.

Faster 2. – Time spent compacting is reduced as each layer achieves full compaction with less passes.

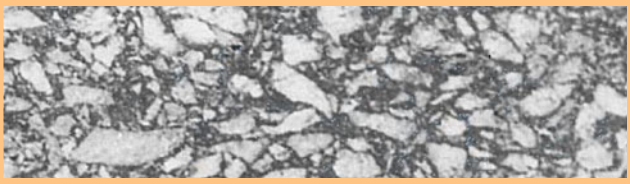
Superior – Optimum compaction can be difficult or even impossible to achieve with conventional equipment. *Dual Force* gives reliable, long lasting results.

See for yourself the *Dual Force* difference

These samples have been taken from a single reinstatement, the only difference is the compaction equipment used. (air voids coloured blue)



Sample 1 - The conventional plate compactor used on this half of the reinstatement leaves a high percentage of air voids.



Sample 2 - The *Dual Force* plate compactor achieves a much lower void content. This half of the reinstatement will last 100% longer.

The density of core samples taken from asphalt can be measured accurately and the percentage of voids calculated. Un-bound materials can be measured using a nuclear density gauge, an impact tester or a buried sensor.

The results of testing show *Dual Force* compaction is superior for all materials

HOW TO COMPARE

Using the commonly quoted weight and vibrator force to judge performance is misleading. It's like guessing how fast a car will go from the quoted weight and horsepower. Just as a heavy car needs more power to keep up with a sports car, heavy plate compactors need more power to maintain a reasonable speed. This doesn't give us any idea what compaction work the machine is doing. We need to know what pressure a machine exerts on the ground.

We can ignore the vibrator force by assuming it is sufficient to move the machine and the frequency is right to vibrate the material. The weight is irrelevant on its own but is used with a measurement of the base contact area to give a pressure figure.

Pressure Calculation

To categorise and compare machines, a simple measurement and calculation gives a figure known as 'the static weight per unit area', this equates directly to the pressure* a machine puts on the ground.

You can work out this figure for any Plate compactor by following these four steps

Step 1 Note the weight of the machine, from the identification plate, operator manual or weigh it.

Step 2 Measure the base (a & b) where it contacts the floor

Note: Published equipment data can include the curved ends and the handles so these figures can not be used.

Step 3 Multiply (a x b) to give the base contact area

Step 4 Divide the weight by the area

Example - PC450	
Metric	Imperial
Step 1.	
83 kg	184 lb
Step 2.	
(a) 0.45m	1.48 ft
(b) 0.5m	1.65 ft
Step 3.	
0.45 x 0.5 = 0.225m^2	1.48 x 1.65 = 2.442 sq ft
Step 4.	
83 / 0.225 = **368 kg/m^2**	184 / 2.442 = **75 lb/sq ft**

For the standard plate compactor used in this example the 'static weight per unit area' or static pressure is;	**368** kg/m^2	**75** lb/sq ft
A ***Dual Force*** plate has a smaller dimension (b) 0.094 m, 0.31 ft so the static pressure increases by over 5 times	**1965** kg/m^2	**402** lb/sq ft

With this knowledge you can assess and compare any piece of vibratory compaction equipment for yourself.

* engineers would normally express pressure using N/m^2 and lbf/sq inch

ALTERNATIVES

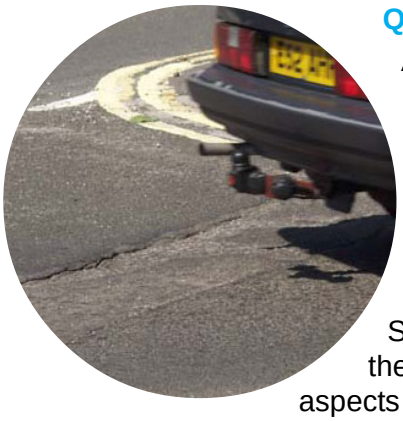
Common compaction equipment compared to a Belle Group ***Dual Force*** PC 400

Compaction Equipment	 Dual Force Plate	 Standard Plate	 Rammer	 Reversible Plate	 Single Drum Roller	 Double Drum Roller
Static pressure	**1808 kg/m² 370 lb/sqft**	405 kg/m² 83 lb/sqft	662 kg/m² 135 lb/sqft	1400 kg/m² 286 lb/sqft	601 kg/m 403 lb/ft	631 kg/m 423 lb/ft
Weight	**81 kg 178 lb**	79 kg 174 lb	55 kg 121 lb	224 kg 493 lb	427 kg 939 lb	960 kg 2112 lb
List Price	**£1068 100%**	£918 86%	£1390 130%	£3300 308%	£8000 749%	£11000 1029%
	To compact 100mm - 4”of asphalt					
Total Nº. of passes	**8**	30	12	18	30	14
Number of layers	**1**	3	2	3	3	2
	To compact 300mm - 12”of mixed stone					
Total Nº. of passes	**7**	18	12	10	18	12
Number of layers	**1**	3	2	2	3	2
Handling requirement	**Manual possible**	Manual possible	Manual possible	Hoist Crane	Hoist Crane	Hoist Crane
Transport requirement	**Car**	Car	Car	Pick Up Truck	Truck & Trailer	Heavy Truck Trailer

- TEN *Dual Force* plates for the price of one double drum roller
- Hirers - more hires for the same investment
- Contractors - every road gang can have one
- Up to 3 times deeper material layers - speeds up the job
- Up to 3 times fewer compaction passes - faster working
- No difficulties handling, transporting or storage

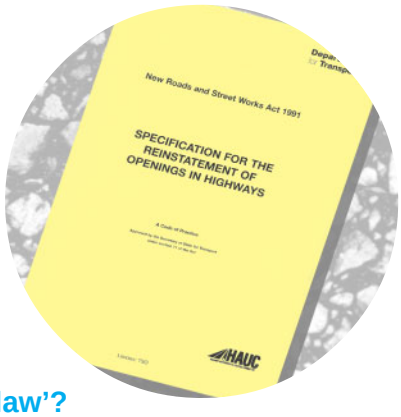
Dual Force stands out as the exceptionally economical alternative.

THE HIGHEST SPECIFICATION



Q. Why did Belle make the innovative leap to *Dual Force*?

A . "Necessity is the mother of all invention" The UK Government introduced legislation to improve the standard of road repairs. This barred the use of all ineffective plate compactors on public highways.



Q. What is the UK legislation?

A. The New Roads and Streetworks Act 1993 (NRSWA) was the result of a long study in to all aspects of Highways work. One section in particular details the methods, materials and machinery that should be used for highway reinstatements.

Q. Who knows enough about highway work to 'lay down the law'?

A. A team of representatives from Local and National Government and Utility companies from across the UK was formed to write the specifications. Working together as the Highway Authorities and Utilities Committee (HAUC) the details are practicle and realistic.

Q. Has the legislation been effective?

A. Yes, but it has been a slow process. Old working practices have taken some time to change.

The cost of re-doing substandard work and heavy fines for non-compliance have lead utility companies 'by the financial nose' to follow the specification.

Q. What difference has the legislation made?

A. The Transport Research Laboratory was commissioned by the Department of Environment, Roads and Regions to monitor the quality of streetworks. After 3 years 51% of repairs where deemed to be very good or good. When the specifications where first introduced the figure was as little as 5%. This indicates a vast improvement, although there is still a lot more contractors can do to improve the situation.

The uptake of *Dual Force* vibrating plates has helped many contractors comply with the compaction requirements. As old, ineffective equipment is phased out the percentage of good and very good reinstatements will increase further.

Q. What are the requirements for compaction and the equipment used?

A. The compaction specification was devised after very thorough research and testing to arrive at a specification that would produce consistently good results.

Compaction Plant			Vibrating Plate		Vibrotamper (rammer)	Single Drum Vibrating Roller		Double Drum Vibrating Roller	
Weight Category			1400kg/m² 286lb/sqft	1800kg/m² 329lb/sqft	50kg 110lb	600kg/m 401lb/ft	1000kg/m 669kg/m	600kg/m 401lb/ft	1000kg/m 669lb/ft
Bitumious mixture *(asphalt)*			Number of compaction passes required **(X=not permitted)**						
Layer Depth	40mm	1 ½"	**6**	**3**	5	10	5	5	4
	60mm	2 ¼"	**X**	**5**	7	12	7	7	5
	80mm	3 ¼"	**X**	**6**	**X**	**X**	8	**X**	6
	100mm	4"	**X**	**8**	**X**	**X**	**X**	**X**	8
Granular *(mixed stone)*									
Layer Depth	100mm	4"	**5**	**3**	4	**X**	6	3	3
	150mm	5"	**X**	**5**	8	**X**	**X**	6	5
	200mm	8"	**X**	**7**	**X**	**X**	**X**	**X**	7

Table detailing, equipment and number of compaction passes for different layer thickness.

Q. Is the specification still up to date with advances in materials and equipment technology?

A. The regional and national HAUC committees constantly review the situation and can offer new guidelines. A major revision in 2002 proposed that rollers in the 600 to 1000kg/m category should not be permitted. This was after years of evidence that reinstatements with this equipment continued to fail. It is thought that as so many passes need to be made, the hot asphalt material has cooled and solidified before full compaction can be achieved.

Q. The small single drum rollers are widely used, doesn't a ban cause serious problems?

A. The use of this equipment was so widespread that reprieve was granted for one year. Giving manufacturers a chance to improve the equipment or how it is used.

Q. Can *Dual Force* plate compactors be used instead of rollers?

A. In most circumstances, yes. Many contractors already use *Dual Force* machines for all but the largest reinstatement work. They can be used on backfill fill materials, the cost is lower and results are better.

Q. Hand-Arm Vibration Syndrome (HAVS) is a big issue with plate compactors, Does *Dual Force* have any effect on this?

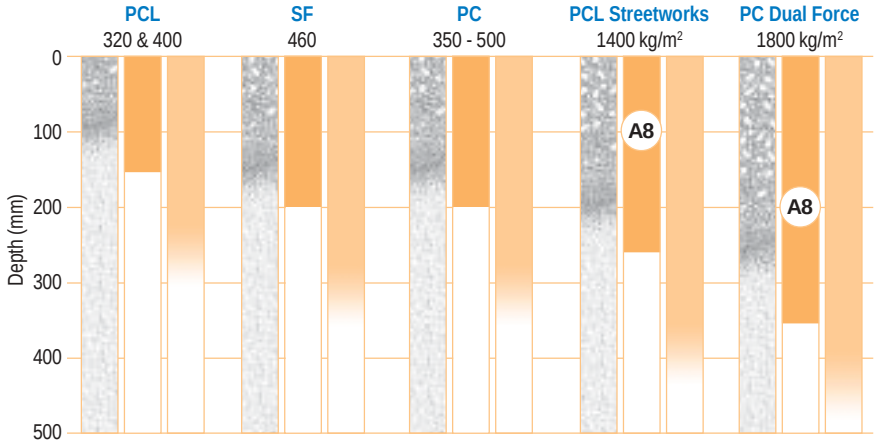
A. Plates with Dual Force actually reduce operator exposure to harmful vibration. Rollers can be notoriously bad. The performance of Dual Force means jobs get finished quicker. The PC range of plate compactors from Belle Group are world leading low hand-arm vibration compaction machines.

Q. It sounds like *Dual Force* could be right for my organisation. How can I convince the rest of my team?

A. Call the Belle Group office and they will help arrange all the information, demonstrations and presentations you need.

You can choose the Highest Compaction for your profits...

Model	Static Pressure		Plate Width		Fuel	Weight	
	Kg/m2	lb/sqft	mm	inch		kg	lb
PCL StreetWorks	1460	299	320	12 ½	Petrol - Gasoline	47	103
PC 350	2016	413	350	14	Petrol - Gasoline	79	174
PC 400	1808	370	400	16	Petrol - Gasoline	81	178
PC 400	2087	427	400	16	Diesel	94	207
PC 450	1965	402	450	18	Petrol - Gasoline	83	183
PC 450	2062	422	450	18	Diesel	96	211
PC 500	1812	371	500	19 ½	Petrol - Gasoline	85	187
PC 500	1895	388	500	19 ½	Diesel	98	216
Revolutionary lightweight DIY plate compactor, made possible with *Dual Force*							
MPC 300	556	114	300	12	Petrol - Gasoline	37.5	82.5



Compaction Comparison
with non Dual Force compactors in the Belle range

- Sub base / Gravel
- Sand
- Max. Layer Depth
- Max. Compaction Depth
- A8 Layer (lift) depth for U.K. Streetworks (NRSWA) HAUC Specification Appendix A8

This information is given as a comparative guide. Compaction is dependent on the specific material and surrounding ground conditions.