Manual
Durometer
PCE-HT-225A

CONTENTS

1. General Description

1.1. Applications

With the merits of simple structure, easy correction, maintenance and repair, and portability, the Concrete Test Hammer is widely used in civil engineering and construction industry for testing the strength of concrete. Compared to other nondestructive testers, the Concrete Test Hammer is an economical and practical nondestructive testing instrument.

HT-225A is a medium Concrete Test Hammer, its kinetic energy of impact is 2. 207J(0.225kgfm). It is extensively used for testing the strength of various concrete members (slab, beam, and column) of normal building strength and bridge.

1.2. Basic principle

When testing the strength of concrete, Concrete Hammer uses a certain elastic force to transit the impact force of an impact hammer to the surface of concrete, its initial kinetic energy redistributes, a part of energy in the form of plastic deformation or residual deformation is absorbed by the concrete, and another part of energy which is proportional to the surface hardness is transmitted to the impact hammer, making the hammer rebound to a certain height, then the strength of the concrete is derived from the proportional relation between the height of resilience and the concrete strength.

1.3. Structure of Concrete Test Hammer

The Concrete Test Hammer is mainly composed of flip system, value-indicating system and shell component. Its structure is shown in Fig. 1. The diagram shows the state that the impact hammer has finished impact in the test and the pushbutton has locked the movement. ie. retaining state of resilience value.
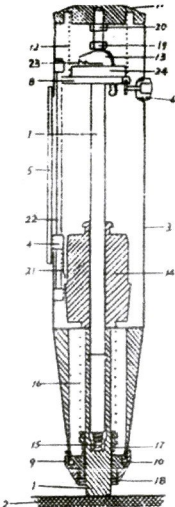
1. Flip rod
2. Test surface
3. Shell
4. Pointer block
5. Dividing rule
6. Pushbutton
7. Center guide rod
8. Guide flange
9. Cap
10. Clasp
11. Tail hood
12. Pressure spring
13. Hanger
14. Impact hammer
15. Buffer pressure spring
16. Flip tension spring
17. Tension spring seat
18. Felt ring
19. Bolt
20. Nut
21. Pointer piece
22. Pointer shaft
23. Hanger
24. Hanger dowel

Fig(1) Structure of Concrete Hammer

1.4. Main technical specifications

The main performance indicators of HT-225A Concrete Test Hammer are as follows:

1) Nominal kinetic energy: 2.207J(0.225kgfm)
2) Mean value of steel-anvil ratings of Concrete Test Hammer: 80±2
3) Overall dimension: ⌀66×280mm
4) Weight: 1kg
5) Test thickness: ＜70cm

2. Operating and Testing Methods of Concrete Test Hammer

2.1. Operating method of Concrete Test Hammer

To use and operate the correctly can give better play to its efficiency and improve the accuracy of test. Therefore, the operating personnel of the instrument must carry out operation according to the stipulated operating rules and requirement. In the whole process of the instrument, it is necessary to pay attention to the correct gesture of holding the instrument. The correct gesture of holding the instrument is that one hand holds the middle portion of the instrument, and which also plays the function of straightening up in the whole process; another hand holds and presses the tail end of the instrument, and which is mainly for exerting pressure on the instrument while also playing the auxiliary function of straightening up.

The basic points of the operation of the Concrete Test Hammer are that the force used must be even and slow, the Concrete Test Hammer should be straightened up to vertically aiming at the test surface, and should not be swayed.

The operating procedures of the Concrete Test Hammer are as follows:

2.1.1. Make the flip rod 1 of the Concrete Test Hammer press against the surface of concrete, lightly press the tail hone 11 to make push button 6 release guide flange 8, under the action of pressure spring 12,the guide flange brings along the pointer block to move downward to ‘0’ position; at that time, hanger 13 links with the tail of impact hammer, the flip rod extends out from the shell of instrument, then test can be carried out. During this process of operation, when the pushbutton releases the guide flange, the operator's two hands should raise the Concrete Test Hammer to leave the test surface of concrete which it originally pressed against, the speed of raising should be quick so as to make it easier for the hanger to link with the impact hammer.

2.1.2. Maker the extended flip rod aiming at the test point of the test surface of the test specimen of concrete and keep the center axis of the Concrete Test Hammer to be perpendicular to the test surface: then use one hand to hold the instrument shell 3, and other hand to slowly and evenly hold and press the tail hood 11, at that time flip tension spring 16 is stretched, she flip rod is pressed into the instrument shell, I. e. the impact hammer 14 obtains the energy from the flip tension spring.
When being pushed and pressed to a certain position, the back of hanger 13 touches the bolt 19 on the tail hood, at that time flip tension spring should be stretched by 75mm, the impact hammer 14 has obtained an energy of 2. 207J specified by the design of the instrument, and is at position ready to be set off at a touch.
During this process of operation, care must be taken not to use too much strength to

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result in an impact, and the center axis of the instrument should always be kept perpendicular to the test surface without sway.

2.1.3. The impact hammer will be disconnected with the hanger when continuing to exert pressure on the tail hood. Owing to the action of the flip tension spring 16, the impact hammer rapidly impacts along the center guide rod 7 toward the flip rod 1, the kinetic energy is transmitted to the concrete test specimen through the flip rod.
During this process of operation, the impact hammer collides with the flip rod many times, therefore the operator must hold the Concrete Hammer firmly swaying, and make the axis of the instrument keeping perpendicular to the test surface.

2.1.4. After resiling, the impact hammer brings the pointer block 4 to a certain position, then the operator should continue holding and pressing the Concrete Hammer to keep the flip rod against the test surface, and read from the dividing ruler the value N corresponding to the dividing line on the pointer block 4. If the light is dim or it is inconvenient to read, the operator can, after finishing flip, press down the pushbutton 6 to lock the guide flange, making the pointer block 4 keep in position, then take the instrument to a place where it is convenient to observe, so as to read the value N and make a record.
The above-mentioned is the whole process of one flip test and the operator can obtain a resilience value, and by repeating this process the required resilience value of the test point can be obtained.

2.2. Testing method of Concrete Hammer

To strictly execute the technical rules of Concrete Hammer and skillfully master the testing technology of the Concrete Hammer, the basic performance and operating method of the instrument are the prerequisites for smoothly carrying on the test of strength by the resilience method.

As for the provinces and cities that have established regional resilience curves and the regional technical rules of resilience method, they can also adopt regional curves or execute regional rules. Those provinces and cities that have not established resilience curves or rules should the Technical Rules for the Evaluation of Compression Resistance of Concrete by Using JGJ123-85 resilience method .

2.2.1 Preparatory process of test

1) Selection of test zone
In accordance with the requirement of technical rules of resilience methods, the test zone should be selected on the representative member according to the quality condition of the member.

A. The test zone should be selected on the lateral face of concreting (the side of laid — on shutter board that is perpendicular to the concreting direction). If it is impossible to meet this requirement, it can be selected on the concreting surface or bottom.

B. The test zone should be selected on the surface of the exposed part of the member where it is easy to measure the resilience value and the carburized depth.

C. The test zone should be selected on the two basically symmetrical test surfaces (hereinafter referred to as test surface) on two relative surfaces of the member. If it is impossible to meet this requirement, it is allowed to have only one test surface.

D. The surface of test zone should be clean, flat and dry, and must not have joint, finishing coat, rendering coat, laitance, oil stain, and voids and pits, the grinding wheel provided

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with the machine can be used to clean the surface impurity substances and polish the rough places if necessary, and the surface should not have any residual powder or debris.

2) The number of test zones on every test member should be no less than 10, and they should be evenly distributed on the test surface, and should bypass the reinforcing bar and embedded iron parts within the concrete or set up nearby.

3) The spacing between two adjoining test zones should not be greater than 2m.

4) It is desirable that the size of test zone can hold 16 resilience test points, usually is about 400cm2.

5) Test points should be evenly distributed within the scope of test zone, the spacing between two adjoining test points should not be less than 3cm, the distance between the test point and the edge of member or exposed reinforcing bar and iron parts should not be less than 5cm. Test points should bypass reinforcing bar, air hole and exposed stone.

2.2.2. Rules for resilience test

1) According to the standard condition of Concrete hammer, test the instrument and it should measure up to the standard.

2) According to the technical rules of resilience method, select and arrange test zones, test surfaces and test points and they should have clear numbering marks.

3) All the small—sized and low—rigidity members or those with the test location less than 10cm thick, should be provided with support to fix it securely, then test can be carried out.

4) If the test surface layer of the concrete has been wetted for a short term, test should not be carried out until the surface layer is dried by air.

5) Steam - cured concrete should not be tested until that the member has undergone a natural curing for 14 days after being taken out from the curing pit.

6) The reading accuracy of the resilience value should be up to 1 in the test, and the measured resilience value should be noted on the test record sheet.

7) Each test point can be tested only once, no repeated resilience and tests on the same point are allowed.

8) The two relative test surfaces of each test zone should be tested on 8 points each, and 16 points in total. If tests can only be carried out on one test surface, then test on 16 points should be carried out on that surface. (The test surface can be expanded appropriately if permitted.)

9) To the non horizontally tested surface, the included angle between the center axis of Concrete test Hammer and the horizontal line should be determined, and the "+" or "—" angle value and the corresponding resilience value should be noted. The positive and negative included angles are shown Fig. 2.

10) When tests are carried out on concreting surface, the measured resilience values should be noted with "bottom", "top" or "lateral face ".

11) Whether the test surface is carbunized or not should be timely judged, and should be noted for the measured resilience value.

12) The dry and wet degree of the test surface should be judged and should be noted with dry surface or wet surface and their respective resilience values.

13) If the surface layer and the interior of test location of the concrete are not of the same quality and show obvious difference, or there are serious defects in concrete, they are not suitable for resilience tests.

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14) Concrete that has suffered chemical corrosion, fire, cold injury during hardening period, high — temperature or humid environment for a long period of time or has been impregnated with water is not suitable for resilience tests.
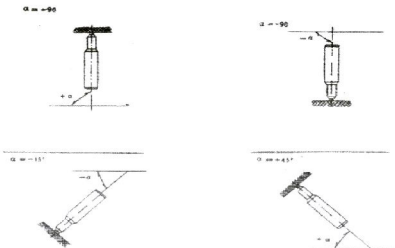
Fig (2)

Fig. 2 Diagram of test angle α

15) When the ambient temperature is lower then 5℃ or higher than 35℃, it is not suitable to carry out resilience tests.
16) If the radius of curvature of the test location is small than 23cm, it is not suitable to carry out resilience tests.

2.2.3. Determination of carburized depth

Carburization is the main factor of affecting the test of concrete strength by resilience method, therefore it is necessary to carry out the measurement of carburized depth immediately after the resilience tests, and the measurement result should be taken as the basis of the determination of concrete strength. The measuring method is as follows:
1) Use a proper tool to make a hole of 15mm diameter in the location. the hole depth is slightly greater than the carburized depth of the concrete.
2) Clean away powder and debris in the hole, but it is forbidden to wash by liquid.
3) After the cleaning, immediately drip 1% alcoholic phenothalin solution on the hole wall. The un-carburized concrete will change color to a purplish red while the carburized concrete will not change color.

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4) Use steel ruler to measure once or twice the vertical distance from the test surface to the place on the hole wall where color is unchanged, the accuracy is to 0.5 mm. That distance is the very carburized depth of that test zone.

5) For determination of the value of carburized depth, it is necessary to select one test point for one test zone. If the concrete qualities or resilience values of two adjoining test zones are basically similar, then the value of the adjoining carburized depth can be used as representative.

3. Processing of test data

3.1. Calculation of resilience value

When the Concrete Test Hammer is used to test the lateral face of concreting in horizontal direction, the three greatest values and three smallest values in the 16 resilience values should be rejected, take the remaining 10 resilience values and calculate the mean resilience value of the test zone by the following formula:

$$(1) \qquad N = \frac{\sum\limits_{i=1}^{10} N_i}{10}$$

Where, N —— mean resilience value of the test zone, the calculated value keeps valid up to one digit after decimal point.

Ni —— resilience value of the i test points.

When the Concrete Hammer is used to test the lateral face of concreting in non horizontal direction, the measured data should data should be used first to calculate the mean resilience value Nα of the test zone by formula (1) according to the angle α between the axis of Concrete Hammer and the horizontal direction, then convert it by the following formula into the mean resilience value of the test zone tested in horizontal direction.

$$(2) \qquad N = N_\alpha + \triangle N_\alpha$$

Where, N —— mean resilience value of the test zone tested when the Concrete Hammer and the horizontal direction are in an α angle, the calculated value keeps valid up to one digit after decimal point.

Nα —— the correction values of resilience values of different test angles consulted from Table 1, the value keeps valid up to one digit after decimal point.

The correction values △Nα of resilience tested in non horizontal state.

Correction values △Nα of resilience values at different test angles α   Tab. 1

△Nα	test angles α							
	-90°	-60°	+60°	+45°	+30°	-30°	45°	60°
20	-6.0	-5.0	-4.0	-3.0	+2.5	+3.0	+3.5	+4.5
30	-5.0	-4.0	-3.5	-2.5	+2.0	+2.5	+3.0	+3.5
40	-4.0	-3.5	-3.0	-2.0	+1.5	+2.0	+2.5	+3.0
50	5.0	3.0	-2.0	-1.5	+1.0	+1.5	+2.0	+2.5

Note: The △Nα correction values corresponding to No that have not been listed in

the table can be obtained by using interpolation, with an accuracy to one digit after point. When the Concrete Hammer is used to test the concreting surface or bottom in non horizontal direction, they should be converted into the mean resilience value of the test zone of the lateral face of concreting respectively according to the following formula.

$$Nstse = \triangle Ns \qquad (3)$$

Where, Ns —— the mean resilience value of the test zone of the concreting surface or bottom, the calculated value keeps valid up to one digit after decimal point.

$\triangle Ns$ —— correction value of concreting surface or bottom, consulted from the table, keeping valid up to one digit after decimal point.

Correction values of resilience values of different concreting surfaces. (See Tab. 2)

Correction values $\triangle Ns$ of resilience values of different test surfaces Tab. 2

Ns	$\triangle Ns$	
	surface	bottom
20	+2. 5	3. 0
25	+2. 0	— 2. 5
30	+1. 5	-2. 0
35	+1. 0	1. 5
40	+0. 5	—1. 0
45	0	— 0. 5
50	0	0

Note:

(1) The $\triangle Ns$ correction values corresponding to Ns that have not been listed in the table can be obtained by using interpolation, with an accuracy to one digit after point.

(2) In the table, the correction values related to the concreting surface refer to the correction values after ordinary mortar rendering.

(3) In the table, the correction values related to the concreting bottom refer to the correction values under normal concreting condition when the surface and bottom of a structure or a member adopt same kind of shuttering.

(4) In the test, if neither the Concrete Hammer is in horizontal direction nor the test zone is the lateral face of concreting, an angle correction for the resilience value should be carried out first, then the revise of concreting surface is carried out.

3.2. Calculation of carburized depth

The mean value of carburized depth of each test zone should be calculated according to the following formula:

$$L = \frac{\sum\limits_{i=1}^{n} L i}{n} \qquad (4)$$

Where, L —— the mean value of carburized depth (mm) of the test zone, the calculated value keeps valid up to one digit after decimal point.

Li —— The value of carburized depth(mm) measured at i time;

n —— Times of measurement of carburized depth of test zone.

If the mean value of carburized depth L calculated according to formula (4) is smaller than or equal to 0. 4 mm, then it should be treated as un-carburized, i. e. $Li \geqslant 6mm$, then it should be calculated according to a mean value of carburized depth L=6mm.

3.3. Evaluation of concrete strength

The determination of concrete strength can be divided into individual evaluation and sampling evaluation. The usual sequence is as follows: first set the strength of test zone, then the strength of test specimen, and then the strength of member and the strength of the whole structure. On general condition, individual members are used as the basic units for evaluating the strength of concrete. On the basis of evaluating the strength of the sampled members respectively, the strength evaluation for whole structure can be carried out.

Determination of the strength Rni of test zone

On the basis of the mean resilience value N of each test zone (after calculation and correction, keep valid up to one digit after decimal point) and the mean carbonized depth L, find out the strength value Rni of the corresponding test zone by referring to the data listed in the conversion table. The conversion table is seen in Appendix 2.

Determination of the strength Rn of test specimens

The mean strength value Rn of the concrete specimens should be calculated according to the following formula:

$$R_n = \frac{\sum R_{ni}}{n}$$

(5)

Where: R_n —— the mean strength value of the concrete speciment (MPa), keeping valid up to one digit after decimal point.

n —— for the structure or member evaluated individually, take the number of test zone of a test speciment; for structure or member evaluated by sampling, take the sum of the numbers of the test zones of the sampled specimens.

The strength values of the concrete specimens under the first condition and under the second condition can be calculated according to the following formulas:

$$R_{n1} = 1.8(R_n - KS_n)$$

(6)

$$R_{n2} = 1.8(R_n) \min$$

(7)

Where: $Rn1$ —— the strength value of the concrete specimen under first condition (MPa), accuracy keeping valid to one digit after decimal point.

$Rn2$ —— the strength value of the concrete specimen under second condition (MPa), accuracy keeping valid to one digit after decimal point.

Sn —— the strength standard difference of the concrete specimens (MPa), calculated on formula (8), accuracy keeping valid to two digits after decimal point.

$$S_n = \sqrt{\frac{\sum_{i=1}^{n}(R_{ni})^2 - n(R_{ni})^2}{n-1}}$$

(8)

$(Rni) \min$ —For the structure or member evaluated individually, take the lowest concrete strength value (MPa) in a test specimen of the test zone; for the structure or member evaluated by sampling, take the lowest concrete strength value (MPa) in every sampled specimen of the test zone.

K: The acceptance coefficient values should be taken from Table 3;

n —For the structure or member evaluated individually, take the number of the test zones of a test specimen; for the structure or member evaluated by sampling, take the sum of

1.4. Main technical specifications

The main performance indicators of HT-225A Concrete Test Hammer are as follows:

1) Nominal kinetic energy: 2.207J(0.225kgfm)
2) Mean value of steel-anvil ratings of Concrete Test Hammer: 80 ± 2
3) Overall dimension: ф66×280mm
4) Weight: 1kg
5) Test thickness: <70cm

2. Operating and Testing Methods of Concrete Test Hammer

2.1. Operating method of Concrete Test Hammer

To use and operate the correctly can give better play to its efficiency and improve the accuracy of test. Therefore, the operating personnel of the instrument must carry out operation according to the stipulated operating rules and requirement. In the whole process of the instrument, it is necessary to pay attention to the correct gesture of holding the instrument. The correct gesture of holding the instrument is that one hand holds the middle portion of the instrument, and which also plays the function of straightening up in the whole process: another hand holds and presses the tail hood of the instrument, and which is mainly for exerting pressure on the instrument while also playing the auxiliary function of straightening up.

The basic points of the operation of the Concrete Test Hammer are that the force used must be even and slow, the Concrete Test Hammer should be straightened up to vertically aiming at the test surface, and should not be swayed.

The operating procedures of the Concrete Test Hammer are as follows:

2.1.1. Make the flip rod 1 of the Concrete Test Hammer press against the surface of concrete, lightly press the tail hood 11 to make push-button 6 release guide flange 8, under the action of pressure spring 12,the guide flange brings along the pointer block to move downward to "0" position. at that time, hanger 13 links with the tail of impact hammer, the flip rod extends out from the shell of instrument, then test can be carried out. During this process of operation, when the pushbutton releases the guide flange, the operator's two hands should raise the Concrete Test Hammer to leave the test surface of concrete which it originally pressed against, the speed of raising should be quick so as to make it easier for the hammer to link with the impact hammer.

2.1.2. Maker the extended flip rod aiming at the test point of the test surface of the test specimen of concrete and keep the center axis of the Concrete Test Hammer to be perpendicular to the test surface: then use one hand to hold the instrument shell 3, and other hand to slowly and evenly hold and press the tail hood 11, at that time flip tension spring 16 is stretched, the flip rod is pressed into the instrument shell, i. e. the impact hammer 14 obtains the energy from the flip tension spring.

When being pushed and pressed to a certain position, the back of hanger 13 touches the bolt 19 on the tail hood, at that time flip tension spring should be stretched by 75mm, the impact hammer 14 has obtained an energy of 2，207J specified by the design of the instrument, and is at position ready to be set off at a touch.

During this process of operation, care must be taken not to use too much strength to

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Appendix 1 - Common faults of the Concrete Test Hammer and the analysis on their causes

No.	State of faults	Analysis on causes
1	When concrete hammer flips in test, the pointer block stays at the starting position and will not move.	The field angle of the pointer piece on pointer block relative to pointer shaft is too small. The pointer piece is fractured.
2	In the process of flipping, pointer block sways and rises step by step.	The field angle of pointer piece on pointer block is somewhat small. The fitting between pointer block and pointer shaft is too loose. Pointer block touches and rubs with dividing ruler locally or the local friction between pointer block and the groove of machine shell is too great.
3	Pointer block is carried up before flipping, making reading impossible.	The field angle of pointer piece on pointer block is too large.
4	Impact hammer strikes too early.	1. The hook end of hanger has become a small obtuse angle. 2. The tail end of impact hammer is locally broken.
5	Incapable of flipping.	1. Hanger spring has dropped. 2. The hook end of hanger is fractured or has become an obtuse angle owing to frictions. 3. The flipping tension spring has been fractured.
6	The flipping rod cannot extend out, thus being useless.	Push button will not act.
7	The flipping rod is easy dropping.	The fitting between the end of center guide rod and the inner hole of flipping rod is not tight.
8	The rated value of the instrument in normal state is on the low side	1. There are dirts on the impact plane of impact hammer and flipping rod. 2. There are dirts between impact hammer and center guide rod, so the friction has augmented. 3. The contact of impact faces between impact hammer and flipping rod is uneven. 4. Partial claw at the end of center guide rod is fractured. 5. The movement is damaged.

Appendix 2 - Conversion table of concrete strength value of test zone

Rebound value	MPa								
	Impact direction				Horizontal	Impact direction			
	90°	60°	45°	30°	0°	-30°	-45°	-60°	-90°
20	10.3	10.3	10.3	10.3	10.3	13.1	13.7	14.3	14.9
21	10.3	10.3	10.3	10.3	11.4	14.3	14.9	15.5	16.2
22	10.3	10.3	10.3	10.3	12.5	15.4	16.0	16.7	17.4
23	10.3	10.3	10.3	10.4	13.7	16.7	17.4	18.0	18.8
24	10.3	10.3	10.3	11.6	14.9	17.9	18.6	19.3	20.0
25	10.3	10.8	11.6	12.7	16.2	19.2	20.0	20.8	21.5
26	11.0	12.0	12.8	14.0	17.5	20.6	21.4	22.1	22.8
27	11.5	13.3	14.0	15.3	18.9	22.1	22.8	23.6	24.5
28	13.4	14.6	15.4	16.7	20.3	23.5	24.3	25.0	25.9
29	14.8	16.0	16.7	18.0	21.8	25.0	25.9	26.7	27.6
30	16.2	17.5	18.2	19.6	23.3	26.5	27.4	28.2	29.1
31	17.6	18.9	19.6	21.0	24.9	28.2	29.1	30.0	30.9
32	19.1	20.8	21.2	22.7	26.5	29.8	30.7	31.6	32.5
33	20.8	22.0	22.7	24.3	28.2	31.6	32.5	33.5	34.4
34	22.4	23.6	24.5	26.0	30.0	33.3	34.2	35.2	36.1
35	24.1	25.7	26.0	27.8	31.8	35.2	36.1	37.1	38.2
36	25.9	27.1	27.9	29.6	33.6	36.9	37.9	38.9	39.9
37	27.8	28.8	29.6	31.4	35.5	38.9	39.9	41.0	42.0
38	29.6	30.7	31.6	43.5	37.5	40.7	41.8	42.8	43.9
39	31.6	32.5	33.5	35.4	39.5	42.8	43.9	45.0	46.1
40	33.6	34.6	35.5	37.5	41.6	44.8	45.9	47.0	48.1
41	35.5	36.5	37.5	39.5	43.7	47.0	48.1	49.2	50.4
42	37.7	38.7	39.7	41.8	45.9	49.0	50.2	51.3	52.5
43	39.7	40.7	41.8	43.9	48.1	51.3	52.5	53.6	54.8
44	42.0	43.0	44.1	46.3	50.4	53.4	54.6	55.8	57.0
45	44.1	45.2	46.3	48.5	52.7	55.8	57.0	58.2	59.5
46	46.5	47.6	48.7	51.0	55.0	58.0	59.2	60.0	
47	48.7	49.9	51.0	53.4	57.5				
48	51.3	52.5	53.6	56.0	60.0				
49	53.6	54.8	56.0	58.5					
50	56.8	57.5	58.8	60.0					

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Appendix 3 - Conversion table of rebound value to psi

Rebound Value	90 degrees (kg/cm2)	90 degrees (psi)
20	125	1778
21	135	1920
22	145	2062
23	160	2276
24	170	2418
25	180	2560
26	198	2816
27	210	2987
28	220	3129
29	238	3385
30	250	3556
31	260	3698
32	280	3983
33	290	4125
34	310	4409
35	320	4552
36	340	4836
37	350	4978
38	370	5263
39	380	5405
40	400	5689
41	410	5832
42	425	6045
43	440	6258
44	460	6543
45	470	6685
46	490	6969
47	500	7112
48	520	7396
49	540	7681
50	550	7823
51	570	8107
52	580	8250
53	600	8534
Rebound Value	90 degree (a)	Pounds per sq. In.