Operating Instructions

Original SCHMIDT

PROCEQ SA ZURICH SWITZERLAND

Concrete Test Hammer

Types L and LR

ISO 9001

proceq

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Represented By:
KALAMAZOO PAPER CHEMICALS
8782 Gull Road
Richland, MI 49083
616-629-9759

I. General Information

There are different types of test hammers:

Type N impact energy = 2.207 N · m (0.225 kgm) is intended for testing concrete in ordinary building and bridge constructions.

Type NR impact energy = 2.207 N · m (0.225 kgm) corresponds substantially to type N, but it is equipped with a special recording device.

Type L impact energy = 0.735 N · m (0.075 kgm) is a smaller version of type N. It is suitable for testing small and impact-sensitive parts of concrete or artificial stone.

Type LR impact energy = 0.735 N · m (0.075 kgm) corresponds substantially to type L, but is equipped with a special recording device.

Type LB impact energy = 0.735 N · m (0.075 kgm) is particularly suitable for the continuous control of the quality of burnt clay material and tile products.

Type M impact energy = 29.43 N · m (3 kgm) is especially suitable for determining the strength of mass concrete and for testing the quality of concrete road pavements and airfield runways.

Type P pendulum-type hammer, impact energy = 0.883 N · m (0.09 kgm) is intended for testing materials of low hardness and strength such as lightweight building materials of every description, plasterwork and surfacings. With concrete of low strength (cube compressive strength 5 to 25 N/mm^2 (700 to 3500 psi) type P gives better results than the types N and L.

Type PT impact energy = 0.883 N · m (0.09 kgm) with a larger hammer head surface has been developed for testing of building materials with extremely low compressive strength (cube compressive strength of 0.5 to 5 N/mm^2 (70 to 700 psi).

Fig. 1 **The Concrete Test Hammer Type L during Calibration Tests** carried out in the Swiss Federal Institute for Testing Materials in Zurich, Switzerland

II. Operating Instructions for the Concrete Test Hammer (Fig. 2)

1. By lightly pressing on the head of the impact plunger (1) the plunger is released and will slide out of the housing (3) by itself.
2. The plunger (1) is pressed against the spot of the concrete surface (2) to be tested. Just before it disappears completely in the housing (3) the hammer is released. Release must be effected by **slowly** increasing the pressure on the housing. At the moment of impact the hammer must be held exactly at right angle to the surface (2). Do not touch the push-button (6)!
3. After the impact the hammer mass (14) rebounds by a certain amount which is indicated on the scale (19) by the rider (4). The reading of the rider position gives the rebound value in percent of the forward movement of the hammer mass.
4. By simply removing the hammer from the spot tested, it is reset for a further test and at the same time the indication is cancelled. The rider never returns quite to zero. In its extended position the plunger (1) is slightly out of the longitudinal axis of the hammer.
5. After having finished the tests, the plunger (1) together with its guide bar (7) and guide disk (8) is locked in its rear position by means of the push-button (6). Locking should always be effected after releasing the impact, i.e. with untensioned impact spring (16). The lock also serves for fixing the rebound reading after impact tests in dark or not easily accessible locations.
6. The test hammer is calibrated for horizontal impact direction, i.e. for testing vertical surfaces. When using it on inclined or horizontal surfaces, the rebound value R_α must be corrected as per table I.

Table I **Correction of the Test Hammer Indications for Non-horizontal Impacts**

Rebound value R_α	Correction for inclination angle α upwards		downwards	
	+ 90°	+ 45°	— 45°	— 90°
10			+ 2.4	+ 3.2
20	— 5.4	— 3.5	+ 2.5	+ 3.4
30	— 4.7	— 3.1	+ 2.3	+ 3.1
40	— 3.9	— 2.6	+ 2.0	+ 2.7
50	— 3.1	— 2.1	+ 1.6	+ 2.2
60	— 2.3	— 1.6	+ 1.3	+ 1.7

1 Impact plunger
3 Housing compl.
4 Rider with guide rod
6 Pushbutton compl.
7 Hammer guide bar
8 Disk
9 Cap
10 Two-part ring
11 Rear cover
12 Compression spring
13 Pawl
14 Hammer mass
15 Retaining spring
16 Impact spring
17 Guide sleeve
18 Felt washer
19 Plexiglass window scale printed on window
20 Trip screw
21 Lock nut
22 Pin
23 Pawl spring

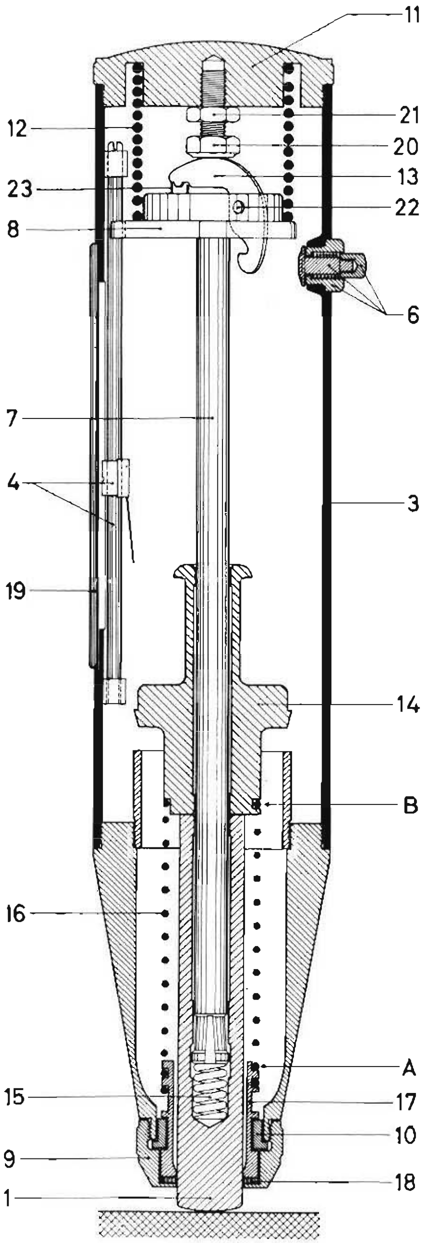


Fig. 2
Longitudinal Section of the Type L Concrete Test Hammer

Condition on impact

When ordering spare parts, please state No. of part and serial No. of test hammer!

III. Determination of the Strength of Concrete and Reinforced Concrete

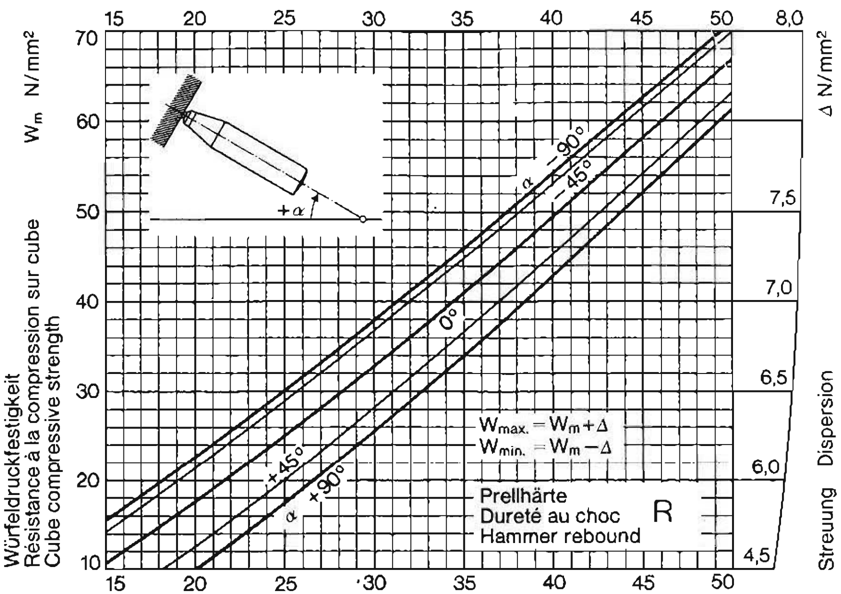
1. Selecting the points to be tested: Above all, surfaces which were encased in a form are to be favoured. For testing the specimen must be clamped rigidly. It is best to test on vertical surfaces.
2. Preparing points to be tested: Before testing, any plasterwork or coating must be removed. Slightly uneven surfaces caused by unplaned wooden forms can be smoothed by hand with the carborundum stone supplied with the hammer.

   The top surface of the concrete is only suitable for hammer tests if the always present cement slurry is previously removed. To be sure of achieving this, the concrete must as a rule be ground off until its normal texture is exposed.

   With old concrete the excessively hard surface layer must be removed to a depth of approx. ½ in. For this work a light-weight high-speed hand grinder (output approx. 750 Watts, speed approx. 6000 r.p.m.) with a cup wheel of 5 in. dia. will, as experience shows, be sufficient. The ground surface must be at least as large as to permit 5 to 10 test hammer impacts to be made on the mortar without hitting coarse aggregate particles. As a rule an area of about 4 by 4 in. will suffice.
3. Carrying out impact test at 5, or better 10, points of the prepared area. Take the mean value **R** of the 5 to 10 hammer readings. In taking the mean, **all** the individual readings of the test hammer must be taken into account; only obvious "off shots" are to be eliminated and to be replaced by a further impact test. Obvious "off shots" are those test hammer readings that deviate from the mean of the others by more than 5 units. Experience shows that they occur when the impact hits an aggregate particle or a pore lying close to the surface. **R** is called the **Rebound Number.**
4. The most likely value W_m and the minimum value $W_{min.}$ of the cube compressive strength of the concrete are given in table II. It is recommended to calculate the mean value of R to an accuracy of ½ scale unit, the values W, however, to the nearest N/mm^2. The cube compressive strength can also be taken with sufficient accuracy from fig. 3.

Fig. 3 **Cube Compressive Strength in N/mm²**
plotted against the Rebound Number

Type L Test Hammer



The curves apply to compact Portland cement concrete with good quality gravel/sand aggregate. Age 14 to 56 days. Smooth and dry concrete surface.

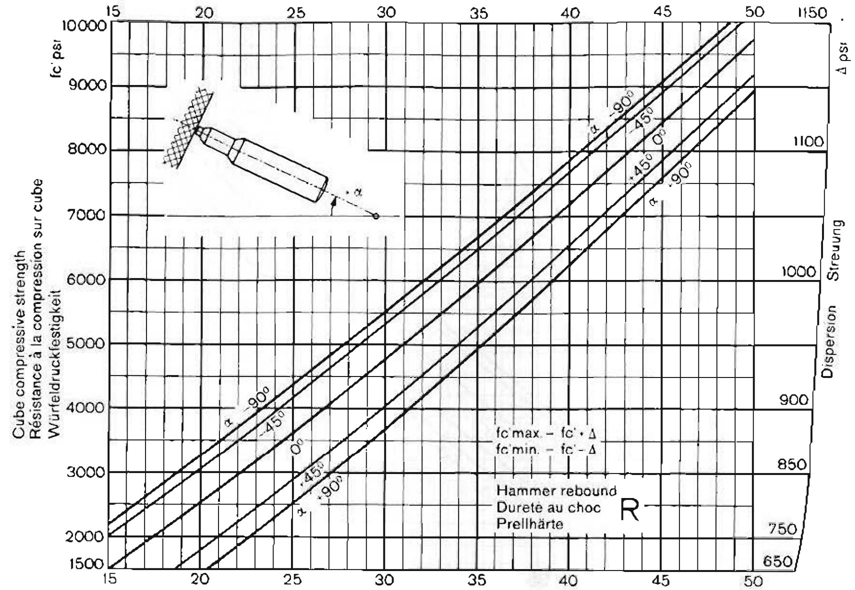
W_m = most likely value of the cube compressive strength in N/mm².

The dispersion limits $W_{max.}$ and $W_{min.}$ are so defined that they include 80 percent of all the test results.

Note under Section IV "Limits of Validity of the Calibration Curves"!

Fig. 3a **Cube Compressive Strength in psi**
plotted against the Rebound Number

Type L Test Hammer



The curves apply to compact Portland cement with good-quality gravel/sand aggregate. Age 14 to 56 days. Smooth and dry concrete surface.

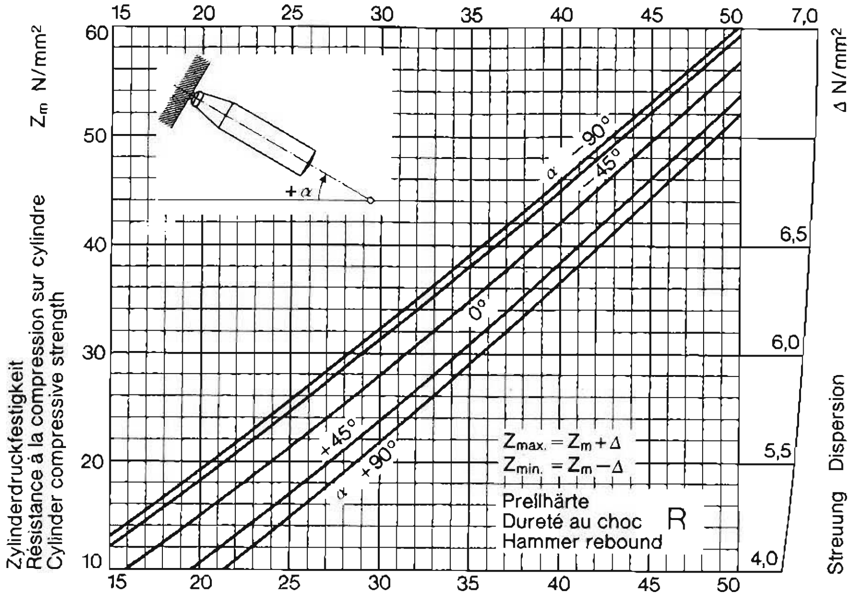
fc' = most likely value of the cube compressive strength in psi.

The dispersion limits fc'max. and fc'min. are so defined that they include 80 percent of all the test results.

Note under Section IV "Limits of Validity of the Calibration Curves"!

Fig. 3b **Cylinder Compressive Strength in N/mm²**
plotted against the Rebound Number

Type L Test Hammer



The curves apply to compact Portland cement with good-quality gravel/sand-aggregate. Age 14 to 56 days. Smooth and dry concrete surface.

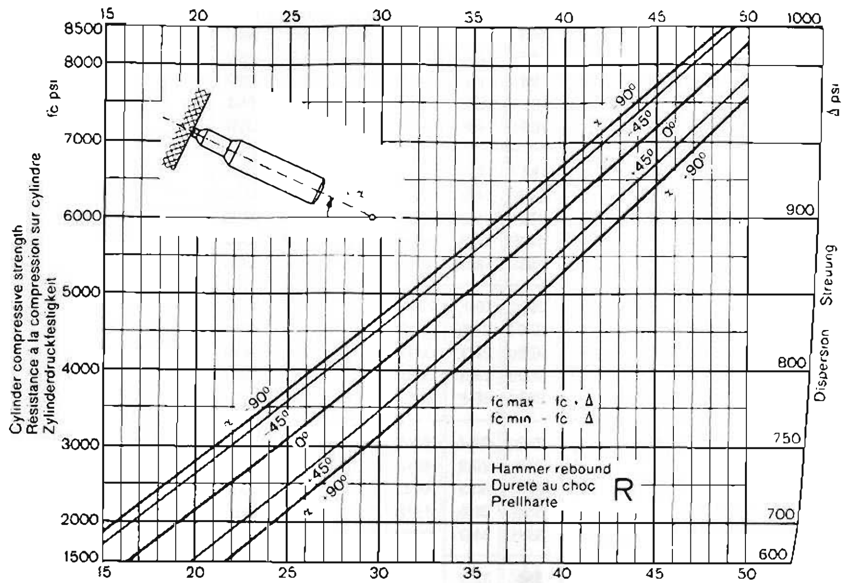
Z_m = most likely value of the cylinder compressive strength in N/mm².

The dispersion limits $Z_{max.}$ and $Z_{min.}$ are so defined that they include 80 percent of all the test results.

Note under Section IV "Limits of Validity of the Calibration Curves"!

Fig. 3c **Cylinder Compressive Strength in psi**
plotted against the Rebound Number

Type L Test Hammer



The curves apply to compact Portland cement with good-quality gravel/sand aggregate. Age 14 to 56 days. Smooth and dry concrete surface.

fc' = most likely value of the cylinder compressive strength in psi.

The dispersion limits fc'max. and fc'min. are so defined that they include 80 percent of all the test results.

Note under Section IV "Limits of Validity of the Calibration Curves"!

Cube Compressive Strength as a Function of the Rebound Number R

Table II

R	14–56 Days						7 Days					
	W_m			W_{min}			W_m			W_{min}		
	kp/cm²	N/mm²	psi	kp/cm²	N/mm²	psi	kp/cm²	N/mm²	psi	kp/cm²	N/mm²	psi
15	105	10.3	1490	58	5.7	820	125	12.3	1780	78	7.6	1110
16	119	11.7	1690	69	6.8	980	138	13.5	1960	88	8.6	1250
17	134	13.1	1910	82	8.0	1170	152	14.9	2160	100	9.8	1420
18	148	14.5	2100	94	9.2	1340	166	16.3	2360	112	11.0	1590
19	163	16.0	2320	107	10.5	1520	180	17.7	2560	124	12.2	1760
20	178	17.5	2530	120	11.8	1710	195	19.1	2770	137	13.4	1950
21	193	18.9	2740	134	13.1	1910	209	20.5	2970	150	14.7	2130
22	208	20.4	2960	148	14.5	2100	223	21.9	3170	163	16.0	2320
23	224	22.0	2190	162	15.9	2300	238	23.3	3380	176	17.3	2500
24	239	23.4	3400	176	17.3	2500	252	24.7	3580	189	18.5	2690
25	255	25.0	3630	191	18.7	2720	267	26.2	3800	203	19.9	2890
26	270	26.5	3840	205	20.1	2920	281	27.6	4000	216	21.2	3070
27	286	28.1	4070	220	21.6	3130	296	29.0	4210	230	22.6	3270
28	302	29.6	4290	235	23.1	3340	310	30.4	4410	243	23.8	3460
29	318	31.2	4520	250	24.5	3560	325	31.9	4620	257	25.2	3650
30	335	32.9	4760	266	26.1	3780	341	33.5	4850	272	26.7	3870
31	351	34.4	4990	282	27.7	4010	357	35.0	5080	288	28.3	4100
32	368	36.1	5230	298	29.2	4240	373	36.6	5300	303	29.7	4310
33	385	37.8	5470	315	30.9	4480	389	38.2	5530	319	31.3	4540
34	402	39.4	5720	331	32.5	4710	405	39.7	5760	334	32.8	4750
35	419	41.1	5960	347	34.0	4930	422	41.4	6000	350	34.3	4980
36	436	42.8	6200	364	35.7	5180	438	43.0	6230	366	35.9	5200
37	453	44.4	6440	380	37.3	5400	454	44.5	6460	381	37.4	5420
38	471	46.2	6700	397	38.9	5650	472	46.3	6710	398	39.0	5660
39	488	47.9	6940	414	40.6	5890	488	47.9	6940	414	40.6	5890
40	506	49.6	7200	431	42.3	6130	506	49.6	7200	431	42.3	6130
41	523	51.3	7440	448	43.9	6370	523	51.3	7440	448	43.9	6370
42	541	53.1	7690	465	45.6	6610	541	53.1	7690	465	45.6	6610
43	558	54.7	7930	482	47.3	6850	558	54.7	7930	482	47.3	6850
44	576	56.5	8190	500	49.0	7110	576	56.5	8190	500	49.0	7110
45	594	58.3	8450	517	50.7	7350	594	58.3	8450	517	50.7	7350
46	612	60.0	8700	535	52.5	7610	612	60.0	8700	535	52.5	7610
47	630	61.8	8960	552	54.2	7850	630	61.8	8960	552	54.2	7850
48	648	63.6	9210	570	55.9	8110	648	63.6	9210	570	55.9	8110
49	666	65.3	9470	587	57.6	8350	666	65.3	9470	587	57.6	8350
50	685	67.2	9740	606	59.4	8620	685	67.2	9740	606	59.4	8620

Cylinder Compressive Strength as a Function of the Rebound Number R

Table II

R	14–56 Days						7 Days					
	W_m			W_{min}			W_m			W_{min}		
	kp/cm²	N/mm²	psi	kp/cm²	N/mm²	psi	kp/cm²	N/mm²	psi	kp/cm²	N/mm²	psi
15	89	8.7	1270	49	4.8	700	106	10.4	1510	66	6.5	940
16	101	9.9	1440	59	5.8	840	117	11.5	1660	75	7.4	1070
17	114	11.2	1620	70	6.9	1000	129	12.7	1830	85	8.3	1210
18	126	12.4	1790	80	7.8	1140	141	13.8	2010	95	9.3	1350
19	139	13.6	1980	91	8.9	1290	153	15.0	2180	105	10.3	1490
20	151	14.8	2150	102	10.0	1450	166	16.3	2360	116	11.4	1650
21	164	16.1	2330	114	11.2	1620	178	17.5	2530	128	12.6	1820
22	177	17.4	2520	126	12.4	1790	190	18.6	2700	139	13.6	1980
23	190	18.6	2700	138	13.5	1960	202	19.8	2870	150	14.7	2130
24	203	19.9	2890	150	14.7	2130	214	21.0	3040	161	15.8	2290
25	217	21.3	3090	162	15.9	2300	227	22.3	3230	173	17.0	2460
26	230	22.6	3270	174	17.1	2470	239	23.4	3400	184	18.0	2620
27	243	23.8	3460	187	18.3	2660	252	24.7	3580	196	19.2	2790
28	257	25.2	3650	200	19.6	2840	264	25.9	3750	207	20.3	2940
29	270	26.5	3840	213	20.9	3030	276	27.1	3920	218	21.4	3100
30	285	28.0	4050	226	22.2	3210	290	28.4	4120	231	22.7	3280
31	298	29.2	4240	240	23.5	3410	303	29.7	4310	245	24.0	3480
32	313	30.7	4450	253	24.8	3600	317	31.1	4510	258	25.3	3670
33	327	32.1	4650	268	26.3	3810	331	32.5	4710	271	26.6	3850
34	342	33.6	4860	281	27.6	4000	344	33.7	4890	284	27.9	4040
35	356	34.9	5060	295	28.9	4190	359	35.2	5100	298	29.2	4240
36	371	36.4	5280	309	30.3	4390	372	36.5	5290	311	30.5	4420
37	385	37.8	5470	323	31.7	4590	386	37.9	5490	324	31.8	4610
38	400	39.2	5690	337	33.1	4790	401	39.3	5700	338	33.2	4810
39	415	40.7	5900	352	34.5	5010	415	40.7	5900	352	34.5	5010
40	430	42.2	6110	366	35.9	5200	430	42.2	6110	366	35.9	5200
41	445	43.7	6330	381	37.4	5420	445	43.7	6330	381	37.4	5420
42	460	45.1	6540	395	38.7	5620	460	45.1	6540	395	38.7	5620
43	474	46.5	6740	410	40.2	5830	474	46.5	6740	410	40.2	5830
44	490	48.1	6970	425	41.7	6040	490	48.1	6970	425	41.7	6040
45	505	49.5	7180	439	43.1	6240	505	49.5	7180	439	43.1	6240
46	520	51.0	7390	455	44.6	6470	520	51.0	7390	455	44.6	6470
47	536	52.6	7620	469	46.0	6670	536	52.6	7620	469	46.0	6670
48	551	54.1	7840	485	47.6	6900	551	54.1	7840	485	47.6	6900
49	566	55.5	8050	499	49.0	7100	566	55.5	8050	499	49.0	7100
50	582	57.1	8280	515	50.5	7320	582	57.1	8280	515	50.5	7320

Cylinder compressive strength = 0,85 × cube compressive strength.

IV. Limits of Validity of the Calibration Curves

The calibration curves of the concrete test hammer (table II and fig. 3) are based on measurements made on a large number of test cubes which were first subjected to the hammer test and then crushed. All the cubes were of concrete with good quality gravel/sand aggregate and Portland cement. With each test at least 10 hammer impacts were made on one of the side surfaces of the test cube lightly clamped in the crushing machine.

According to experience, the calibration curve practically does not depend on the cement content of the concrete, the granulometric gradation, the diameter of the largest particle of the gravel/sand aggregate nor on the water/cement ratio.

As experience shows, deviations from the normal calibration curves occur in the following cases:

1. Products of artificial stone with special composition of the concrete and with small dimensions. It is recommended to carry out a special series of tests to determine the relationship between rebound number and quality of material in each individual case. With light-weight and thin-walled test objects the type L test hammer is to be preferred.
2. With aggregate of not very strong, light-weight or cleavable stone (e.g. pumice, crushed brick, gneiss) the strength is lower than given by the calibration curve. In case of doubt the correlation between rebound number and strength applying to the material on hand must be determined by tests.
3. Aggregate with excessively smooth, polished surface is of no use for concrete of greater strength; since the rebound number only depends on the strength of the mortar, it does not permit any conclusion as to the strength in this case either.
4. The same phenomenon as in 3. has been observed in a very extreme form with concrete that had been produced with unwashed loamy aggregate.
5. Concrete, poor in sand, drily mixed and insufficiently worked can contain honeycombs not visible from the outside that will impair its strength but not its rebound number.
6. On concrete from which the form has just been removed and which is wet or which has hardened under water, the test hammer will give values of R which are too low. The concrete must be dry when carrying out an impact test.
7. With old dried-out concrete the surface is always disproportionately hard. Therefore the mean strength is lower than is indicated by the test hammer. The following procedure is to be recommended: Carry out hammer tests (5 to 10 impacts each) at all the locations of the structure to be tested; close to a number of these locations grind the concrete to a depth of ½ in.; repeat the hammer tests at the ground locations taking care that the impact plunger does not contact coarser particles of the aggregate.
   The R values of the last-mentioned test evaluated with the standard calibration curve give reliable strength values, sometimes somewhat on the low side.
8. In view of the decreasing accuracy of the strength determination with decreasing quality of the concrete, special care is indicated with rebound values R of 25 and less, i.e. with probable cube compressive strengths of below 25 N/mm² (3500 psi). In critical cases reliance should not be put on the test hammer alone but at least two or three crushing tests should also be made.

V. Servicing Test Hammer (Fig. 2)

The test hammer requires no special care. Only see that the impact plunger (1) is always clean to prevent ingress of dust into the interior of the housing as much as possible.

After long service (as a rule after 1000 to 2000 impacts) the hammer must be cleaned. For this purpose proceed as follows:

1. Allow plunger (1) to slide out of housing. Unscrew front cap (9) and withdraw two-part ring (10). Unscrew rear cover (11) and withdraw compression spring (12) and the moving parts of the hammer to the rear (disengage pawl [13]!).
2. By a light blow of the hammer mass (14) on the plunger (1) the latter is separated from the hammer guide bar (7) and the spring (15) is released. Pull hammer mass from guide bar. Disengage impact spring (16) from hammer mass at its rear end (B); leave its front end (A) engaged in the guide sleeve (17).
3. Clean the moving parts thoroughly, in particular the guide bar (7) and the contacting surfaces between hammer mass (14) and plunger (1). Thoroughly scrape out the bore of the plunger with a wire brush.
4. To assemble the hammer, proceed in the reverse sequence. Do not forget the spring (15) and the felt washer (18). **Lightly** lubricate the guide bar (7) with a thin-bodied oil.
5. As a rule the rider (4) should not be disassembled nor its guide rod oiled so as not to change the initially set friction.

VI. Adjusting Test Hammer

1. Release of impact: To check remove the window (19) and carry out an ordinary impact test while pushing the rider (4) back to the indication 90 by hand. The impact must be released at the indication 100. Any necessary adjustment of the moment of release is made with the trip screw (20) which is then locked in position by the lock nut (21). On hammers of the latest production series the scale is printed on the rear of the plexiglass window (19); on these hammers an index mark engraved on the housing indicates the scale end point (indication 100).
2. Rider: The friction of the rider on its rod must be 30 to 60 grams. This is tested by means of weights provided with a hook for suspending to the rider body. With the guide rod removed from the housing the frictional force can also be measured with a letter balance.
   The catch spring of the rider must be shaped in such a manner that it will be positively carried along by the hammer mass without, however, increasing the rider friction. To check proceed exactly in the same way as in checking the impact release exept that the rider is not pushed back so far. The rider must not be carried along when it is on 50 or less; it must be carried along when it is placed on 80 or more. If necessary bend the catch spring to its correct shape.
3. Adjusting impact spring (16): The front fixation (A) of the impact spring must be adjusted in such a way that with the spring untensioned the hammer mass (14) occupies the position corresponding to "zero" indication of the rider. For reasons connected with the operation of the hammer, the scale does not go as far as zero; therefore the adjustment is checked with the hammer held vertically upwards. In this position the spring is not untensioned but stretched by the weight of the hammer mass by exactly 5 mm. For checking the setting, use is made of the thick index line on the scale or of the double index line on the housing located 5 mm behind the imaginary zero point of the scale. With the window (19) removed and the disk (8) locked by the pushbutton (6) hold the hammer stationary and push the rider (4) up with a piece of wire: it must contact the hammer mass in the range of the index line.
   The effective length of the spring is adjusted at the front fixation point (A). For this purpose clamp the guide sleeve (17) in the vice and open up the spring a little; with a screwdriver the spring end can now be lifted out of its hole and engaged in one of the adjacent holes. Displacing the spring end by one hole corresponds to an alteration of the spring length by about 0.4 mm.

VII. The Testing Anvil

1. The testing anvil (fig. 4) serves to check the proper operation of the test hammer. This weighs 16 kg. It must be placed on a rigid and smooth surface (stone floor, heavy table).
   The indentation provided to receive the impact plunger is ground plane.
2. On the anvil the type L test hammer must give the reading shown on the calibration value plate (eg. 73 ± 2).
   If in spite of correct adjustment a hammer does not indicate at least the lowest value it is probably dirty and must be cleaned.
   The contact surfaces of the testing anvil and impact plunger too, must be clean.
3. If the rebound number on the anvil R_a deviates more from the nominal value then the R number measured on the concrete will be falsified in the same proportion. Thus the following formula applies for the test evaluation:

$$R = \frac{\Sigma r}{n} \cdot \frac{\text{nominal value}}{R_a}$$

   where n = number of individual measurements on the concrete
   R_a = rebound number of test hammer on anvil
   The formula is practically useful up to $R_a = 68$. At lower R_a values the instrument has to be cleaned and recalibrated.
4. If there is no anvil available, every test hammer must at least occasionally be checked by comparing it with a new or newly-adjusted test hammer. The comparative impact tests should be carried out on an object with as hard a surface as possible. For example a black smith's anvil or a heavy block of hard homogeneous natural stone with a ground surface will be suitable for this purpose.

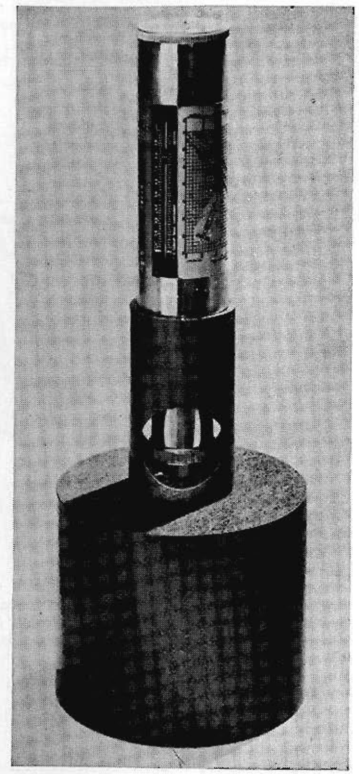


Fig. 4
Testing Anvil with Test Hammer supported upright in Guide Tube.