BRITISH STANDARD

BS 1881-127: 1990

Testing concrete —

Part 127: Method of verifying the performance of a concrete cube compression machine using the comparative cube test

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Cement, Gypsum, Aggregates and Quarry Products Standards Policy Committee (CAB/–) to Technical Committee CAB/4, upon which the following bodies were represented:

Association of Lightweight Aggregate Manufacturers
Association of Metropolitan Authorities
Association of Quality Pulverised Fuel Ash Suppliers
British Aggregate Construction Materials Industries
British Cement Association
British Civil Engineering Test Equipment Manufacturers' Association
British Precast Concrete Federation
British Ready Mixed Concrete Association
Building Employers' Confederation
Cement Admixtures Association
Cementitious Slag Makers Association
Concrete Society
County Surveyors' Society
Department of the Environment (Building Research Establishment)
Department of the Environment (Property Services Agency)
Department of Transport
Department of Transport (Transport and Road Research Laboratory)
Electricity Supply Industry in England and Wales
Federation of Civil Engineering Contractors
Institute of Concrete Technology
Institution of Civil Engineers
Institution of Highways and Transportation
Institution of Structural Engineers
Institution of Water and Environmental Management (IWEM)
Royal Institution of Chartered Surveyors
Sand and Gravel Association
Society of Chemical Industry

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Association of Independent Testing Laboratories
Department of Trade and Industry (National Measurement Accreditation Service)

This British Standard, having been prepared under the direction of the the Cement, Gypsum, Aggregates and Quarry Products Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 May 1990

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Contents

Foreword

This Part of BS 1881 has been prepared under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Policy Committee to describe a method for verifying the performance in operation of compression testing machines used for testing concrete cubes in accordance with BS 1881-116.

BS 1881-115 specifies the requirements relating to control and measurement of the force applied to the specimen, the geometry and hardness of the machine platens and the means of alignment that ensure correct application of the applied force.

This Part of BS 1881 gives a procedure for verifying the overall performance of a concrete cube testing machine in normal operation as described in BS 1881-116, by comparing the cube test results obtained on the machine with those obtained on a reference machine. This procedure is referred to as a comparative cube test.

A comparative cube test service was introduced in 1970, approved by the British Calibration Service[1)] in 1981 and operated to the criteria laid down in BCS Publication 0407. The committee introduced the comparative cube test in clause **9** of BS 1881-115:1986 as an alternative method to the use of the proving device described in appendix A of that standard. Both methods provide means of establishing compliance with the requirements of **9.1** a), b) and c) of BS 1881-115:1986. Where the results of a comparative cube test satisfy the criteria given in this Part of BS 1881, an assurance is obtained that the machine can be operated satisfactorily to test cubes. Where the results of a comparative cube test fail to satisfy the criteria, the cause(s) should be sought and deficiencies rectified. For this purpose it may be necessary to seek advice from the testing machine manufacturer or other specialist.

The combination of cube sizes and nominal strengths used in the comparative cube test is necessary to provide an effective test of performance.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[1)] The British Calibration Service is now part of the National Measurement Accreditation Service (NAMAS).

0 Introduction

The objective of the comparative cube test is to provide an effective verification of a concrete cube testing machine in operation. This is done by comparing the cube test results obtained on the testing machine with those obtained on a reference machine. Cost considerations limit the number of cubes that can be used for this purpose so a combination of cube sizes and strength levels has been chosen which will be particularly sensitive to deficiencies in machine performance. The method is based upon obtaining, in the long term, coefficients of variation of lower than 1.5 % between the strengths of cubes from a batch. The cube making is controlled to achieve this level of uniformity.

There are several possible sources of error in cube testing. Relative tilting of the testing machine platens during loading (non-compliance with **9.1** c) of BS 1881-115:1986) affects results throughout the strength range but the effect is greatest for 150 mm cubes of very high strength concrete. Compliance with **9.1** c) is most efficiently tested using such cubes and experience has shown that six 150 mm cubes of 70 N/mm^2 mean strength are sufficient to provide an adequate test. Similar considerations determine the choice of six 100 mm cubes of 70 N/mm^2 mean strength and six 100 mm cubes of 14 N/mm^2 mean strength for testing compliance with **9.1** a) and **9.1** b) of BS 1881-115:1986 respectively. Experience has shown that each of these cube sets will also reveal other common deficiencies in machine performance. Together the three sets of cubes provide a very effective test of performance covering the force range of concrete testing using only eighteen cubes on each machine.

For comparative cube testing, which is concerned only with comparison between sets of cubes from the same batch, the actual strength level of the concrete and any variability between nominally similar batches are quite unimportant, but low variability between cubes made from a single batch and absence of bias between sets used on different machines are of the utmost importance. For these reasons the procedures for making cubes given in this Part of BS 1881 differ from those given in BS 1881-108 and BS 1881-125. For example, strict temperature control of the curing environment would only increase the cost of the test unnecessarily. On the other hand, because even small reductions in variability between cubes from a batch improve the effectiveness of the test, expenditure on controlling moulds to tighter tolerances than required by BS 1881-108 and the elimination of water leakage at mould bases is justified.

The management responsible for the machine being verified and also the operator are required to affirm compliance with the operational procedures of this Part of BS 1881 to minimize operational variations that non-compliance with the procedures could add.

1 Scope

This Part of BS 1881 describes the method of comparative cube testing for verifying the performance in normal operation of compression testing machines of at least 2 000 kN force capacity for testing 100 mm and 150 mm concrete cubes in accordance with BS 1881-116.

It describes the reference machine, cube-making and storage, test procedure and certification of the concrete cube testing machine.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 1881 the definitions given in BS 882, BS 1610-1 and BS 1610-2, BS 1881-101 and BS 5328 apply, together with the following.

2.1
reference laboratory

organization accredited by the National Measurement Accreditation Service (NAMAS) to provide concrete cubes made under controlled conditions and to undertake the comparative cube test

2.2
reference machine

compression testing machine used by the reference laboratory for comparative cube testing and used only for reference purposes

2.3
batch

quantity of concrete mixed in one cycle of operations of the mixer

2.4
group

total number of cubes of one size produced from the same batch in moulds filled and vibrated together (see **4.4**)

2.5
set

six cubes of one size and produced from the same batch, but from six different groups (see **4.1**)

2.6
long term coefficient of variation

mean coefficient of variation of strength of the latest 25 consecutive sets of cubes of a specified nominal size and strength, used on the reference machine

3 Equipment and environmental control

3.1 Reference machine

3.1.1 *General.* The reference machine shall comply with BS 1881-115 and with **3.1.2** to **3.1.7** of this Part. Compliance with **9.1** of BS 1881-115:1986 shall be established using the procedures given in appendix A of that Part and shall be checked, prior to use, every week in which the reference machine is used for comparative cube testing.

3.1.2 *Rate of application of force.* The reference machine shall be capable of applying the force automatically at a rate of increase of stress of 0.30 ± 0.05 N/(mm^2 s) until no greater force can be sustained.

3.1.3 *Accuracy of the forces.* The forces applied by the reference machine over the range 100 kN to 2 000 kN shall be known to an uncertainty of ± 0.5 %, at a 95 % confidence level. The verification of the reference machine shall be made using devices directly traceable to the National Standard of Force. The uncertainty of the forces measured by the verifying devices shall be ± 0.1 %, at a 95 % confidence level.

The reference machine shall be reverified annually or after it has been moved to a new location or has been subject to disturbance, major repairs or adjustments.

NOTE This verification of the reference machine should be undertaken by the National Physical Laboratory but, if this requirement cannot be met, then it should be undertaken by an organization accredited by NAMAS, using force measuring devices meeting these uncertainties and following agreed procedures.

3.1.4 *Monitoring programme.* Immediately after the verification specified in **3.1.3**, a verification of the reference machine shall be undertaken by the reference laboratory using force measuring devices which meet the grade 1.0 requirements of BS 1610-2:1985; this procedure shall be repeated at intervals of approximately 3 months. If this monitoring programme indicates a drift or a change of indicated force in excess of 0.5 %, then the comparative cube tests shall be suspended and the reference machine adjusted and re-verified (see **3.1.3**).

3.1.5 *Application of the force.* The force shall be applied to the cube with auxiliary platens interposed between each machine platen or spacing block and the cube.

3.1.6 *Auxiliary platens.* The auxiliary platens shall comply with clause **6** of BS 1881-115:1986 and shall be checked for flatness in accordance with that Part at monthly intervals by the reference laboratory. These measurements shall be traceable to the National Standard of Length.

3.1.7 *Machine environment.* The environment of the reference machine shall be maintained at a temperature of 20 ± 2 °C. Continuous automatic records of temperature or a daily record of maximum and minimum temperatures shall be made. The measurements shall be traceable to the National Standard of Temperature.

3.2 Cube moulds

3.2.1 *Construction.* The moulds shall comply with BS 1881-108 in respect of their construction.

3.2.2 *Assembly.* Assemble the moulds in the manner described in BS 1881-108, and take additional steps, such as the use of a gasket, to prevent leakage.

NOTE The use of oil or grease between the mould and base plate has been found to be inadequate in preventing all trace of water leakage from all moulds during compaction, on a vibrating table, of large batches of cubes and during subsequent storage prior to hardening. The use of squares of 1 mm thick plastics-coated grey strawboard covering the area of the baseplate covered by the cube and the lower mould flange has been found to be more effective in eliminating leakage. Such a gasket should be used only once.

3.2.3 *Tolerances.* When assembled without a gasket, a mould shall comply with the requirements for new moulds in **3.1.2** of BS 1881-108:1983. In use the moulds shall be checked at least annually in respect of their dimensions and flatness and when there is any cause to suspect that their dimensions may not be within the specified limits. The measurements of dimension shall be traceable to the National Standard of Length.

NOTE The increased tolerances permitted in **3.1.3** of BS 1881-108:1983 are not acceptable for this Part of BS 1881.

3.2.4 *Cleaning and storage.* After use, dismantle the mould completely, clean it thoroughly and oil it. Store the reassembled mould upside down to prevent foreign matter falling into the mould and to allow excess oil to drain out.

3.3 Mixing and compacting equipment

3.3.1 *Laboratory mixer,* i.e. a pan mixer complying with **3.1** of BS 1881-125:1986.

3.3.2 *Vibrating table,* of adequate size to accommodate moulds for a group of cubes. An adjustable time switch for the motor of the vibrating table is recommended.

3.4 *Balance,* complying with **4.2** of BS 1881-114:1983. The balance shall be calibrated on initial commissioning and at least annually thereafter using weights of which the accuracy can be traced to the National Standard of Mass. The balance shall be checked after relocation or disturbance. A certificate stating the accuracy shall be obtained from the organization carrying out the check.

3.5 *Curing tanks,* constructed from a corrosion resistant material and of capacity to store at least all the cubes from one concrete batch.

3.6 *Mixing and curing environment.* Maintain the mixing laboratory, moist curing environment and curing tank room at a temperature of 20 ± 5 °C. Keep a daily record of the maximum and minimum temperature. These measurements shall all be traceable to the National Standard of Temperature.

4 Requirements for concrete cubes

4.1 Specimen requirements

Three sets of six cubes shall be made for testing on each machine to be verified and the same number of cubes from the same groups shall be selected for testing on the reference machine and shall comprise:

a) six 150 mm cubes of 70 N/mm^2 to 85 N/mm^2 mean strength;

b) six 100 mm cubes of 70 N/mm^2 to 85 N/mm^2 mean strength;

c) six 100 mm cubes of 14 N/mm^2 to 19 N/mm^2 mean strength.

4.2 Constituent materials

4.2.1 *Cement*

The cement used shall comply with BS 12 and shall be stored in a silo or suitable airtight containers.

4.2.2 *Aggregate*

Separate coarse and fine aggregates complying with BS 882 shall be used. The maximum nominal size of coarse aggregate shall be 20 mm for 150 mm cubes and 10 mm for 100 mm cubes.

4.2.3 *Storage environment*

Store all materials in the mixing laboratory in accordance with **4.4** of BS 1881-125:1986 before use.

4.3 Mixes

Three mix designs are required of low to medium workability, two to give a strength of 70 N/mm^2 to 85 N/mm^2 and one to give a strength of 14 N/mm^2 to 19 N/mm^2 at the time the cubes are used. The size of the batch and its mixing shall be generally in accordance with **6.2** of BS 1881-125:1986, and any modifications shall be recorded.

4.4 Cube making procedure

Place a group of moulds (see **2.4**), comprising one-sixth of the total number needed for a batch, on the vibrating table without overlap. By means of a scoop, fill each mould with concrete in at least two layers for the 100 mm cubes and three layers for the 150 mm cubes and compact each layer by vibration. Fill the moulds in groups. Vibrate any additional cubes made for checking the strength of the batch as an extra group. After compaction, transfer the moulds to a firm bench and trowel the top surface of the concrete to be as flush as possible with the top of the mould walls. It is essential that the same operator trowels all of the cubes from a batch. Inspect each mould to ensure that no leakage has occurred during vibration. Wipe clean the outside of each mould and label it with a consecutive cube number related to the order of filling.

NOTE The method of filling and trowelling should be consistent between cubes, e.g. any surcharge and its removal should be similar for each cube. Excessive trowelling should be avoided.

If, in spite of precautions, traces of water leakage on the base plate or from the mould joints are found, mark the mould and check it for compliance with **3.2.3** of this Part before re-use. The cube made in this mould is permitted to be used if the requirements for density of cubes in **4.8** of this Part are satisfied.

4.5 Initial curing

4.5.1 *Procedure*

Immediately after making, move the cubes in their moulds into a moist curing environment which shall be maintained at not less than 90 % r.h. at 20 ± 5 °C. Keep the cubes in the moist environment for at least 16 h before demoulding.

NOTE The high humidity required in moist air curing rooms is normally produced by spraying water as a fine aerosol. The bacterium *Legionella pneumophila* is widespread in nature and is present in the water systems of many buildings. Scale in pipework and chemical nutrients in the water supply may encourage growth of this organism which multiplies between 20 °C and about 45 °C. Inhaling infected aerosols is a known route for transmission of legionellosis. It is therefore advisable to maintain cold water supplies if possible below 20 °C and to store hot water above 60 °C. Cold water supplies may be disinfected by chlorination to at least 5 mg/L free chlorine. Regular periodic checking for the presence of *Legionella* species in industrial water supplies is a sensible precaution.

4.5.2 *Demoulding*

Demould the cubes without damaging them, mark each cube clearly and indelibly with the batch number and cube number and identify the trowelled face. Take precautions to minimize drying of the demoulded cubes.

4.6 Density measurement

4.6.1 *Procedure*

Immediately after demoulding the cubes weigh each cube in air and record its mass m_a. Then weigh the cube in water using a stirrup similar to that described in BS 1881-114. Immerse the cube fully in the water in the tank, ensuring that the stirrup does not touch the bottom of the tank and that air bubbles are not trapped on the surfaces of the cube and the stirrup. Weigh the completely immersed cube and record its apparent mass m_w, correcting for the apparent mass of the empty stirrup when weighed immersed in water to the same depth as when holding the cube. Measure and record the temperature of the water.

4.6.2 *Calculation*

Calculate the volume, V, (in m^3) of each cube from the formula

$$V = \frac{m_a - m_w}{\rho_w}$$

where:

m_a is the mass of the cube in air (in kg);

m_w is the mass of the cube in water (in kg);

ρ_w is the density of the water in the container at the measured temperature (in kg/m^3).

Calculate the density, D, (in kg/m^3) of each cube from the formula $D = \frac{m_a}{V}$

4.7 Storage

4.7.1 *Procedure*

After density measurement, place all the cubes from the concrete batch in the same curing tank. Stack cubes vertically in sets (see **2.5**) so that each set has the same number of cubes at each level in the tank. Store all the cubes made from one batch in the same part of the tank and as close together as is consistent with access of water to the vertical faces of the cubes.

NOTE It is convenient for easy identification of sets to stack all six cubes of the set in one stack. If it is found that removal of cubes from such a deep tank is too difficult, each set may be stacked close together in two stacks of three. It is essential that, however the cubes are stacked, all sets have the same number of cubes stored at each level in the tank to avoid the introduction of bias between sets arising from any temperature gradient from the bottom to the top of the tank.

4.7.2 *Storage time*

Store the cubes for at least 40 days before using them for comparative cube testing. Treat all cubes in a batch similarly from the time of the making of the cubes until subsequent despatch for testing.

4.8 Validation and allocation of sets

Calculate the mean density for each set of cubes and the overall mean density of all of the cubes made from a batch. If the mean density of a set of cubes differs from the overall mean density by more than 5 kg/m^3, do not use the set. Calculate the standard deviation of density of all the cubes from the same batch and if the value exceeds 6.0 kg/m^3, do not use the cubes. Test on the reference machine the set of six cubes having a mean density closest to the overall mean density. If more than one set is equally close to the overall mean density, then use the set with the lowest standard deviation.

4.9 Packing and transporting

Take the cubes to be tested on the machine to be verified straight from the curing tanks, wrap them in wet paper towelling and put them in one or more polyethylene bags, sealed so as to prevent loss of moisture. Where the cubes cannot be transported under supervision, provide additional packing and put the package into a strong box with a secure lid. Despatch the cubes from the reference laboratory usually two days prior to the test date but never more than four days prior to the test date (see **4.7.2**).

4.10 Instructions

Provide a waterproof envelope with the cubes in which the following are enclosed:

a) a document giving the nominal strength of each set of cubes;

b) the date on which the cubes shall be tested;

c) an instruction sheet, which states the procedures in accordance with this Part of BS 1881, by which the cubes shall be tested (see appendix A, Form A);

d) copies of forms which shall be used to report results (see appendix A, Form B).

5 Testing of cubes

5.1 Machine to be verified

5.1.1 *Date of testing*

Test the cubes in the machine to be verified on the date specified in the instructions.

5.1.2 *Preparation*

On receipt, either open the bags and immerse the cubes in water in a curing tank or alternatively leave them in the closed bags. Remove the cubes from the curing tank or bags and test them while they are still wet. Examine the cubes on removal from the bags and record any damage against the cube reference number.

5.1.3 *Placing the cube in the testing machine*

Follow the procedures given in **5.2** of BS 1881-116:1983. In addition, record the position of the marked trowelled face relative to the front of the machine.

5.1.4 *Loading*

Follow the procedures given in **5.3** of BS 1881-116:1983. Record the maximum force applied to the cube in the units of the testing machine scale or display at the best resolution available and without conversion of units or rounding of values.

NOTE Each broken cube with its identification, should be retained (see note 3 to clause **8**). Where the cube failure was observed to be unusual, and the remains are likely to disintegrate, a sketch should be made of the broken cube, identifying the trowelled face.

5.2 Reference machine

5.2.1 *Date of testing*

Test the cubes on the same date as those tested on the machine to be verified.

5.2.2 *Placing the cube in the reference machine*

Remove the cubes from the curing tank and test while they are still wet. Follow the procedures given in **5.2** of BS 1881-116:1983. In addition, record the position of the marked trowelled face relative to the front of the reference machine.

5.2.3 *Loading*

Follow the procedures given in **5.3** of BS 1881-116:1983. Apply the force at a rate of increase of stress of 0.30 ± 0.05 N/(mm^2 s) and record the maximum force applied to the cube in the units of the reference machine scale at the best resolution available.

6 Results

6.1 Machine being verified

Record the results of the test on the forms supplied by the reference laboratory. The completed forms shall be signed by the machine operator and countersigned by the supervisor or manager to the effect that the tests have been correctly carried out in accordance with this Part of BS 1881. Return the forms to the reference laboratory and retain a copy or record of the results in the laboratory that is reporting results.

6.2 Reference machine

Keep a record of the results from all cubes tested on the reference machine.

7 Calculations

7.1 General

All calculations shall be carried out by the reference laboratory.

7.2 Results obtained on the reference machine

Calculate the mean strength, $\bar{x}_r$, and standard deviation, s_r, for each set of cubes from the six results obtained on the reference machine. If the standard deviation exceeds 3.0 N/mm^2 for the high strength cubes or 0.7 N/mm^2 for the low strength cubes, then do not use the results of the tests carried out on the cubes made from that batch.

7.3 Results obtained on the machine being verified

Calculate the mean strength, $\bar{x}$, and standard deviation, s, from the six results for each set of cubes obtained on the machine being verified.

7.4 Analysis of performance

Calculate the difference between the mean strength obtained from each set of cubes on the reference machine and the mean strength obtained for the corresponding set of cubes on the machine being verified and express it as a percentage of the mean strength obtained on the reference machine using equation 3. Calculate the 95 % confidence interval (l, u) for the difference and also express it as a percentage of the mean strength obtained on the reference machine using the Student's "t" distribution by equations 1 and 2.

$$l = d - e \quad (1)$$

$$u = d + e \quad (2)$$

in which

$$d = 100(\bar{x} - \bar{x}_r)/\bar{x}_r \quad (3)$$

$$e = \frac{91\sqrt{(s^2 + s_r^2)}}{\bar{x}_r} \quad (4)$$

Use these values of the confidence interval to assess the performance of the machine as described in appendix B.

8 Test certificate

The reference laboratory shall issue a certificate signed by the head of the reference laboratory or other approved signatory stating:

a) the name of the reference laboratory;

b) the reported serial number, make, model and location of the concrete cube testing machine being assessed and the date of the comparative cube test;

c) the identification of each of the cube batches;

d) the means and standard deviations for each of the three sets calculated for both the reference machine and the machine being verified;

e) whether or not the machine complied with the stated criteria of appendix B. In the event of non-compliance the certificate shall be over-printed with the statement in bold text that the machine did not comply.

A machine shall not be certified for compliance with this Part of BS 1881 for a limited range or for one size or strength of cube.

NOTE 1 Any use of the machine for cube testing within a period of non-compliance is not within the scope of this standard.

NOTE 2 Individual results of the tests on the reference machine should be made available by the reference laboratory on request.

NOTE 3 Advice may be sought from the reference laboratory, machine manufacturer or other specialist on possible causes of the failure of the machine to comply. These causes may include operational faults, machine faults or random error. Examination of the tested cubes by specialists may assist diagnosis.

Appendix A Documents used in comparative cube testing

The instruction sheet, Form A, which can be sent with the concrete cubes to be tested in the machine to be verified, and the results sheet, Form B, may be found useful in operating a comparative cube scheme.

Form A. Procedure for testing cubes

1. *Information.*

Cubes to be tested on:		
Cube batch number	Cube size	Approximate strength (N/mm^2)
	150 mm	
	100 mm	
	100 mm	

2. *Preparation.* On receipt, either open the polyethylene bags and immerse the cubes in water in a curing tank complying with clause **3** of BS 1881-111:1983 or leave the cubes in the closed bags. Remove the cubes from the curing tank or bags and test them while they are still wet. Examine the cubes on removal from the bags and record any damage against the cube reference number.
3. *Placing the cube in the testing machine.* Follow the procedures given in **5.2** of BS 1881-116:1983. In addition, record the position of the marked trowelled face relative to the front of the machine.
4. *Loading.* Follow the procedures given in **5.3** of BS 1881-116:1983, with the exception that the maximum force applied to the cube shall be recorded in the units of the testing machine scale or display, at the best resolution available and without conversion of units or rounding of values.

   NOTE Each broken cube with its identification, should be retained. Where the cube failure was observed to be unusual, and the remains are likely to disintegrate, a sketch should be made of the failure, identifying the trowelled face.
5. *Results.* Record the results of the test on the forms supplied by the reference laboratory. The completed forms shall be signed by the machine operator and countersigned by the supervisor or manager to the effect that the tests have been correctly carried out in accordance with BS 1881-127. Return the forms to the reference laboratory and retain a copy or record of the results in the laboratory that is reporting results.

Form B. Comparative cube testing results	Sheet 1 of 2
1. General information	Date of test.....
Name and address of laboratory	Machine Make: Model: Serial No:
Method of load pacing[a] automatic pacing meter pacing disc stopwatch none used	Cubes positioned with trowelled face towards[a] front back left right of machine
Reference numbers and details of any damage observed to cubes as received.	
I confirm that the test was done in accordance with the instructions supplied, which I have read. Signed.....Machine operator Countersigned.....Supervisor or Manager	
[a] Circle the appropriate item.	

Form B. Comparative cube testing results *(concluded)*					Sheet 2 of 2
2. Maximum force data.					
Batch Number .... Specimen number	Maximum force[a] (as indicated on the machine)	kN tonnef kgf tonf lbf	Specimen size[a]	100 mm 150 mm	Maximum force of machine range used
			Size of sub-platens if used		Testing time from.......... to..........
			Appearance of failed cube		
Batch Number .... Specimen number	Maximum force[a] (as indicated on the machine)	kN tonnef kgf tonf lbf	Specimen size[a]	100 mm 150 mm	Maximum force of machine range used
			Size of sub-platens if used		Testing time from......... to...........
			Appearance of failed cube		
Batch Number .... Specimen number	Maximum force[a] (as indicated on the machine)	kN tonnef kgf tonf lbf	Specimen size[a]	100 mm 150 mm	Maximum force of machine range used
			Size of sub-platens if used		Testing time from......... to...........
			Appearance of failed cube		

[a] Circle the appropriate item.

Appendix B Performance criteria

The performance of the machine being verified should meet the following criteria.

a) For each of the three sets of cubes tested, where the confidence interval does not include zero, the difference between the means should not exceed 4.0 %.

NOTE A machine fails to comply either when $l > 0.0$ % and $d > 4.0$ % or when $u < 0.0$ % and $d < -4.0$ %.

b) Where the standard deviation of the results for a high strength set of cubes given by the machine being verified exceeds 3.0 N/mm^2, it should not exceed 3.3 times the standard deviation of the corresponding results given by the reference machine.

NOTE A machine fails to comply when $s > 3.0$ N/mm^2 and $s > 3.3\ s_r$.

c) Where the standard deviation of the results for a low strength set of cubes given by the machine being verified exceeds 0.7 N/mm^2, it should not exceed 3.3 times the standard deviation of the corresponding results for the reference machine.

NOTE A machine fails to comply when $s > 0.7$ N/mm^2 and $s > 3.3\ s_r$.

Publications referred to

BS 12, *Specification for Portland cements.*

BS 882, *Specification for aggregates from natural sources for concrete.*

BS 1610, *Materials testing machines and force verification equipment.*

BS 1610-1, *Specification for the grading of the forces applied by materials testing machines.*

BS 1610-2*, specification for the grading of equipment used for the verification of the forces applied by materials testing machines.*

BS 1881,*Testing concrete.*

BS 1881-101, *Method of sampling fresh concrete on site.*

BS 1881-108*, Method for making test cubes from fresh concrete.*

BS 1881-111, *Method of normal curing of test specimens (20 °C method).*

BS 1881-114, *Methods for determination of density of hardened concrete.*

BS 1881-115*, Specification for compression testing machines for concrete.*

BS 1881-116*, Method for determination of compressive strength of concrete cubes.*

BS 1881-125*, Methods for mixing and sampling fresh concrete in the laboratory.*

BS 5328, *Methods for specifying concrete, including ready-mixed concrete.*

British Calibration Service Publication No. 0407[2)] Supplementary criteria for laboratory approval for comparative concrete cube testing, January 1981.

[2)] Referred to in the foreword only.

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