BS 1881 : Part 120 : 1983

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Incorporating Amendment No. 1

British Standard

Testing concrete

Part 120. Method for determination of the compressive strength of concrete cores

Essais du béton
Partie 120. Méthode de détermination de la résistance à la compression des âmes en béton

Prüfverfahren für Beton
Teil 120. Bestimmung der Druckfestigkeit von Bentonkernen

Contents

Foreword

This Part of this standard, prepared under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Committee, is a revision of clause 3 of BS 1881 : Part 4 : 1970. Together with Parts 115, 116, 117, 118 and 119, this Part of BS 1881 supersedes BS 1881 : Part 4 : 1970, which is withdrawn.

This Part includes methods of sampling, drilling, preparation of specimens and testing of cores from concrete. The results of the test are given as the measured core strength or the estimated in-situ cube strength which are without allowance for the effect of curing history, or age, or degree of compaction.

The relationship between core and cube strengths is complex and will vary with particular conditions. Planning of core testing and the interpretation of results should be based on information and advice from the specialist literature, e.g. BS 8110, BS 6089 and The Concrete Society Technical Report No. 11.

The photographs in figure 1 are reproduced by permission of The Concrete Society from Technical Report No. 11.

No estimate of repeatability or reproducibility is given in this Part of this British Standard. Reference should be made to BS 5497 : Part 1 for further information on the determination of repeatability and reproducibility.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

British Standard

Testing concrete

Part 120. Method for determination of the compressive strength of concrete cores

1. Scope

This Part of this British Standard describes a method for taking cores from concrete and preparing them for testing and for the method for determining their compressive strength.

NOTE 1. Before deciding to drill cores for compressive testing, it is essential that full consideration be given to the necessity for the test, its aims and the value of the results which will be obtained. Specialist literature, e.g. BS 8110, BS 6089, or the Concrete Society Technical Report No. 11 should be consulted for advice on the number of cores necessary, on the need for trimming and for the assessment of results. It is recommended that before coring full agreement should be reached by all parties on the need for core testing and on how the results should be interpreted.

NOTE 2. 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 this standard the definitions given in BS 5328 apply.

3. Apparatus

3.1 Grinding equipment (required if end preparation is by grinding, see 5.2). Grinding equipment capable of producing a surface to the tolerances specified in 4.8.

3.2 Steel collar. A steel collar with a machined edge suitable for use when capping in accordance with 5.3 method (a).

3.3 Glass capping plate (required if end capping in accordance with method (a) of 5.3). A glass plate at least 8 mm thick with surfaces complying with the tolerances specified in 4.8.

3.4 Steel plate (required if end capping in accordance with method (b) of 5.3). A horizontal steel plate with an upper surface having a flatness tolerance as defined in BS 308 of 0.03 mm wide, a surface texture not exceeding 3.2 pm R_a when determined in accordance with BS 1134 and a Rockwell (Scale B) Hardness Value* of at least 95 when tested in accordance with BS 891 : Part 1.

3.5 Compression testing machine complying with BS 1881 : Part 115 and related to the size of specimens and their expected failure load.

4. Test specimens

4.1 Size of cores. Test specimens shall be 100 mm or 150 mm diameter; the preferred diameter size is 150 mm. The ratio of diameter to the maximum aggregate size shall be not less than 3.

NOTE 1. Concrete cube testing machines are not normally suitable for testing cores of smaller diameter in compression.

The usable length of core shall be such that the length/diameter ratio for strength testing shall be between 1 and 2.

NOTE 2. The preferred length/diameter ratio is between 1 and 1.2.

If the whole length of a core is to be tested in compression, the diameter shall be chosen in the specified ratio to the depth of member from which the core is taken.

NOTE 3. For the static modulus tests (see BS 1881 : Part 121) the length/diameter ratio shall be at least 2 with a maximum of 5.

4.2 Drilling. Unless specifically required otherwise, cores shall be drilled perpendicular to the surface using a diamond core drilling bit and in such a manner as not to damage the cores. The equipment shall comply with the dimensional requirements of BS 4019 : Part 2. The drill shall be kept rigidly positioned during coring, otherwise ridged or curved cores may be obtained. Drilling through reinforcement shall be avoided wherever possible.

4.3 Identification. Immediately after cutting mark each core clearly and indelibly, indicating its location and orientation within the member. Record the direction of drilling of each core relative to the direction of casting.

Mark the core to indicate distances in millimetres from the drilling surfaces so that the location in the element from which the test core came can be confirmed when the ends have been trimmed.

4.4 Examination

4.4.1 *Compaction.* Examine each specimen for compaction, for the presence of voids, for honeycombing and for cracks.

Note the position at which any honeycombing begins.

Describe the compaction of the concrete by comparing the core surface with figures 1 (a) to 1 (e) by measuring excess voidage which is that amount by which the actual voidage exceeds the voidage of a well made cube of the same concrete.

Where the description needs to be amplified, this shall be done by reference to the following terms.

(a) *Small* void. A void measuring not less than 0.5 mm and not more than 3 mm across in any direction.

(b) *Medium* void. A void having a dimension greater than 3 mm but not greater than 6 mm.

(c) *Large void.* A void having a dimension greater than 6 mm.

(d) *Honeycombing.* Interconnected voids arising from, for example, inadequate compaction or lack of mortar.

In order to avoid extremes of subjective bias, two observers shall compare the surface voids of a given core with those shown in figure 1, taking care to ensure that the voids

*Indentations on the face resulting from the hardness test are acceptable.

are viewed in strong light angled so as to highlight them with shadows (as in figure 1). The procedure for the comparison is as follows:

(a) cut a 125 mm x 80 mm rectangular aperture in a piece of thin card;

(b) place the card on the core with elastic bands;

(c) assess the excess voidage of the area of core in view by comparing it with figure 1 and record the assessment;

(d) move the card to other areas and repeat the assessment until the cylindrical face of the core has been surveyed representatively;

(e) average the individual assessments and record the result to the nearest multiple of 0.5 %.

NOTE 1. Where the relative frequencies of small and large voids on the test core differ from those shown in figure 1, estimation of the excess voidage may be facilitated by remembering that a void of a given diameter (or linear dimension) is equal in volume to eight voids having only half that diameter (or linear dimension).

NOTE 2. Where a photographic record of the air-dry core is required, the centre of the photograph should include that 125 mm X 80 mm area having an estimated excess voidage nearest to the average for the whole core. The lighting should also be such that a photograph comparable in quality to figure 1 is obtained, and the photograph should be reproduced to actual size.

4.4.2 Description of aggregate. When required, examine pieces of coarse aggregate for general type and particle shape according to BS 812. Estimate the maximum size to the nearest appropriate size specified in BS 882.

4.4.3 Distribution of materials. Examine each core for evidence of segregation of the individual materials by visually comparing the approximate coarse aggregate/mortar ratio at different planes in the core.

4.5 Measurement of dimensions. Measure the diameter and the length before and after end preparation (see 5.2) in accordance with BS 1881 : Part 114.

4.6 Measurement of mass and density. Weigh each specimen and determine the density as received or saturated, in accordance with BS 1881 : Part 114.

4.7 Measurement of reinforcement. Measure the size and, if possible, spacing of any reinforcing bars. Determine the position of any reinforcement by measuring from the centre of the exposed bars to the top of the core as received and after end preparation (see 5.2).

4.8 Tolerances. The tolerances in accordance with BS 308 : Part 3 of the prepared specimen shall be as follows.

(a) *Flatness.* The flatness tolerance for the prepared end surfaces shall be 0.08 mm wide.

(b) *Squareness.* The squareness tolerance (squareness 3 of BS 308 : Part 3) for the end prepared first with respect to the axis of the specimen as datum axis shall be 2.0 mm wide.

(c) *Parallelism.* The parallelism tolerance (parallelism 4 of BS 308 : Part 3) for the prepared top surface with respect to the bottom surface of the specimen as datum face shall be 2.0 mm wide.

(d) *Cylindricity.* The cylindricity tolerance for the core shall be 3 % of the core diameter.

5. Preparation of cores

5.1 General. Cores which do not comply with the requirement for cylindricity in 4.8 or that are badly honeycombed should not be tested.

When it is necessary to reduce the length of core to that appropriate to a particular test, saw the core perpendicular to its longitudinal axis. When the core is to be tested in compression, prepare flat ends preferably by grinding as in 5.2 or by capping as in 5.3 if grinding is impractical.

5.2 End preparation by grinding. Before grinding, store cores in water at 20 ± 2 °C. Remove them for not more than 1 h for grinding and measurement. Grind the ends of the cores to the tolerances given in 4.8. After grinding, return the cores to the water.

NOTE. The need to trim the length will depend on the purpose for which the core was taken.

Grind the ends of the specimen for testing in compression to the tolerances given in 4.8. Grinding is the preferred method of end preparation but if this is impractical, cap the ends using either of the two methods specified in 5.3.

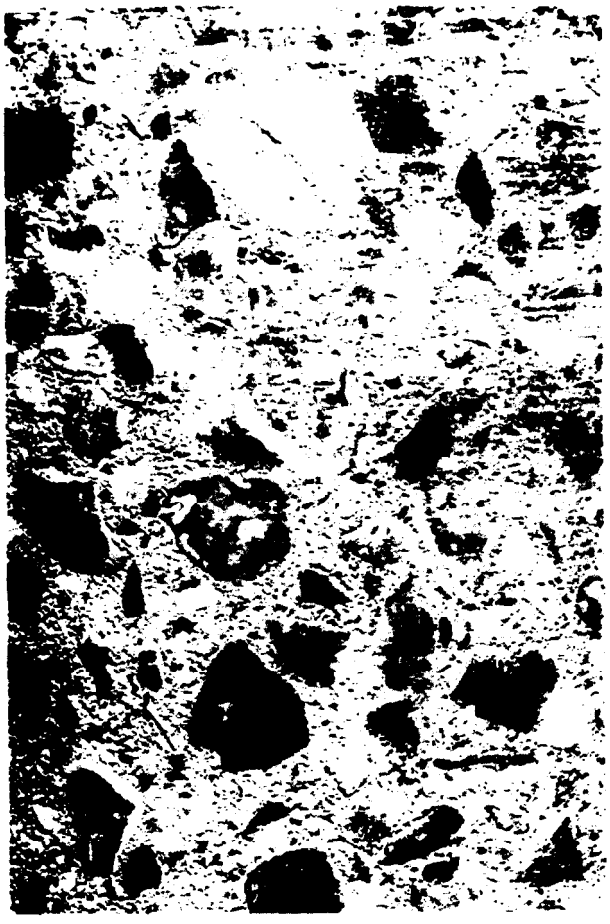
5.3 End preparation by capping. Before capping by method (a), store cores in water at 20 ±2 ° C. Before capping by method (b), store cores in a dry condition. Caps shall be made as thin as possible and shall not exceed 10 mm thickness at any point.

Before the.upper surface is capped the surface shall first be roughened by hacking or wire brushing. The method given in (a) is suitable for specimens which have been soaked in water and the method given in (b) is suitable for dry specimens.

(a) The capping material consists of a mortar composed of three parts by mass of high alumina cement complying with BS 915 to one part by mass of fine sand (most of which passes a 300 µm BS 410 woven wire sieve). Place the soaked specimen on a horizontal plate, and rigidly clamp a steel collar of correct diameter and having a machined upper edge to the end of the specimen to be capped, in such a way that the upper edge is horizontal and just extends above the highest part of the concrete surface. Fill the capping material into the collar until it is in the form of a convex surface above the edge of the collar. Press down the glass capping plate, coated with a thin film of mould oil, on to the capping material with a rotary motion until it makes complete contact with the edge of the collar. Immediately place the specimen with collar and plate in moist air of at least 90 % r.h. and at a temperature of 20 ±5 °C, and remove the plate and collar when the mortar is hard enough.

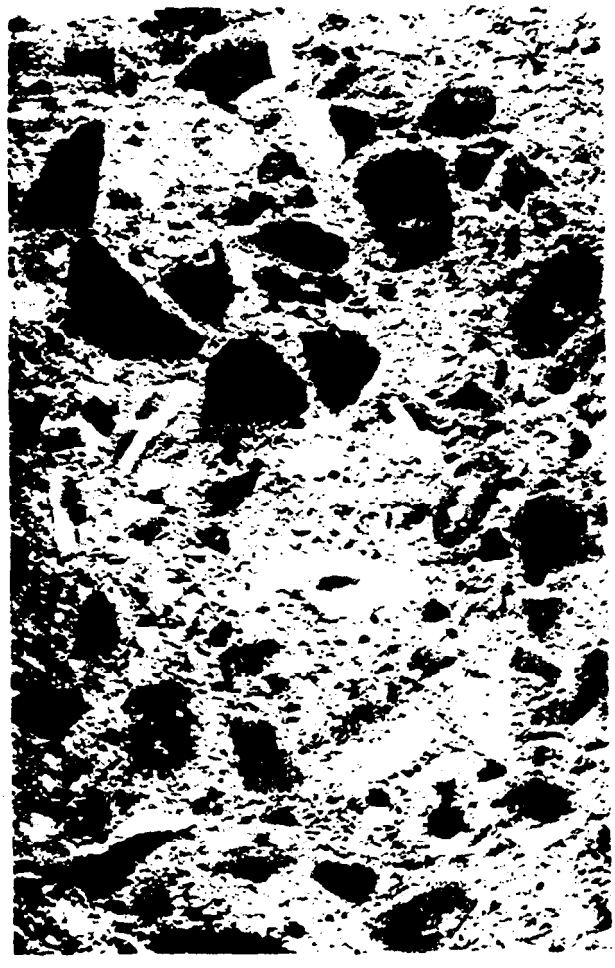
(b) The capping material consists of a mixture composed of equal parts by weight of sulphur and fine siliceous sand (most of which passes a 300 µm BS 410 woven wire sieve and is retained on a 150 µm BS 410 woven wire sieve) together with a small proportron (1 % to 2 %) of carbon black. Alternatively, use a mixture* of sulphur and pulverized-fuel ash in suitable proportions to provide a higher strength than that of the concrete. Heat the mixture to a temperature of approximately 130 °C to 150 °C and then allow it to cool slightly while being stirred continuously. Pour the mixture onto a level machined steel plate that has been slightly warmed and thinly coated with paraffin. Place the specimen into this layer with its axis vertical using a guide. After a few seconds, cut away the surplus material around the specimen with a sharp knife and lift the specimen off the plate. The cap shall not flow or

'A granular mixture ready for use is available end for information on its supply apply to Enquiry Section, BSI, Linford Wood, Milton Keynes MK14 6LE. enclosing a stamped addressed envelope for reply.



(a) Excess voidage = 0

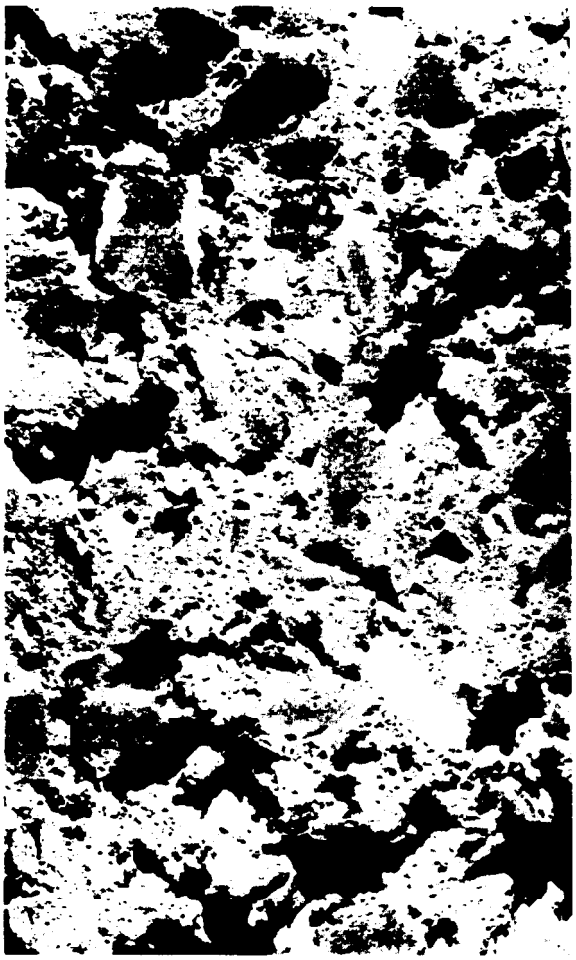
(b) Excess voidage = 0.5 %



9c0 Excess voidage = 1.5 %

(d0 Excess voldage = 3 0 %

Figure 1. Actual-size photographs of cores of different voidages masked to give a standard area of 125 mm x 80 mm in each case



(e) Excess voidage = 13.0 %

Figure 1. *(concluded)*

fracture before the concrete fails when the specimen is tested.

5.4 Storage. After end preparation by grinding or capping, immerse the specimen in water at 20 ± 2 °C for at least 1 h and until it is in a saturated condition for testing. Do not test cores from high strength concrete capped with high alumina cement mortar until the caps reach a higher strength than that expected for the concrete.

6. Procedure

6.1 General. Test the core in compressron not less than 2 days after end preparation and immersing in water. Cores with cracked or loose caps shall not be tested. Test the core immediately on removal from the water and whilst it is still wet.

6.2 Placing the core in the testing machine. Wipe the bearing surfaces of the testing machine and of any auxiliary platens clean and remove any water, loose sand or other material from the ends of the core. Centre the core carefully on the lower platen of the machine. Wherever possible use a jig to align the specimen, Do not use any packing other than auxiliary steel platens between the ends of the core and the platens of the testing machine.

6.3 Loading. Without shock apply and increase the load continuously at a constant rate within the range of 0.2 N/(mm^2.s) to 0.4 N/(mm^2.s) until no greater load can be sustained. On manually controlled machines as failure is approached the load-indicator pointer will begin to slow down; at this stage operate the controls rapidly and smoothly to maintain as far as possible the specified loading rate. Record the maximum load. Normal failures are reasonably symmetrical. Note any unusual failures and the appearance of the concrete.

7. Calculation and expression of results

7.1 Calculation and expression of results. Calculate the compressive strength of each core by dividing the maximum load by the cross-sectional area, calculated from the average diameter. Express the results to the nearest 0.5 N/mm^2.

NOTE. The presence of reinforcement in cores cut from reinforced concrete may affect the result.

7.2 Estimated in-situ cube strength

7.2.1 *For cores free of reinforcement.* Calculate the estimated in-situ cube strength to the nearest 0.5 N/mm^2 from the equation

$$\text{estimated in-situ cube strength} = \frac{D}{1.5 + \frac{1}{\lambda}} \times \text{measured compressive strength of core}$$

where

D is 2.5 for coresdrilled horizontally (for precast units perpendicular to height when cast); or 2.3 for cores drilled vertically (for precast units parallel to height when cast);

A is the length (after end preparation) /diameter ratio.

NOTE. It should be noted that in-situ strengths estimated from the above formula cannot be equated to standard cube strengths.

7.2.2 For cores with reinforcement perpendicular to the core axes. Calculate the estimated in-situ cube strength by multiplying the strength obtained from the formula in 7.2.1 by the following factors:

(a) for cores containing a single bar:

$$1.0 + 1.5\,\frac{\phi_r d}{\phi_c \ell}$$

(b) for specimens containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of $\phi_r d$ need be considered. If the bars are further apart, their combined effect should be assessed by using the factor:

$$1.0 + 1.5\,\frac{\Sigma \phi_r d}{\phi_c \ell}$$

where

ϕ_r is the diameter of the reinforcement;

ϕ_c is the diameter of specimen;

d is the distance of axis of bar from nearer end of specimen;

ℓ is the length of the specimen after end preparation by grinding or capping.

8. Test report

8.1 General. The report shall affirm that the specimens were taken, prepared and tested in accordance with this Part of this standard.

8.2 **Information to be provided by the producer of the test specimens for inclusion in the test report**

8.2.1 Mandatory information. The following information shall be provided by the producer of the test specimens for inclusion in the test report:

(a) identification of the core (see 4.3);

(b) date of drilling;

(c) direction of drilling relative to direction of casting, e.g. vertically, horizontally or diagonally;

(d) name of person taking cores;

(e) conditions of storage.

(f) required age of concrete at time of testing, if known.

8.2.2 Optional information. If requested the following information shall be provided by the producer of the test specimens for inclusion in the test report:

(a) name of project;

(b) component or part of project;

(c) specified concrete strength;

(d) concrete mix details;

(e) admixtures used.

8.3 **Information to be provided by the test laboratory for inclusion in the test report**

8.3.1 Mandatory information. The following information shall be provided by the test laboratory for inclusion in the test report:

(a) identification of the specimen;

(b) condition of specimen when received (include poor compaction, honeycombing or bad dimensions);

(c) date of receipt of the specimen;

(d) average diameter;

(e) maximum and minimum lengths, as-received;

(f) density of the specimen (as-received or saturated and the method of determining the volume);

(g) length after preparation, and location in relation to the length received;

(h) method of end preparation;

(i) compaction of concrete, distribution of materials, classif ication of voids and presence of cracks;

(j) date of test;

(k) age of specimen, when known, at date of test;

(l) length of time specimen was stored in water before strength testing;

(m) maximum load of failure;

(n) measured compressive strength and estimated in-situ cube strength;

(0) appearance of concrete and type of fracture;

(p) size, position and spacing of any reinforcement;

(q) certificate that the test has been carried out in accordance with this Part of this standard;

(r) other remarks.

8.3.2 Optional information. If requested the following information shall be provided by the test laboratory for inclusion in the test report:

(a) copy of the photograph, or photographs, of the core as-received;

(b) description of aggregate, including maximum size, group classification, particle shape;

(c) other remarks,

Publications referred to

BS 308	Engineering drawing practice
	Part 3 Geometrical tolerancing
BS 410	Specification for test sieves
BS 812	Methods for sampling and testing of mineral aggregates, sands and fillers
BS 882	Coarse and fine aggregates from natural sources
BS 891	Method for Rockwell hardness test
	Part 1 Testing of metals
BS 915	High alumina cement
BS 1134	Method for the assessment of surface texture
BS 1881	Testing concrete
	Part 114 Method for determination of density of hardened concrete
	Part 115 Specification for compression testing machine for concrete
	Part 121 Method for determination of static modulus of elasticity in compression
BS 4019	Core drilling equipment
	Part 2 Concrete drilling equipment
BS 5328	Methods for specifying concrete, including ready-mixed concrete
BS 5497	Precision of test methods
	Part 1 Guide for the determination of repeatability and reproducibility for a standard test method
BS 6089	Guide to the assessment of concrete strength in existing structures
BS 8110	Structural use of concrete
	Part 1 Code of oractice for design and construction

*Concrete Society Technical Report No. 11

*The Concrete Society, Concrete core testing for strength. London, May 1976. (including addendum 19871. Technical Report No. 11. Obtainable from the Concrete Society, Devon House, 12 - 15 Dartmouth Street, London SW1H 9BL.

This Britrsh Standard, having been prepared under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Committee, was published under the authority of the Standards Board and comes into effect on 31 January 1983.

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Cooperating organizations

The Cement, Gypsum, Aggregates and Quarry Products Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following:

Association of Consulting Engineers
Association of County Councils
Association of District Councils
Association of Metropolitan Authorities
Autoclaved Aerated Concrete Products Association
*British Precast Concrete Federation Ltd.
'British Quarrying and Slag Federation
British Railways Board
*British Ready Mixed Concrete Association
British Steel Industry
Cement Admixtures Association
'Cement and Concrete Association
*Cement Makers' Federation
Chemical Industries Association
*Concrete Society Limited
*County Surveyors' Society
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*Department of the Environment (PSA)
*Department of the Environment (Transport and Road Research Laboratory)
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Stone Federation

The organisations marked with an asterisk in the above list, together with the following, were directly represented on the Technical Committee entrusted with the preparation of this British Standard:

British Civil Engineering Test Equipment Manufacturers' Association
Electricity Supply Industry in England and Wales
Greater London Council
Institute of Concrete Technology
Coopted member

Amendments issued since publication

Amd. No.	Date of issue	Text affected
6109	July 1989	Indicated by a line in the margin

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