前記の石橋博士の御請求による補記

第一　セメントの強度試験規定

其一　純セメントの抗張強度

(1) American Society for Testing Materials.

Committee on Uniform Tests of Cement of the American Society of Civil Engineers.

1. 試驗片は頸部に於て一平方吋の面積を有するブリッケット
2. 加重の速度は一分間に六百听
3. 抗張强度は少くも次の値を有すべし

濕潤せる空氣中に一日間		150－200听
〃	水中に六日間	450－550
〃	〃二十七日間	550－650

水の温度は約華氏七十度

(2) Engineering Standards Committee (英)

1. 試驗片は頸部に於て一平方吋の面積を有するブリッケット
2. 加重の速度は一分間に五百听
3. 抗張强度は少くも次の値を有すべし

濕潤せる空氣中に一日間	水中に六日間	400听
〃	〃二十七日間	500

水の温度は華氏五十八乃至六十四度

七日より二十八日に至る增加は次の割合より少なるべからず

七日の試驗結果	400－450听なる時	25%
〃	450－500 〃	20%
〃	500－550 〃	15%
〃	550－600 〃	10%
〃	600以上 〃	5%

4. 六個のブリッケットに對する結果の平均を以て抗張強度とす

(3) 佛國政府

1. 試驗片は頸部に於て五平方サンチメートルの面積を有するブリッケット

2. 抗張強度は少くも次の値を有すべし

濕潤せる空氣中に一日間海水中に	六日間	15 kg/cm²
〃 〃	二十七日間	30 〃
〃 淡水中に	六日間	25 〃
〃 〃	二十七日間	35 〃

七日より二十八日の間に抗張強度は少くも三キログラムを增加すべし

3. 六個のブリッケットの内最良の四個に對する結果の平均を以て抗張強度とす

其二　砂入セメントの抗張強度

(1) American Society for Testing Materials

Committee on Uniform Tests of Cement of the American Society of Civil Engineers.

1. 砂は Ottawa, Ill. の者にて 20×20 (線徑 0.0165吋)を通過し 30×30 (線徑 0.0112吋)に止められたる者

2. 試驗片及加重速度は其一に仝し. 割合は 1:3.

3. 抗張強度は少くも次の値を有すべし

濕潤せる空氣中に一日間水中に	六日間	150 − 200 听
〃 〃	二十七日間	200 − 300

水の温度は約華氏七十度

(2) Engineering Standards Committee (英)

1. 砂は Leighton Buzzard の者にて 20×20 (線徑 0.0164吋)を通過し 30×30 (線徑 0.0108吋)に止められたる者

2. 試験片及加重速度は其一に仝し．割合は 1:3.

3. 抗張强度は少くも次の値を有すべし

濕潤せる空氣中に一日間水中に	六日間	120听
〃	〃 二十七日間	225

水の温度は華氏五十八乃至六十四度

七日より二十八日に至る増加は 20% より少なるべからず

4. 六個のブリッケットに對する結果の平均を以て抗張强度とす

（3） 佛國政府

1. 砂は Leucate の者にて半,一,一半,二ミリメートルの孔を通過せる三種の砂の等分を混和したる者

2. 割合は 1:3

3. 抗張强度は少くも次の値を有すべし

濕潤せる室氣中に一日間海水中に	六日間	6 kg/cm²
〃	〃 二十七日間	12 〃
〃	淡水中に六日間	8 〃
〃	〃 二十七日間	15 〃

海水試験にては七日より二十八日の間に抗張强度は少くも二キログラムを增加すべし

淡水試験にては七日より二十八日の間に抗張强度は少くも二キログラムを增加すべし

4. 六個のブリッケットの内最良の四個に對する結果の平均を以て抗張强度とす

（4） 獨國政府

1. 砂は Verein Deutscher Portland Zement Fabrikaten の供給する石英砂の六十目 /cm² (線徑 0.38mm) を通過し百二十目(線徑 0.32mm) にて止められたるものと同様の者

2. 試験片は頸部に於て五平方サンチメートルの面積を有するブリ

ツケツト

3. 割合は 1:3

4. 加重の速度は一分間に六千グラム

5. 抗張強度は緩結セメントにて少くも次の値を有すべし

濕潤せる空氣中に一日間水中に二十七日間　16 kg/cm²

水の温度は攝氏十五乃至十八度

急結セメントの強度は多少之より小なるべし

6. 最良の十個のブリツケツトに對する結果の平均を以て抗張強度とす

(5) Oesterreicher Ingenieur- und Architekten-Verein

1. 砂は石英砂にて六十四目 /cm² (鑢徑 0.40mm) を通過し百四十四目 (鑢徑 0.30 mm) にて止められたるもの

2. 試驗片は頸部に於て五平方サンチメートルの面積を有するブリツケツト

3. 割合は 1:3

4. 加重の速度は一分間に六千グラム

5. 抗張強度は少くも次の値を有すべし

緩及中	濕潤せる空氣中に一日間水中に	六日間	12	kg/cm²
	〃　〃	二十七日間	18	〃
急	〃　〃	六日間	8	〃
	〃　〃	二十七日間	12	〃

水の温度は攝氏十五乃至十八度

6. 六個のブリツケツトの內最良の四個に對する結果の平均を以て抗張強度とす

其三　砂入セメントの抗壓強度

(4) 獨國政府

1. 砂は其二の者と同じ

2. 試驗片は五十平方サンチメートルの立方體

3. 割合は 1:3

4. 加重は立方體の側面に加ふ

5. 抗壓强度は緩結セメントにて少くも次の値を有すべし

濕潤せる空氣中に一日間水中に二十七日間　160 kg/cm²

急結セメントの强度は多少之より小なるべし

6. 最良の十個の立方體に對する結果の平均を以て抗壓强度とす

(5) 墺國政府

1. 砂と試驗片は其二の者と同じ

2. 抗壓强度は少くも次の値を有すべし

緩及中	濕潤せる空氣中に一日間水中に二十七日間	180 kg/cm²
急	〃　〃	120 〃

3. 六個のブリッケットの内最良の四個に對する結果の平均を以て抗壓强度とす

第二　鐵筋混凝土桁强弱試驗

次の表は鐵筋混凝土桁の强弱に關する試驗を記載せる文書を示せる者にて此等の文書は我邦に有觸れたる者多きが故に今其詳細を記さず表中第二行に記せる略字は

Pr. = Plain round bar

Ps = Plain square bar

Pl = Flat bar

J = Johnson bar

K = Kahn bar

R = Ransome bar

T = Thacher bar

を示し第三行の文書の番號は次の如し

(1) Emperger-Handbuch für Eisenbetonbau.

(2) Engineering News.

(3) Engineering Record.

(4) Forscherarbeiten auf dem Gebiete des Eisenbetons.

(5) Journal of the Western Society of Engineers.

(6) Marsh-Reinforced Concrete.

(7) Proceedings of the American Society of Engineers.

報告者	用ひたる釬	文書
Commission du Ciment Armé (Paris)	Pr.	(1)
Emperger	Pr. Pl. R. T.	(1), (4) Heft III
Harding	Pr. J. K. R.	(2) 1906, (3) 1905, (5), (6)
Lanza	Pr. R.	(6), (7) 1903
Marburg	Ps. J. R T.	(2) 1904, (6)
Mörsch	Pr. T.	(1)
Probst	Pr. Ps. J. R.	(1), (4) Heft VI

此等の實驗の外 E. Brown 氏の The Canadian Society of Civil Engineers, 1908 に報告せる實驗あり，其結果の概略は次の表の如く之に關して同氏は下に附記せる意見を有せり

Beam	Size	% reinf.	Age days	Max. load lbs.	Const. in M= cbd²	Wgt. of beam lbs.	Wgt. of steel lbs.	Failure
Johnson 5—½″ rods 3 at 45°	7.9″×11.7″ ×10′0″ C.toC.	1.04	392	22,000	473	1001	31.0	Tension in central third, and compression above.
Ransome 3—½″ rods One bar bent up to come out over support	6¾″×9¾″ ×6′0″ C. to C.	1.25	363	36,400	800	450	17.5	End face cracked diagonally. Cracks joining base cracks. Rods pulled at end. Compression failure showing at one support
Kahn 2—½″ rods	6″×7″ ×6′0″ C. to C.	1.33 net	405	12,500	645	279	17.8	Tension in central third, compression in concrete above.
Kahn 1—¾″ rod	6″×8″ ×6′0″ C. to C.	1.30 net	413	15,100	578	310 est.	17.0	Tension in central third, compression in concrete above.
Ransome 2—½″ rods No diagonal bars	6″×8″ ×6′0″ C. to C.	1.15	386	16,000	612	312	11.0	Tension in central third, compression in concrete above.

* * * "The tests described in the preceding pages cover considerable variation as regards method and percentage of reinforcement, including beams with no diagonal reinforcement, beams with diagonal reinforcement secured by bending up of tension bars when no longer required as tension reinforcement, and beams with wing bars having as a very considerable weight of diagonal reinforcing metal over the entire length. The results have been presented in sufficient detail to enable the reader to follow the make-up of each beam, and its behaviour under test. It would be idle to attempt to make any detailed comparisons between the carrying capacity of the various beams and the weights of steel employed, since such comparisons must inevitably be affected by a variety of conditions, the exact influence of which would be in all probability uncertain, and in any case would be the subject of dispute. The wing bars gave diagonal reinforcement over the entire length of the beams, irrespective of the central third not being under shearing action. The diagonal wings on this portion would appear, therefore, to have mainly assisted the bond. The bars were only obtainable sheared over the whole length. None of the diagonal metal is figured in the percentage net reinforcement, which was constant throughout the length. On the other hand, in the case of beams reinforced with straight rods, corrugated or twisted, the only diagonal reinforcing provided was that obtained by bending up tension bars when the conditions permitted. In this way the tension reinforcement was diminished towards the free ends, and the total weight of steel was very little in excess of what it would have been for a uniform tension reinforcement alone throughout the beam. The number of rods used to obtain the required degree of reinforcement is of importance in making comparisons, as it affects the distribution of stress between steel and concrete. The nature of the loading, the ratio of depth to span of the beam, are also factors to be borne in mind in considering the advantages of any particular type of reinforcement. Roughly speaking, in the case of the wing bars, about one-third of the gross section appears as diagonal reinforcement, leaving two-thirds to be used in figuring the net tension reinforcement. By using the same weight of steel in the form of straight bars, the gross section can be utilized as tension reinforcement and a much lighter diagonal reinforcement be provided by the bending up of bars at intervals. The exact effects of thus equalizing the gross weights of steel used, in reinforcing by methods differing so essentially as those discussed above, cannot be inferred with certainty from the results of tests in which the percentage reinforcements figured on the net sections are much more nearly equal than the gross weights. The nature and extent of such influences would ever be a matter of personal opinion. A close observation of the behaviour of the beams under test, and a study of the results of the tests

has, however, led the author to the opinion that under ordinary circumstances a sufficient reinforcement can be provided without using so much material as is involved in a bar having heavy wings spaced uniformly along its length irrespective of the form of shear diagram, and providing the same net tension reinforcement throughout irrespective of the variable bending moment. Beam in practice may have to take up their loads at earlier periods after manufacture than beams under laboratory test, and additional precautions may be necessary. But the author believes that all adequate reinforcement can be provided by a careful disposition of straight rods, due regard being paid to the form of the bending moment and shearing force diagrams. The results of a test on a beam reinforced with two Ransome bars and having no diagonal reinforcement whatever (See Table, P. 57) have been referred to already. The beam was loaded at the third points, just outside which the conditions were severe, as the shear attained its full value, and the bending moment was sensibly the same as over the central third. The beam failed, not by end shear, but in the central third. It is true that the concrete was rich and mature, the beam being thirteen months old. But bearing these facts in mind, the result is a striking one, and taken in conjunction with the evidences of the tests, as to the efficacy of a bent bar in resisting end shearing, it has suggested the thought that diagonal reinforcing may possibly be a somewhat over-estimated factor in the proportioning of reinforced concrete beams. It is necessary beyond any doubt, but the means by which the necessary amount may be obtained with the minimum expenditure of steel will probably be determined by experience in practice, and by comparative tests outside the scope of this paper, rather than by theoretical investigations on assumed conditions, imperfectly realized in practice."