majer, when the ratio $\frac{CaO}{SiO_2}$ falls below unity the slag is useless; the ratio of alumina to silica must be between 0.45 and 0.50. According to Mr. Prost, the composition of slags habitually used in the manufacture of Puzzolan cements must be nearly represented by the formula 2 SiO_2, Al_2O_3, 3 CaO."

Mr. E. C. Eckel* gives the following analyses of slag and slag cement:

Analyses of Slags in Actual Use and Composition of Slag Cements

CONSTITUENT.	SLAG			CEMENT		
	Choindez, Switzerland.	Saulnes, France.	Chicago, Ill.	Choindez, Switzerland.	Saulnes, France.	Chicago, Illl.
SiO_2	26.24	31.50	32.20	19.5	22.45	28.95
Al_2O_3	24.74	16.62	15.50	17.5	13.95	11.40
FeO	0.49	0.62			3.30	0.54
CaO	46.83	46.10	48.14	54.0	51.10	50.29
MgO	0.88		2.27		1.35	2.96
CaS	0.59					
$CaSO_4$	0.32					
S						1.37
SO_3					0.35	
Loss on ignition					7.50	3.39
$\frac{CaO}{SiO_2}$	1.78	1.46	1.49			
$\frac{Al_2O_3}{SiO_2}$	0.93	0.52	0.48			

Process of Manufacture of Puzzolan Cement. No kilns are required except for burning the lime. Molten slag as it flows from the blast furnace is granulated by coming in contact with a stream of cold water. This renders the product more strongly hydraulic, and most of the sulphur is removed as it strikes the water. As sent to the cement plant, it usually contains from 30% to 40% of water, and the first operation is to pass it through a dryer. The dried slag may or may not have a preliminary grinding before adding the slaked lime.

The lime is produced by burning a pure limestone, and then slaking it with water to which has been added a small percentage of caustic soda or other similar material, to make the resulting cement quicker setting. After drying, the slaked lime is mixed with the slag and ground in ball mills and tube mills, or in other forms of fine grinding machinery, and is ready for packing in bags or barrels for shipment.

*Mineral Resources of the United States, 1901.

CHAPTER XXIX

REFERENCES TO CONCRETE LITERATURE

While this chapter is not a complete bibliography of concrete literature, it presents a comprehensive list of valuable books and articles relating to the subject.

Under General References the names of authors are arranged alphabetically. The various subject headings under Subject References are also arranged alphabetically, and the references are printed in order of dates, the latest first. Articles are usually described by their subject-matter instead of giving their titles verbatim. In the case of similar articles printed in two or more periodicals, preference is generally given to the one bearing the earlier date. For references to this treatise see the Index.

ABBREVIATIONS

The following abbreviations (most of which correspond to those adopted by the Engineering Index) are employed:

Ann. de Ponts et Chauss.—Annales des Ponts et Chaussées. m. Paris.
Arch. Rec.—Architectural Record. New York.
Beton u. Eisen.—Beton und Eisen. Vienna.
Can. Eng.—Canadian Engineer. Montreal, Canada.
Cement and Eng. News.—Cement and Engineering News. Chicago.
Comptes Rendus—Comptes Rendus de l'Académie des Sciences. Paris.
Con. Eng.—Concrete Engineering. Cleveland, Ohio.
Deutsche Bau.—Deutsche Bauzeitung. Berlin.
Eng. Contr.—Engineering Contracting. New York.
Eng. Mag. — Engineering Magazine. New York & London.
Eng. News. — Engineering News. New York.
Eng. Rec. — Engineering Record. New York.
Gen. Civ. — Génie Civil. Paris.
Ins. Eng. — Insurance Engineering. Boston.
Int. Eng. Cong. — International Engineering Congress, St. Louis, 1904.
Jour. Am. Chem. Soc. — Journal American Chemical Society. Easton, Pa.
Jour. Assn. Eng. Socs. — Journal of the Association of Engineering Societies, Philadelphia.
Jour. Fr. Inst. — Journal Franklin Institute. Philadelphia.
Jour. W. Soc. Engs. — Journal of the Western Society of Engineers, Chicago.
Munic. Engng. — Municipal Engineering. Indianapolis.
Oest. Monatschr. f. d. Oeff. Baudienst. — Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. Vienna.

Pro. Am. Soc. Civ. Engs. — Proceedings of the American Society of Civil Engineers. New York.
Pro. Am. Soc. Test. Mat. — Proceedings of American Society for Testing Materials. Philadelphia.
Pro. Assn. Ry. Supts. — Proceedings of the American Association of Railway Superintendents of Bridges and Buildings. New York.
Pro. Engs. Club of Phila. — Proceedings Engineers' Club. Philadelphia.
Pro. Engs. Soc. of W. Penn. — Proceedings of Engineers' Society of Western Pennsylvania. Pittsburgh.
Pro. Inst. Civ. Engs. — Proceedings of the Institution of Civil Engineers. London.
Ry. & Eng. Rev. — Railway & Engineering Review. Chicago.
R. R. Gaz. — Railroad Gazette. New York.
Rept. Chief of Engs., U. S. A. — Report of Chief of Engineers, U. S. A.
Rept. Eng. Dept. — Report of Engineering Department, Washington, D. C.
Rept. Met. W. & S. Board. — Report of Metropolitan Water & Sewerage Board, Massachusetts.
Revue Gen. des Chemins de Fer. — Revue Générale des Chemins de Fer. Paris.
Rev. Tech. — Revue Technique. — Paris.
Schw. Bauz. — Schweizerische Bauzeitung. Zürich.
Tech. — Technograph. University of Illinois. Champaign, Ill.
Tech. Qr. — Technology Quarterly. Boston.
Trans. Am. Soc. Civ. Engs. — Transactions American Society of Civil Engineers. New York.
Trans. Am. Soc. Mech. Engs. — Transactions American Society of Mechanical Engineers. New York.

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Bridges

Location	Max. span ft.	Max. rise ft.	Crown thickness ft.	Reinforcement	Authority
Switzerland	259	87′	4′	Longitudinal & transverse bars	*Eng. News*, Aug., 1909, p. 133.
42d St., Phila.	250	53	3	Double steel arch ribs	*Eng. News*, May, 1909, p. 540.
C. B. & Q. R. R. Trestles					*Eng. News*, May, 1909, p. 546.
Delaware River D. L. & W. R. R.	150	40	6		*Eng. Rec.*, Apr., 1909, p. 542.
Paulins Kill D. L. & W. R. R.	120	60	6		*Eng. Rec.*, Apr., 1909, p. 541.
Grand River L. S. & M. S. Ry.	160	71½	7	Longitudinal & transverse bars	*Eng. Rec.*, Apr. & May, 1909.
Cumberland Valley Ry.	100	32	5	None	*Eng. News*, Apr., 1909, p. 377.
Wyoming Ave., Phila.	90	28	2½	Horizontal longitudinal rods in spandrel walls. No other reinforcement	*Eng. Rec.*, Feb., 1909, p. 233.
Harrisburg, Pa. Viaduct					*Eng. Rec.*, Aug., 1908, p. 228.
Maumee, Waterville, Ohio	90	25	2	Longitudinal & transverse rods	*Cement*, Aug., 1908, p. 116.
Sandy Hill, N. Y.	60	8½	1½	Ribs, angle bars, latticed	*Trans. Am. Soc. Civ. Engrs.*, Vol. LIX. p. 195.
Walnut Lane Phila.	233	70	5½	None	*Eng. News*, Jan., 1907, p. 117.
Paterson, N. J.,	54	2.5	1.8	11 ribs about 4 ft. apart	*Eng. Rec.*, Sept., 1904, p. 303
Plainwell, Mich.,	54	8	1.25	4-inch 6-lb. channels 1.9 ft. apart	*Eng. News*, May, 1904, p. 456
Waterloo, Iowa,	72	7.2	1.18	Steel Ribs	*Eng. Rec.*, Feb., 1904, p. 185
Yellowstone River,	120	15	2.0	Lattice girders	*Eng. News*, Jan., 1904, p. 25

*An asterisk precedes the references which are especially noteworthy.

Location.	Max. span ft.	Max. rise ft.	Crown thickness ft.	Reinforcement.	Authority
Plano, Ill.,	75	38½	3	¾″ and ⅞″ corrugated bars	*Eng. Rec.*, Jan., 1904, p. 18
3rd St., Dayton, Ohio,	110	14.25	2.1	Melan, 4 angles, latticed	Edwin Thacher, 1904
Newark, N. J.,	132	16.2	3	Melan, 4 angles, latticed	Edwin Thacher, 1904
Kankakee, Ill.,	73	8.4	1.33	Thacher, rods near top and bottom	Edwin Thacher, 1904
Mishawaka, Ind.,	110	14	2	Melan, 4 angles, latticed	Edwin Thacher, 1903
Prospect Ave., N. Y,	85	8½	2.25	Corrugated bars	*Eng. News*, Dec., 1903, p. 588
Riverside, Cal.,	87	36 9	3.5	None	*Eng. News*, Oct., 1903, p. 353
Leominster, Mass.,	45	6.25	1.1	Round rods anchored	J. R. Worcester, 1903
Des Moines River,	100	28	1.67	Melan	*Cement*, July, 1902, p. 200
Zanesville, Ohio,	122	11.5	2.5	¾″ x 5″ bars	*Eng. News*, March, 1902, p. 261
Concord, Mass.,	56	7	1.1	None	J. R. Worcester, 1901
Lansing, Mich.,	120	23	2	Melan, 4 angles, latticed	Edwin Thacher, 1901
South Bend, Ind.,	100	11	2.5	Melan, 4 angles, latticed	Edwin Thacher
Chatellerault, France,	164	15.7	1.7	Hennebique	Revue Gen. des Chemins de Fer, Dec., 1901
Kirchheim, Germany,	124.6	18	2.6	None	*Eng. News*, Oct., 1899, p. 246
Germany,	132	14.7	0.82	Monier	*Eng. News*, Sept., 1899, p. 179
Switzerland,	128	11	0.56	Monier	*Eng. News*, Sept., 1899, p. 179
Southern Ry., Austria,	32.8	3-3	0.5	Monier	*Eng. News*, Sept., 1899, p. 179
Topeka, Kan.,	125	12	1.8	Melan beams	*Eng. Rec.*, April 16, 1898
Inzigkofen, Germany,	140	14.5	2.3	33 000 lb. cast iron	*Eng. News*, Sept., 1896, p. 178
Munderkingen, Germany,	164	16.4	3.3	None	Inst. Civ. Engs., V. 119, p. 224
Cincinnati, Ohio,	70	10	1.25	Melan beams	*Eng. News*, Oct., 1895, p. 214
Maryborough, Queensl'd	50	4	1.25	Steel rails	*Engng.*, London, May 10, 1895, p. 395
Neuhäusel, Hungary,	55.78	3.7	0.82	Skeleton girders	Inst. Civ. Engs., V., 114, p. 402
Philadelphia, Penn.,	25.39	6.5	3	1½″ mesh. ¼″ wire netting	*Eng. News*, Sept., 1893, p. 189

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Terrell, C. E. Garage, White Plains, N. J. Eng. News, Dec., 1907, p. 633.
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Newark Warehouse Co., Newark, N. J. Eng. Rec., Aug., 1907. p. 152.
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R. H. H. Steel Laundry Building, Newark, N. J. Eng. Rec., June, 1907, p. 677.
Burleigh, W. F. Murphy Varnish Co. Building, Newark, N. J. Eng. Rec., May, 1907, p. 555.
Holy Angels School, Buffalo, N. Y. Eng. Rec., April, 1907, p. 491.
Ketterlinus Lithographic Manufacturing Co. Building, Phila. Eng. Rec., Feb., 1907, p. 128.
Eagle Warehouse and Storage Co. Building Brooklyn, N. Y. Eng. Rec., Jan., 1907 p. 19.
Marlborough Apartment House, Baltimore, Md. Eng. Rec. Jan., 1907, p. 99.
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Cadillac and Packard Automobile Shops, Detroit, Mich. Eng. Rec., Nov., 1906, p. 544.
Traders Paper Bond Co. Building, Bogota, N. J. Eng. Rec., Oct., 1906, p. 457.
A. T. & S. F. Railway Station. Eng. News, Sept., 1906, p. 246.
Marlborough Hotel Annex, Atlantic City, N. J. Eng. News, March, 1906, p. 251.
Taylor & Wilson Manufacturing Co. Building, McKees Rocks, Pa. Eng. Rec., Dec., 1905. p. 695.
B. T. Babbit Works, Jersey City, N. J. Eng. Rec., Dec., 1905, p. 747.
North West Knitting Co. Building, Minneapolis, Minn. Eng. News, June, 1905, p. 593.
Concrete Medical Laboratory, Brooklyn, Navy Yard. Eng. News, March, 1905 p. 310.
Masonic Temple Building, Toledo, Ohio. Eng. News, March, 1905, p. 287.
United Shoe Machinery Shops, Beverly, Mass., Eng. Rec., March, 1905, p. 257.
Bilgram Machine Shop, Philadelphia. Eng. Rec., Feb., 1905, p. 136.
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*Store building, Chicago, Ill. Eng. Rec., June, 1904, p. 713.
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*Kelly & Jones Company's factory building. Eng. Rec., Feb., 1904, pp. 153 and 195.
Lighthouse at Nicolaieff, Russia. Eng. Rec., Jan., 1904, p. 100.
*Factory building, Long Island City, N. Y. Eng. Rec., Jan., 1904, p. 67.
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*The Filtration works of the East Jersey Water Supply Company, Little Falls, N. J. G. W. Fuller, Trans. Am. Soc. Civ. Eng., Vol. L, p, 394.
*Ingalls Building, Cincinnati, O. Eng. Rec., May, 1903, p. 540.
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Elevator, Buffalo, N. Y. C. R. Neher, Jour. Assn. Eng. Socs., April, 1901, p. 275.
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