From the library of Chris Zynda

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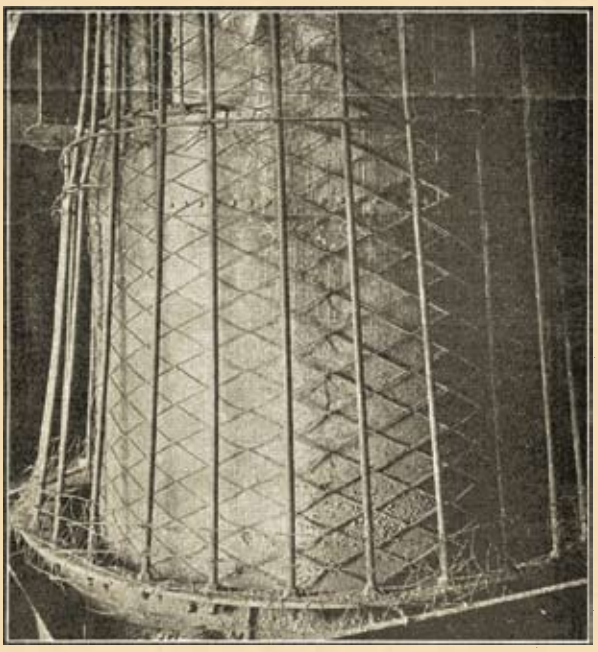
Guniting Steel Cement Kiln Stacks

Steel Kiln Stacks at St. Mary's Cement Co.'s Plant, St. Mary's, ON, Canada, Made Self-Supporting by Application of Gunite Which Will Also Prolong Their Life Indefinitely—Results of Tests Undertaken in Connection with the Work

by John E. Lind, Manager, St. Mary's Cement Co. Ltd., St. Mary's, ON, Canada

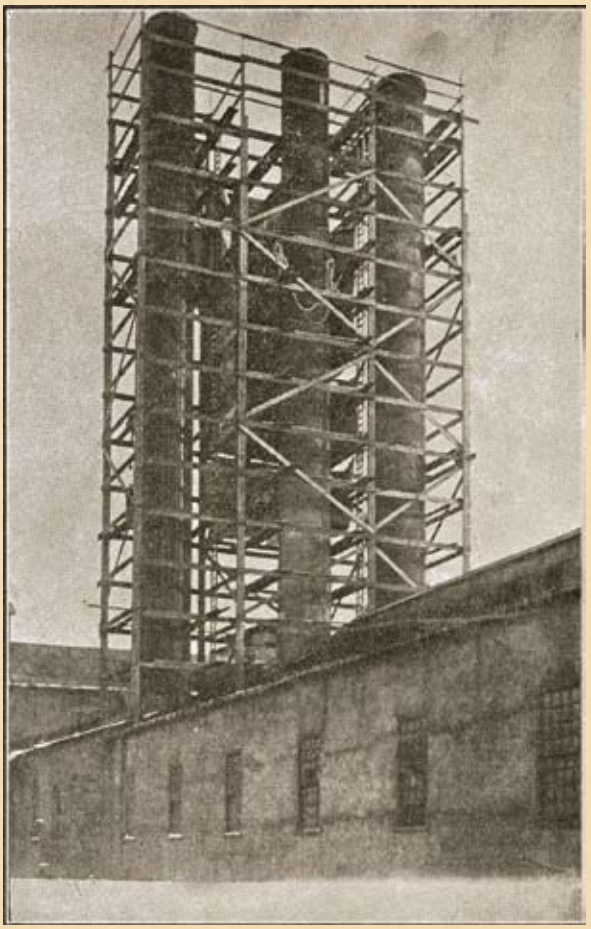
SOME interesting guniting work was recently accomplished at the plant of the St. Mary's Cement Co. Ltd., St. Mary's, Ont., where three steel kiln stacks were coated with gunite in order to make them self-supporting, and thus do away with guy ropes. The principal reason, however, was to extend the life of the stacks indefinitely, as the average life of kiln stacks under ordinary circumstances is only six years. The stacks are 122 ft. high, 6 ft. 6 in. in diameter, and made of ¼-in. steel plate, and lined with 4-in. circular fire brick. The work was somewhat unusual and was in the nature of an experiment as the writer cannot remember having ever heard of cement-kiln stacks having been gunited before. The work however, has been entirely successful and quite up to expectations. It is interesting to note that the work was carried out in winter, and sometimes under severe climatic conditions. On one day, January 11th, there was a particularly severe storm when the wind reached a velocity of 55 miles per hour, but the stacks did not show any visible signs of having been damaged by the excessive strain to which they were subjected. The work occupied 34 days.



SHOWING HOW THE MESH IS FIRST WRAPPED AROUND THE STACK

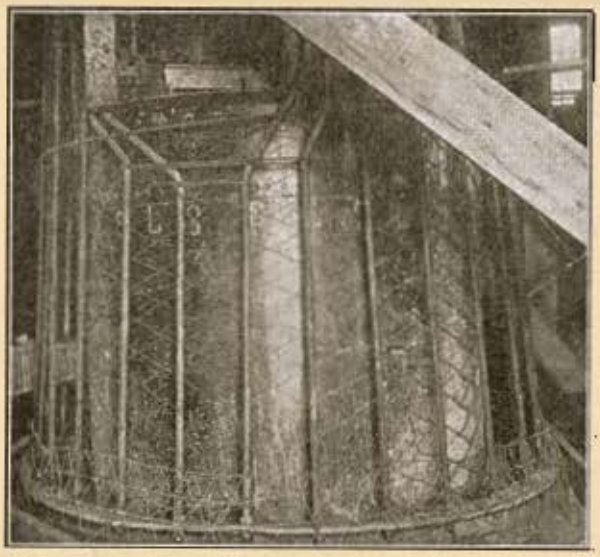
The Rods are then Placed Vertically with the Band Rods at Occasional Intervals.

The foundations of the old stacks were octagon in shape, 9 ft. in diameter and 9 ft. deep to bed rock. These were enlarged to 18 ft. in diameter and down to bed rock, and filled with concrete of one to six mixture, to take care of the wind stresses. In the old foundation, three rounds of 1-in.



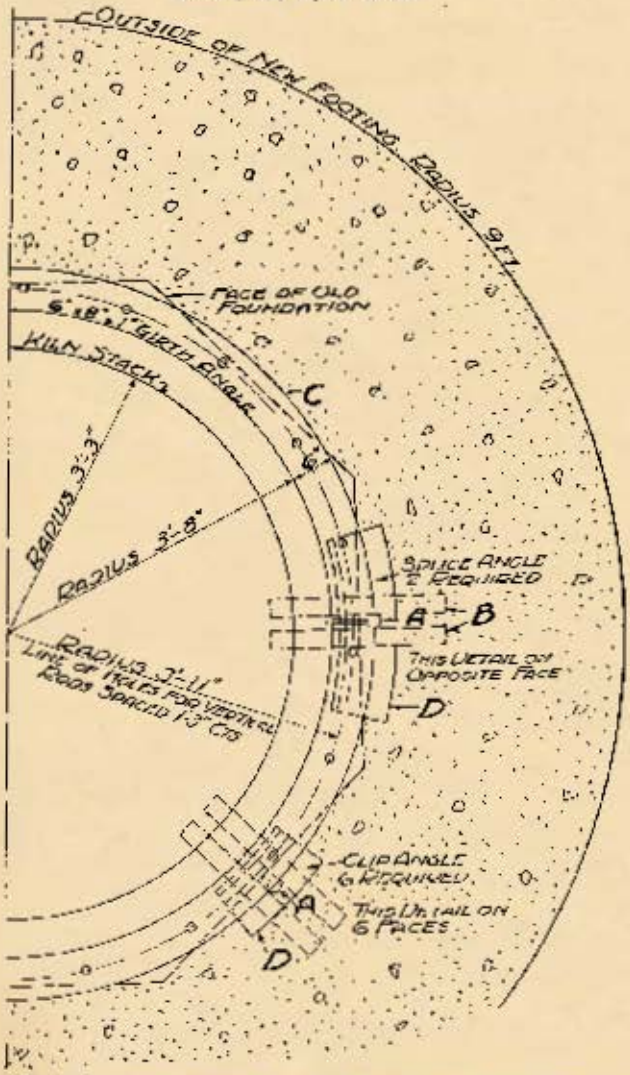
VIEW OF THE THREE KILN STACKS

Showing the Left-Hand Stack With the Rods and Mesh in Place, the Middle Stack With the Gunite Being Applied and the Right-Hand Stack Completed



THIS VIEW SHOWS HOW THE MESH IS SUBSEQUENTLY PLACED OUTSIDE THE RODS

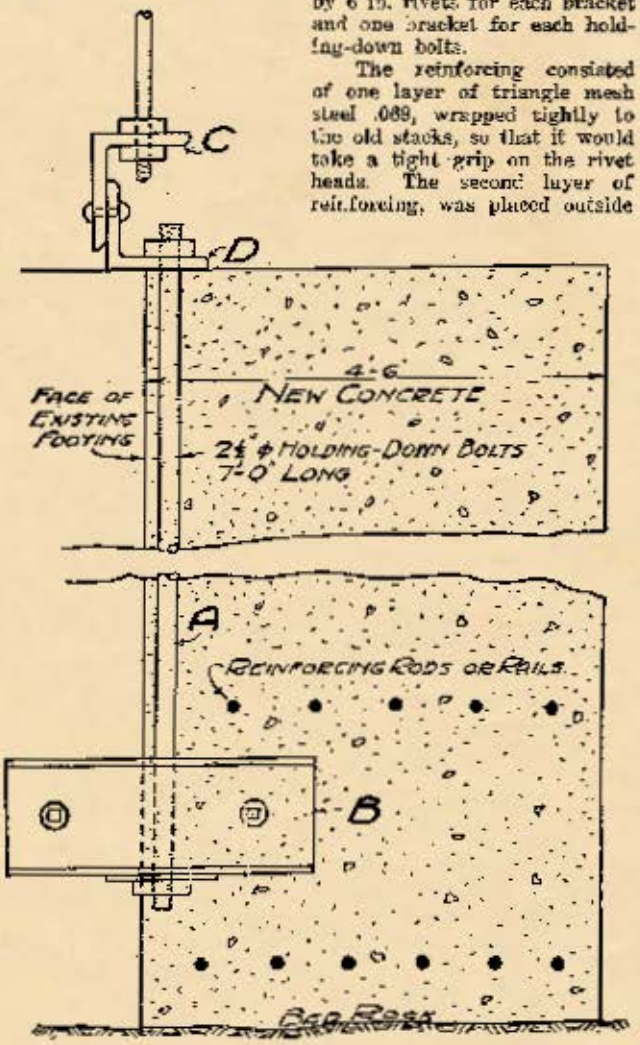
Also Shows How the Rods are Bent Around the Clean-out Doors Shown at the Top of the Cut



THIS SKETCH SHOWS THE EXTENT OF THE NEW CONCRETE FOOTING AND METHOD OF PLACING ANGLES AND BOLTS FOR HOLDING VERTICAL RODS

holes were drilled 3 ft. apart to receive the stubs to bond both foundations together. Eight holding-down bolts: A, 2¼ in. in diameter mild steel, 7 ft. long, were used for each stack, with a 2 in. by 8 in. long gib plate; B, set into the old foundation 8 in. and into the new concrete 10 in. acting as a washer on the bottom of each rod. The angle iron circle C, 6 in. by 8 in. thick with 6-in. flange outside on top was used to receive the reinforcing rods and a 6 in. by 8 in. by 1 in. thick angle-iron bracket, D, 14 in. long, riveted to circle by 6 in. rivets for each bracket and one bracket for each holding-down bolts.

The reinforcing consisted of one layer of triangle mesh steel .069, wrapped tightly to the old stacks, so that it would take a tight grip on the rivet heads. The second layer of reinforcing, was placed outside



SECTION OF FOUNDATION SHOWING DETAIL OF GIRTH ANGLE AND HOLDING DOWN BOLTS

the vertical rods and consisted of 2½ in. mesh No. 7 galvanized wire reinforcing tied tightly to the rods and lapped 6 in. at the ends and 2 in. lapped horizontal. The first set of reinforcing rods, 30 in. number, were 1⅛ in. thick and 89 ft. 6 in. long, bolted to the circle or girth angle with a nut on each side to hold tightly in place. The next set of rods were 1-in. rods, 30 in number, 41 ft. long. The third set, 30 in number, ⅞ in., and the fourth set of ⅝ in. All rods are lapped 10 ft. and securely tied together.

Outside of the reinforcing every 6 ft. the entire height of the stacks a ½-in. rod was bent and securely fastened to both rods and wire mesh horizontally. The thickness of the gunite varied from 18 in. at the base to 4½ in. at the top, and was shot into place with the air pressure constant at 60 lb. The water pressure was held at 95 lb. The stacks were in constant use while this was being done, with a gas temperature of about 700 degrees Fah. This was done to get the maximum expansion while being coated.

The scaffolding was inclosed with canvas where the shooting was under way on the wind side only, as the weather was very severe at times during January.

After shooting, concrete was wet down for 48 hours to avoid too rapid drying.

Tests were undertaking in connection with this work. The sand was tested with regard to grading and mortar strength. The results you will find in Table No. 1. After the gun had started to operate, 6 in. by 12 in., 6 in. by 6½ in. cylinders and 6 in. cubes and standard briquettes were filled. The 6 in. by 12 in. cylinders could not be properly filled owing to their shape. The values of the compressive strength are therefore low and very uneven and have not been included in Table No. 2. The reason for these results was, that the coarse lean material which is normally rejected when the gun is operated under normal conditions, could not escape from the comparatively small and narrow forms, but formed instead pockets and layers in the interior of the test pieces. These could plainly be seen after the cylinders had been broken. The same unsatisfactory conditions were also found in the 6-in. cubes. This explains their low average strength as compared with that of the 1-in. thick specimens.

Cylinder No. 1 which failed at 2,122 lb. per sq. in., was found to be crushed at one end only while the rest was entirely intact. This later section was sawed off and tested. The result is given in Table No. 2, as 6 in. by 6 in. cylinder (2,890 lb. per sq. in.).

To get the proper checking tests, an operator from the St. Mary's Cement Co.'s laboratory made the same kind of test pieces from the cement and sand mixture used by the gun. In the latter case enough water was added to make a mortar of normal consistency. The results will be found in Table No. 2.

TABLE No. 1—SAND FROM DURHAM, ONTARIO

	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Average
Residue on No. 4	———	0.44%	0.00%	0.16%	0.20%
Residue on No. 8	———	11.20%	8.00%	8.70%	8.95%
Residue on No. 14	———	34.32%	23.00%	27.38%	28.43%
Residue on No. 28	———	60.72%	44.00%	51.00%	52.27%
Residue on No. 48	———	87.52%	73.20%	83.18%	83.06%
Residue on No. 100	———	95.76%	93.60%	96.18%	95.51%
Fineness modulus	———	2.91	2.46	2.68	2.68
Tensile strength—					
7 days lb. sq. in.	———	455.0	363.3	345.0	387.7
28 days lb. sq. in.	———	546.7	555.0	575.0	558.9
Crushing strength—					
7 days lb. sq. in.	4654	4397	3675	3745	4082.7
28 days lb. sq. in.	7752	6880	6112	5823	6641.7
Water used for mortars	11.46%	11.8%	11.5%	11.3%	11.51%

TABLE No. 2—STRENGTH OF MORTARS

	Test No. 1				Test No. 2			
	Gun		Hand Made		Gun		Hand Made	
Strength.	Total Load Lb.	Lb. Sq. in.	Total Load Lb.	Lb. Sq. In.	Total Load Lb.	Lb. Sq. In.	Total Load Lb.	Lb. Sq. In.
Tensile, 7 days	550	———	390	———	580	———	290	———
	515	———	375	———	470	———	270	———
	430	515	365	376.7	480	508.3	250	270.0
Tensile, 28 days	640	———	630	———	600	———	480	———
	635	———	545	———	660	———	460	———
	615	630	540	571.7	690	660.0	440	460
Crushing, 6 in. by 6 in. cubes	———	———	———	———	91,420	2,530	75,520	2,098
	———	———	———	———	106,060	2,946	77,000	2,139
	———	———	———	———	121,200	3,367	110,000	3,056
Average	———	———	———	———	———	2,951	———	2,430
6 in. by 6 in. cylinders	110,000	3,890	———	———	———	———	———	———
Test pieces, 1 in. thick	———	———	———	———	28,440	7,110	19,040	4,985
	———	———	———	———	25,060	6,265	18,360	4,965
	———	———	———	———	24,520	6,185	18,320	4,595
Average	———	———	———	———	———	6,503	———	4,948
						Cents		Hand Made
Weight per 1 cu. ft. dry						140.6 lb.		137.4 lb.
Weight per 1 cu. ft. wet						146.7 lb.		145.9 lb.
Moisture absorbed						4.3%		6.2%

The work of guniting the stacks was done under the direction of and according to the plans of the Contract Department of the Cement-Gun Co.