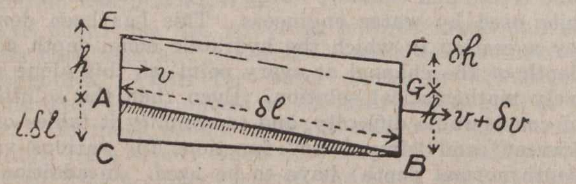
i.e., the water surface becomes vertical, and a "standing wave" is produced. The depth at which this occurs may be called the "critical depth,"—viz. (v^2/g) in a rectangular channel. In the neighborhood of this depth, however, the shape of the water profile cannot be determined exactly by this method, as there is a considerable inclination of the water surface to the bed, so that the stream lines are far from parallel and the square of the mean velocity differs widely from the mean square of the velocities. There is also sure to be a loss of energy due to shock in the case of a "rising standing wave," similar to a sudden expansion in a pipe, while a "falling standing wave" is really a weir effect. For a level bed $i=0$; while for a rising bed i is negative.

Usually the gradient i is small, and the "critical depth" is much below the "normal depth." In this case, if the depth of the water is reduced by a valve to or below the critical depth, a "standing wave" is produced, the water surface rising vertically to normal depth (see paper by Gibson in "Proceedings," Inst. C.E., Vol. 197, in which this result was verified by experiment). If a channel has a very deep slope, and, therefore, low normal depth, the critical depth may be above the normal depth; in such cases, when depressed by a valve below normal depth, the surface rises in a gradual curve to normal depth, while when raised above critical depth—say, by a weir a standing wave is produced, and the water jumps the obstacle instead of ponding up behind it in a "backwater" curve.

The practical importance of these curves, if verified by experiment, is obvious. If the water engineer knows the shape of the water surface curve, the depth of his channel can be designed to follow it without waste of material in side walls of unnecessary height, or without risk of overflow or of putting pressure on his conduit if closed, through under-estimation.

Appendix

In the figure let AB be a very short length of the invert of a channel of uniform section, and EF be the correspond-



ing water surface. Let sin $ABC=i$. Let h and v be the depth and mean velocity at A, while $h+\delta h$ and $v+\delta v$ are depth and velocity at B. Then total head at A=total head at B+ resistance A to B, or $i\delta l+h+(v^2/2g)=h+\delta h+[(v+\delta v)^2/2g]+i^1\delta l$ [where i^1=loss of head per unit length for velocity v and depth $h=(fv^2/2gm)$ or better $K(v^p/m^q)$].

Then $i=(\delta b/\delta l)+(v/g)(\delta v/\delta l)+(\delta v/2g)(\delta v/\delta l)+i^1$. Now if δl and therefore δh and δv are reduced to zero, this becomes $i=(dh/dl)+(v/g)(dv/dl+i^1=(dh/dl)+(v/g)(dv/dh)(dh/dl)+i^1$, as v is a function of h only in a uniform channel. Therefore $(dh/dl)=[i-i^1]/[l-(v/g)(dv/dh)]$ giving the *slope* of the water surface.

But $v=(Q/a)$ where Q is the constant discharge, therefore $(dv/dh)=(Q/a^2)(da/dh)=-(Q/a^2)b=-v(b/a)$, as $\delta a=b\delta h$, where b=breadth of water surface. Therefore, $(dh/dl)=[i-i]/[l-(v^2b/ag]$ and $(dl/dh)=[l-(v^2b/ag)]/[i-i^1]$. Therefore $l_2-l_1=\int_1^2\{[l-(v^2b/ag)]/[i-i^1]\}dh=\int_1^2\phi dh$=area of ϕ, h curve from h_1 to h_2.

(N.B.—In a rectangular conduit b=constant, and $a=bh$. Therefore $(v^2b/ag)=(v^2/gh)$.)

Members of the Canadian committee to consider the construction of a Peace Memorial Bridge at Buffalo have been notified that a bill authorizing the naming of a special American commission for this purpose has successfully passed Congress and Senate. The Buffalo branch of the joint international committee of twenty-five is now planning to get down to active work.

SLAB VALUES OF "GUNITE"

RECENTLY a series of tests were started designed to show the slab values of "Gunite." The first of these tests under official observation has now been completed. The tests were made on 4 ft. slabs, 2 ins. thick, with loose ends, not making any allowance for continuous beam action. A summary of the results of the test are given herewith and are really noteworthy:—

SHORT SUMMARY OF TESTS MADE ON SLABS OF "GUNITE" 2 INS. THICK, 4-FT. SPAN, 28 DAYS OLD, BROKEN JANUARY 20-21, 1920

Slab.	Mixture.	Rein. sq. in. per ft. of width.	1st deflec. at lbs.	Last deflec. at lbs.	Broke at lbs.	Equiv. dis. load.	Lbs. per sq. ft.	Average.	Gross average.
1	...1–3	0.20	1/16–2775	11/16–11440	12352	16469	823		
2	...1–3	0.20	1/16–3360	5/8– 9716	10301	13735	687	766	
3	...1–3	0.20	1/16–2606	5/8–11292	11832	15776	789		
8	...1–2½	0.20	1/16–3877	9/16–12492	13130	17507	875		783
9	...1–2½	0.20	1/16–3261	5/8–11832	12493	16657	833	833	
10	...1–2½	0.20	1/16–3220	5/8–10001	10394	13859	693		
4	...1–3	0.10		7/16– 6798	7373	9831	492		
5	...1–3	0.10	1/16–3331	½– 8556	9040	12053	602	555	
6	...1–3	0.10	1/16–3906	7/16– 8466	9228	11510	570		
7	...1–2½	0.10	1/16–3861	7/16– 8378	9500	12667	633		602
11	...1–2½	0.10	1/16–3180	5/8– 8372	8847	11796	598		
18	...1–2½	0.10	1/16–4373	9/16–10124	10705	14273	714		
12	...1–3	0.15	1/16–2709	5/8–10111	10465	13953	698		
13	...1–3	0.15	1/16–3218	5/8– 8425	8722	11629	581		
14	...1–3	0.15							
15	...1–2½	0.15							671
19	...1–2½	0.15	1/16–4371	9/16–10176	11184	14912	745		
20	...1–2½	0.15							

Thus slabs with 0.20 reinforcements have a safe load of 157 lbs. per sq. ft., with a factor of safety of 5, or 196 lbs. with a fac. safety of 4.

Slabs with 0.10 rein. have safe load of 120 lbs. with E.S. 5 or 150 with F.S. 4.

Slabs with 0.15 rein. have a safe load of 134 lbs. with E.S. 5 or 168 with F.S. 4.

Tests made by putting platform on top of rollers carried on ¾-in. x 3-in. straps, placed at one-third points. Pig iron was piled on top of this platform and deflections read at each addition of 500 lbs.

Reinforcement of expanded metal furnished by the Consolidated Expanded Metals Co. 2¼-in. mesh of areas indicated metal at ⅜ in. from bottom of slab.

At the eighteenth annual convention of the Canadian National Clay Products' Association, which opened on Wednesday, January 21st, at Toronto, the following officers were elected for 1920: Past-president, Thomas Kennedy, Swansea; president, William Burgess, Todmorden; vice-presidents, Ryland H. New, Hamilton, Millard F. Gibson, Toronto, T. H. Graham, Inglewood; and secretary-treasurer, Gordon Keith, Toronto.

Leaside Engineering Co., Ltd., Leaside, Ont., has organized a contracting department, and is prepared to enter into contracts covering the construction of pulp and paper mill plants, Hydro-Electric power developments, industrial plants, factories, warehouses, bridges, wharfs, etc. The company in the past has constructed a large shell plant, consisting of six buildings, for the United States government; wire plant for Canada Wire and Cable Co., Ltd.; tire mill for Dominion Tire Co. at Kitchener, Ont.; complete sets of railway and locomotive shops at Moncton, N.B., Halifax, N.S., and Charlottetown, P.E.I.; 10,000 h.p. Hydro-Electric plant at Cobalt, Ont., for British Canadian Power Co.; 20,000 h.p. Hydro-Electric plant at Beaupre, Que., for Laurentide Power Co., besides a large number of smaller contracts. The company will be represented by Edward C. Warren as manager and J. R. Nichols as general superintendent, both of whom have been in the organization for a number of years and in charge of the above-mentioned undertakings.