absent, with sand at 35% and intermediate at 65%. Fairly good results were obtained with 12% cement, even with 49% sand and 51% intermediate, but this concrete slowly absorbed considerable water, showing a fairly large percentage of very small voids.

In order to be on the side of safety, in starting a new plant, the minimum quantity of cement that has been used when aggregate containing 35% sand has been shipped out, has been 12%, corresponding to about 1.27 bbls. (Canadian) to the cubic yard. The first cut in the gravel pit, arranged for a convenient lay-out for operating conditions, has taken the excavating machines into a part of the deposits running high in sand, and in order to keep the total sand in the finished aggregate down to 35% required a considerable wastage of sand after screening, which cuts down the net output and increases the amount of material to be handled. As the demands of the contractors have taxed the plant heavily, due to a number of causes, among which were delays due to breaks in machinery, lack of storage for the mixed aggregate, shortage of cars at times when the haul was long, or when large amounts of foundation fill materials were being shipped, it was found necessary, at times, to ship out material containing 50% sand, and in some cases, pit-run material. In such cases the cement has been increased to about 15% or 1.7 bbls. (Canadian) per cubic yard. This policy is very expensive, however, as it increases the cost of concrete to the District by about $1 per cubic yard net, over the cost of concrete made with an aggregate containing 35% of sand. As the estimated volume of concrete in the whole aqueduct is about 330,000 cu. yds., the District is, this winter, planning to open another pit, equipped somewhat differently, near the eastern end of the line, to relieve the pressure on the existing plant both by furnishing more aggregate and by shortening the haul, thus getting better efficiency out of the transportation equipment.

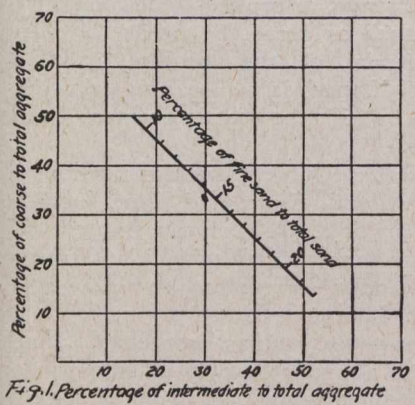

Fig. 1. Percentage of intermediate to total aggregate

The mixed sand and gravel is loaded into 20-yd. air-dump cars at the screening plant, hauled to the contractor's platforms and dumped. The cars are loaded, as nearly as possible to a loose measurement of 23 cu. yds., then scaled, and billed out to the nearest even yard below the scaling. Of 110 cars loaded and billed out, in one test, 15 contained by scaling 22 cu. yds., 75 contained 23 cu. yds., 19 contained 24 cu. yds., and one contained 25 cu. yds. The total measured yardage in the cars was 2583.1 cu. yds., and the total billing was 2,536 cu. yds., a difference of 47.1 cu. yds. or 1.85% more material shipped than billed for, due to taking the nearest even yard below the scaling; or, roughly, the deliveries averaged nearly ½ yd. per car in excess of the billing. A further excess of deliveries over billing, in cars levelled off for measurement, also arises from the mechanical effect of the consolidation of the material in the cars of measured aggregate by the men when levelling off the cars. For example, 17 cars were measured at the plant, then levelled off and trimmed. Before levelling, the measured contents was 392 cu. yds. and after levelling off 380.6 cu. yds., a difference of 11.4 cu. yds., of 3% shrinkage due to consolidation by the men's feet.

The relative weights of the aggregate per cubic foot under different conditions as to moisture and compacting are shown in the following table, the sand in the moist aggregate being about 37% by weight:—

Weight per cubic foot loose and moist	114	lbs.
Weight per cubic foot shaken and moist	122	lbs.
Weight per cubic foot tamped and moist	132.5	lbs.
Weight per cubic foot loose and dry	125.0	lbs.

from which it will be seen that the percentage shrinkage from the loose and moist condition to loose and dry was 9.65% and to shaken and moist 7% and to tamped and moist 15.8%.

The shrinkage in volume during transportation from the pit at mile 30.8 to different points along the line is shown in Table I.

In order to determine the ratio of aggregate billed out from the plant to the yardage of concrete put in place, measurements of both aggregate yardage and yardage of concrete laid were kept by all the division engineers for a week. Owing to inaccuracies in trimming the bottoms of trenches and to the small excess quantities of concrete in the arch sections, due to hand finishing the tops a little higher than the theoretical lines, the payment concrete

Table I.

Shrinkage in yardage of aggregate during shipment from mile 30.8 to different points along aqueduct line.

(Aggregate 50% sand; 4 cu. ft. cement to 16 cu. ft. aggregate = about 1.7 bbls. cement per cubic yard of concrete.

Date.	Mile at which sand was delivered.	Cu. yds. billed.	Cu. yds. measured at pit.	Cu. yds. at plant after levelling and trimming.	Cu. yds. as measured at point of delivery.	Ratio of billed to cu. yds. measured at delivery.	Ratio of cu. yds. measured to cu. yds. delivered and measured there.
August 26	40	23	23.6	22.2	21.8	1.055	1.08
August 26	43	46	46.6	44.2	43.3	1.060	1.08
August 27	51	46	46.2	46.2	42.2	1.090	1.09
August 27	57	69	69.6	67.8	66.6	1.045	1.055
August 27	65	69	[1]68.1	68.1	64.1	1.075	1.06
August 27	71	45	45.4	44.3	41.5	1.085	1.095
August 27	77	45	45.4	44.8	40.8	1.100	1.110
August 27	85	46	45.8	45.0	42.4	[2]1.085	1.08

[1]Car levelled up for measurement at plant and settled in process of levelling.

[2]Side doors of car raised in transit about 2 inches and some material leaked out.