At each shaft access will be had to the tunnel through risers or vertical pipes, 48 or 72 inches in diameter. At most of the shafts two such pipes will be provided, each fitted with valves at the bottom which may be operated from the surface to close either of them when it is desired to gain access to them or to effect any necessary repairs. The valves at the bottom of the risers will be of such a design as to close automatically in case of an abnormal flow through the risers, due to the destruction of the valve at the top by explosion or other accident. At the top of the risers there will be two valves, the one nearer the riser being an emergency valve, which may be closed in case of any damage to the other valve.

It is probable that no immediate changes will be made in the water supply of Manhattan and Bronx, except that pipe lines will be run from the shafts to help out the existing supply in case of emergency. In Brooklyn and Queens, where thirty-five pumping stations are now required, most of the stations will be discontinued for the reason that the water will be delivered through the aqueduct at sufficient pressure to reach all parts. Only in one or two sections will pumping be necessary.

From Hill View reservoir the water will flow through a tunnel, 15 feet in diameter. This will be narrowed to 14, 13, 12 and 11 feet; which is the diameter of the rock tunnel at Fort Green Park, Brooklyn, and at the intersection of Flatbush and Third Avenues. From there on steel pipes, five and one-half feet in diameter and running down to four feet in diameter, will carry the water to the Narrows, and under New York Bay, at the Narrows, the line will be only three feet in diameter. This gradual shrinking of the aqueduct reminds one of those large rivers that flow cut of the mountains in sufficient volume to be navigable and even a menace to the surrounding country in time of flood, but which, when they reach the deserts are drunk up by the thirsty sands and sucked by the torrid sun until they vanish without any clearly defined terminus or possibly flow in a sickly stream to a small stagnant lagoon. Thus, when the entire Catskill system is completed and operating at its full capacity, the waters which three days before poured out of the Ashokan reservoir in a mighty flood, over seventeen feet in diameter, will reach Staten Island, a stream only 3 per cent. of its former size, after having been robbed by the rest of the thirsty city.

LIMITATIONS OF BITUMINOUS CARPET SURFACES.*

By A. W. Dean, M. Am. Soc. C. E.+

A bituminous carpet surface is well defined as "a bituminous surface of appreciable thickness formed on top of a road crust by the application of one or more coats of bituminous material, with gravel, sand or stone chips added." Such a carpet is not formed by the use of one emulsions, consequently, emulsions will not be considered in this discussion, nor will a crust approximating two inches in thickness be considered, inasmuch as when a coat or blanket is made of such thickness, it ceases to become a carpet, but rather becomes an integral part of the road crust or pavement.

Limitations in the use of bituminous carpet surfaces are governed by three principal features. First, character of the

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road crust under the carpet. Second, character of the carpet itself, including both the bitumen and the grit or such material as is applied with the bitumen. Third, character of traffic to be sustained. Taking these in their order named, let us first consider the character of the crust.

This should be of such a nature and on such foundation that the weight of the traffic will be thoroughly sustained without any aid whatever from the carpet. For average traffic on suburban roads, a water bound macadam road on a suitable and sufficient foundation is an ideal crust upon which to apply a bituminous carpet, regardless of the nature of the bitumen used to form the carpet. Under some conditions, a cement concrete crust is excellent and preferable to water bound macadam, in that it has more stability and will withstand a greater load. A concrete crust, however, does not appear to hold a carpet of an asphaltic nature as well as it holds one formed by the use of tar, the adhesion being apparently less with the former than with the latter mate rial. A crust of good gravel, thoroughly compacted, is good under restricted traffic conditions, but it does not appear 10 hold a carpet formed by the use of heavy asphaltic or tar binders, unless the carpet is made of such thickness that it becomes a part of the road crust. Heavy binders as referred to herein are intended to mean binders that require heating to a temperature of at least 180 deg. F. in order to permit satisfactory application. A bituminous carpet on a gravel road appears to be successful under comparatively light traffic if a bitumen is used that does not require heat ing to a temperature above 100 deg. F. before application.

A carpet formed by the use of any material on a dirt road is of no value whatever, as it breaks up under any kind of traffic and very soon ceases to be a carpet.

Continuing to the second principal feature, namely, the character of the bituminous carpet, we have again a very important factor. The kind of bitumen used and the method under which it is applied, the kind and amount of grit used, and the character of the grit, each and all have a very decided influence on the limitations of economical use. perience has shown that a carpet must be uniform in thick ness, and in order to be so the bitumen and grit must each be spread uniformly, and in order to spread the bitumen uniformly experience has shown that it must be distributed by means of pressure applied in some manner, either by in troducing air or steam pressure directly into the tank by which the bitumen is contained, or in securing pressure by means of a pump of some form. Experience has demonstrated also that where it is desired to make a carpet requiring the bitumer where it is desired to make a carpet requir ing the bitumen to be applied at the rate of 3/2 gal. per yd., uniformity is more successfully obtained by applying the bitumen in successfully obtained by applying the bitumen in successive layers of approximately ¹⁴/₄ gal per sq. yd., each layer of bitumen being covered with grit before the succeeding layer is applied.

The grit used for covering the bitumen should contain no clay or loam, and if the traffic to be borne is a mixed traffic, with steel tires predominating, it appears that the best and most lasting results are obtained by using a mixture of coarse and fine material, the coarse material consisting of tough pebbles, or stone broken to pebble size (approximately ½ in. in diameter), mixed with material of a finer nature, such as sand or a coarse grade of stone dust. Such mixing is better accomplished if the two grades of grit are applied separately in forming the blanket, that is, the coarser material being applied first and immediately followed by the finer material. Such method of application appears to give a firmer carpet that will withstand a greater amount of steel tire traffic than will a carpet formed by the use of either coarse or fine material alone. If a car-