Drainage.—The use of any form of pavement or road crust, whether bituminous or non-bituminous, does not relieve the necessity of proper drainage in every case. It is not only necessary to provide for such under-drainage as will place and keep the sub-grade in a condition satisfactorily free from moisture and in a state of suitable efficiency, but it is also necessary to provide and to preserve economically such provisions for surface drainage as will, with the provisions of under-drainage, insure these results fairly permanently. Storm-water coming to the roadway must be carried quickly and rapidly away from it by automatic arrangements to the natural watercourses, where it can be disposed of finally. The arrangements referred to and so made, such as inlets, ditches, gutters, and culverts, should be designed and placed so as to give the least possible offence to the users of the roadway and the abuttors, and yet be built so as to preserve their integrity and efficiency with the least need for attention and expense under even the most persistently adverse natural conditions. A proper longitudinal grade for ditches and gutters is particularly important, in order that the ill and wide effects of standing water may be avoided. A proper cross-section for ditches is also important, in order that the waterway may not become obstructed by the sliding in of the sides.

As related to drainage, the matter of the crown of the roadway is particularly important. The ideal roadway surface would be flat in cross-section were it not for the necessity of the automatic removal of surface water to the channels where it must be most conveniently carried along. Crowning the roadway tends to concentrate the traffic on the ridge where it is then most comfortable for the travellers, and the amount of crown which will result in this concentration on the ridge varies with the type of pavements. Also, the rate of crown necessary for the proper removal of storm-water to the gutters or ditches varies with the type, and with the provisions to be made for the cleaning and the upkeep of the roadway surface. In the general practice, the amount of crown for the shoulders of an uncurbed roadway has usually been a cross-slope of one inch per foot, the shoulders being of the natural earthy material, and this rate is to be recommended for shoulders, except in special cases.

The crown generally used in the construction of broken stone roadways is excessive when bituminous materials are used, and a crown of even one-half inch per foot should be avoided when a lesser crown can be secured without detriment to the surface drainage.

For the various roadway surfacings, the practice generally observed and to be recommended is as given in Table II.

Table II.

Kind of roadway.	Crown Recommended—Maximum.	Crown Recommended—Minimum.
Gravel	1 in. to the ft.	½ in. to the ft.
Broken stone	¾ " " " "	½ " " " "
Bituminous surface	½ " " " "	¼ " " " "
Bituminous macadam	½ " " " "	¼ " " " "
Bituminous concrete	½ " " " "	¼ " " " "
Sheet-asphalt	¼ " " " "	⅛ " " " "
Cement-concrete	⅜ " " " "	¼ " " " "
Brick	⅜ " " " "	⅛ " " " "
Stone block	½ " " " "	¼ " " " "
Wood block	¼ " " " "	⅛ " " " "

Concave pavements of cement-concrete, vitrified block, or stone block may frequently be found advantageous for alleys, and, in such cases, the same rates of slopes in cross-section as those previously given should govern.

Artificial Foundations.—Where the character of the traffic justifies the use of an artificial surfacing, it also demands a correspondingly strong foundation. Whether or not an artificial foundation shall be supplied will depend on the local conditions, but in the selection of the materials and the methods of construction of the artificial foundation, every consideration should first be given to the possibilities for securing the greatest efficiency from the natural foundation. Economy in reference to the roadway will be had from the proper choice of the various materials available for artificial foundations, such as sand, gravel, broken stone, and concrete.

In the construction of a concrete foundation, the subgrade should first be properly prepared and its greatest efficiency developed. The thickness of the cement-concrete artificial foundation usually laid is 5 or 6 inches, but it may be varied advantageously according to the local conditions between 4 and 12 inches. The thickness may be varied sometimes between the centre of the roadway and the sides.

The most usual proportions for a cement-concrete foundation have been one part cement, three parts fine aggregate, and six parts coarse aggregate. This standard, however, is empirical rather than scientific, and a more rational proportion in any case should be developed according to the needs and facilities of each case. It may often be desirable to increase the mass in some cases at the expense of unit strength, or to increase the mass for the sake of economy in the more expensive material.

Subgrade.—The use of any form of pavement or road crust does not relieve the necessity for the construction of a well-drained, thoroughly compacted, homogeneous, and stable subgrade in every case. Indeed, such improvement of the highway generally attracts heavier traffic and thus increases the stresses on the subgrade. Even when an artificial foundation is to be constructed on the subgrade, proper attention should be given to the preparation of the latter, in order that the greatest economy may be had in the design and expense for the artificial foundation, and, generally speaking at least, the higher the type and the more expensive the artificial foundation, the greater care should be exercised to develop to the utmost the possibilities of the subgrade. Uniformity in its composition and compaction, as well as evenness of its surface, is far more important than has apparently been generally considered necessary up to this time, and permanence of all the desirable qualities in the subgrade is equally important.

Joints.—For the ordinary joints in block pavements, the materials and methods of filling should be selected so as to produce not only a surface which will retain to the utmost its imperviousness and the stability of the blocks themselves in place, but also as far as practicable they should conduce toward evenness of wear of the surface of the pavement. If the blocks are resistant to abrasion, but perhaps inclined to round off at the edges of the upper surface under traffic, such filling of the joints is desirable as will lend additional resistance in the blocks to this rounding off at the joints.

A bituminous filler may be preferred to a cement-grout filler, on account of the lower cost of street-opening repairs, the better foothold provided for horses, and the securing of a more resilient and hence less noisy pavement. On steep grades, where some roughness of surface