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FACTORS IN ASPHALT PAVING

Construction, Cost and Maintenance of City Roadways.

SOME LESSONS TAUGHT BY EXPERIENCE

Best Form of Composition with Proportions of Ingredients and How the Necessary Quantity Has Been Determined.

At the convention of the American League of Municipalities held at Toledo, O., last week, City Engineer Rosewater of Omaha read a paper on "Asphalt Paving," in which he said: The first asphalt pavement in the world was laid in the city of Paris about fifty-one years ago. About 6,000,000 square yards, or about 200 miles of European streets, are now paved with that material.

Twenty-five years ago about twelve miles, or less than one-fifth of 1 per cent, of the paved streets of the cities of the United States were paved with asphalt. Today about 1,500 miles of streets in the United States, embracing an area approximating 4,000,000 square yards, are paved with asphalt. This represents in that cost an investment of \$100,000,000, and including the cost of repairs and resurfacing, a total outlay of not less than \$150,000,000.

Independent of the materials used for resurfacing and maintenance, the materials comprising the asphalt pavements of the cities of the United States would fill over 1,000,000 cars, enough to make a train 6,000 miles long, extending from New York to San Francisco and back, aggregating 22,000,000 tons, divided about as follows:

Composition of the Pavement. Classifying by percentages, the materials comprising an asphalt pavement of six-inch concrete base, one and one-half-inch binder and two inches of asphalt topping, as usually laid, will run, approximately, as follows: Stone, 52.1 per cent; sand, 34.4 per cent; cement, 6.3 per cent; stone dust, 2.3 per cent; asphalt, 2.3 per cent, and oil, 0.6 per cent. Thus it will be seen that asphalt covers not to exceed 3.3 per cent of the materials of an American asphalt pavement and ranges as low as 1.8 per cent, when asphalt rich in bitumen are used. Fully 50 per cent of the American asphalt pavements may be termed an artificial bituminous sandstone, the wearing surface being 30 per cent sand and 10 per cent bituminous mastic.

failed completely to meet the dense traffic encountered and within six months after being laid, the remnants were ordered removed.

Within the past ten years successful asphalt pavements have been laid by the same American company in London, Glasgow and Paris, and the granite pavements of several New York City streets have been successfully and satisfactorily displaced with American asphalt pavements.

Monopoly Broken Up.

Up to 1883, asphalt paving specifications within the cities of the United States were practically closed to the use of all asphalts but one, that coming from one portion of Trinidad Island on the South American coast. From 1881 to 1893 the price of asphalt pavements, with six-inch base and two and one-half inch topping, notwithstanding material reductions in cost of materials and labor remained constant at about \$2.00 per square yard, with a five-years' guarantee. The quality of pavements was not uniform, the same contractor very often laid a good pavement on one street and a very poor one on an adjoining street, under the same specifications. Much mystification was indulged in and only the trade was accredited with possession of the secrets of a good asphalt pavement. The engineers of our cities, in view of the limited knowledge of the subject, in preparing specifications placed dependence mainly upon the guaranteed period of maintenance, allowing each bidder to prepare his own formula for proportioning and preparing mixture. In spite of this, to a great extent, on the asphalt portion of the pavement was a farce, few cities maintained a laboratory and where laboratories were maintained, the requisites of a successful pavement were unknown or misunderstood.

Omaha the Pioneer.

The question as to the influence of the sub-base, the construction of the concrete, the nature of the sand, extent of filler in the sand voids, the amount and nature of bituminous kind of oil for fluxing, were all partly understood, and seldom were results similarly obtainable, except by mere accident of chance. Believing that better progress could be made and lower prices obtained by opening the specifications for asphalt pavements to competition, the author of this article, in 1893, prepared specifications for the city of Omaha, admitting all asphalts under the usual bond and guarantee provisions. To succeed in such an effort it became necessary to induce Washington, Chicago, New York, Denver and other cities to co-operate. This was done and proved successful. All sorts of litigation followed. Each attempt of those early in the field was met with costly and stubborn resistance, but the opposition to open specifications proved futile and ultimately developed a field for asphalts from the mines of California, Utah, Kentucky, Venezuela and other localities, in addition to those of Trinidad. The price, as a result of bitter competition for a time, became ruinous to all concerned. The cost of paving dropped, in 1896 and 1897, in many localities fully 50 per cent. The scarcity of expert knowledge brought with this competition some very poor as well as very good pavements. But the public was the ultimate winner, for the more general knowledge gained and the more thorough investigation on the part of all in their endeavor to develop a pavement that would excel others in quality and durability. The outcome is not only better pavements from the Trinidad product, as shown by the success in the congested traffic streets of New York, Paris, London and other cities, but also a keener knowledge of the whole subject, and good pavements are now made from artificial asphalts produced from residua of the California oils and also from asphalts from Venezuela, Cuba and numerous other sources. The engineering profession has in the

last decade also been admitted into the secret sanctuaries of the laboratories and has discovered that, aside from the shape of the streets and the asphalt used, the sand which constitutes 50 per cent of the surface covering, exerts very much influence upon the result. Numerous analysis of poor pavements have shown that it was not always wise to let the bidders make specifications and that many important requisites should be provided for in the specifications. In place of 6 and 7 per cent of bitumen in the asphalt mixtures frequently found in poor pavements of our cities, it has been demonstrated that good pavements should have at least 10 per cent of bitumen. This applies equally to bituminous limestone pavements as to bituminous sandstone pavements.

Careful study of the requisites further shows that the more compact any pavement is the better its wearing qualities, so it is found essential that to secure the minimum of voids in the sand the grains should be so graded as to admit of packing, and finally, after this, the further addition of the powdered filler will make the mass still more compact. Stone dust has been and is largely used for this purpose, but in larger quantities than in years past, and as an improvement finely ground Portland cement is being substituted in place of the stone dust. This has been used, with evidently very excellent results, on the Fifth avenue pavements in New York and those of London, and the same filler was used in Sixteenth street, the leading thoroughfare of Omaha, and is required in all pavements now laid in this city, to an extent of not less than 5 per cent, and 12 per cent will probably be required in the specifications hereafter. The difference in cost, a few cents per yard will not justify its exclusion on economical grounds.

To Make a Good Road.

With these facts bearing on the history of its development and relative to the materials needed in asphalt pavements in view, the factors which enter into the construction of an asphalt pavement, its maintenance and cost, can more readily be comprehended. In this class, as in all pavements, the first essential to good, durable construction is a proper base. A good earth road requires, first of all, proper drainage, both for surface and sub-surface. The solution of this feature is a simple engineering proposition. The next essential is consolidation—the more compact, the less will the surface yield to vehicle traffic and the greater its durability. The fact that earth yields readily to the softening and dissolving influence of water, demands a very high crown upon an earth road that it may shed water as fast as possible to escape its softening agency. The fact that it partly dissolves when wet makes a soil yield more readily when porous, because these voids will quickly absorb or fill with the dissolving agent, hence the more compacted and less porous the less it will be exposed to moistening influences. Again, if the earth roadbed is subjected to water from beneath the surface, it will not only be undergoing constant change in the summer period, but when winter comes the water, when freezing, will expand and heave up the surface. With these fundamental principles outlined, we next come to the pavement proper.

Experiments in Paving.

Diverse of all verbiage, a pavement is a veneering or wearing road surface. It is placed there to protect the base and give it durability. The early attempts at pavements were of the old Roman road order, consisting of layers of large blocks of stone in mortar, which distributed the load over a much wider area than that directly exposed to the tires of the wheels. These roads, with numerous variations, such as slabs of granite, laid in parallel rows for the wheels to run on, iron rail-

ways, with iron or steel surfaces, distributing their loads through the medium of ties or planks, to the earth surface, the macadam roads developed about 100 years ago, with depths of broken stone, varying with the traffic, and depending for their efficiency upon compacting the aggregates; first, on the traffic which took years, and later, upon great road rolling machinery, which crushed and forced the various aggregates to a wedged and compact mass, developing a smooth surface. It was contended even by railway builders, that roadbeds should have a certain elasticity to be practical. It is now clearly demonstrated that the firmer and more yielding the foundation, the more durable it will be. The toughest steel bent back and forth by continuous vibrations, will break. Rock foundations yielding to compression impacts will ultimately crush the particles, and the greater and more numerous the voids, the quicker the change of shape and final destruction. The theory of the need of elastic foundations is erroneous, the elastic requisites should be in the spring of the carriages and rolling stock, and not the roadbed. The construction of the so-called bituminous pavements, which is really a macadam with a bituminous binder, recognizes the need of reducing voids by grading the aggregates so as to reduce the voids from 40 to below 20 per cent, and finally fill this 20 per cent with tar or other bituminous binder.

Qualities of Macadam.

In the construction of macadam pavements it is conceded that next to the earth road the need of a large crown is imperative. Why? For the same reason as in the case of an earth road, to shed water so as to minimize its destructive effect. Experience has demonstrated that, all things considered, the most economic covering for road purposes upon soil capable of immediate consolidation into monolithic form, is a concrete of sand, cement and stone. Unlike the old Roman road, this can be made more uniform with less material and skilled labor by the use of small, broken stone, which, with various grades of sizes and the mortar of sand and cement, produces a compact and uniform mass.

The more ready action of the elements upon what is known as natural cement makes the so-called portland cement preferable for exposed concrete work. Its great cost, until within the last few years, has barred its use largely in our paving works. Since, however, its cost has been largely reduced by the increase of its manufacture in this country, its advantages for paving are recognized and its use is becoming more general. Concrete as outlined could be made for country roads and pavements were it not that the broken limestone soon wears smooth and, like the European asphalts, becomes too slippery. For this reason, this far, it is used as an intermediate layer to distribute the wheel load to the earth. Whenever the upper three or four inches can be economically made into a composite of cement and sand, with provisions to resist the forces of expansion and contraction, we will have a sandstone monolithic pavement capable of continuous resist the action of water, and yet furnish a footing which never can become slippery. Until then a composite covering of sand with bituminous cementing material known as "asphalt" will be used.

Qualities of Asphalt.

Experience has shown that asphalt from Trinidad, Venezuela, California, and numerous other sections of the country, 80 per cent of whose bitumens are soluble in boiling naphtha, possess sufficient adhesive cementing qualities to make a proper paving cement. Experience has further developed that the actual and necessary quantity of bitumen thus soluble to make a proper paving mixture, shall range between the extremes of 10 and 13 per cent by weight. The exact proportion will

vary between these figures, dependent upon the nature of the sand grains and voids in the sand. The specifications should, to insure good results, provide that not less than 10 per cent of bitumen shall be required in the mixture. This does not mean 10 per cent of asphalt, for what is known as refined asphalt varies in the degree of refinement. Bermudez, Venezuela, or California asphalts are, when refined or manufactured, free from sand or other mineral mixtures, and, therefore, contain from 86 to 90 per cent pure bitumen. The Trinidad asphalt, as refined, contains fine, impalpable mineral powder to the extent of 20 per cent. In the latter case, it requires more asphalt to produce the 10 per cent of bitumen, but on the other hand, the amount of filler of stone dust or portland cement required with this asphalt, is proportionally less than with the others.

Method of Test Wrong.

The common method of comparing asphalts, according to their alleged purity based upon the bitumen they contain, is both erroneous and calculated to deceive. It is attempted by so-called anti-trust contractors versus the so-called trust contractors. As a matter of fact, the quantity of bitumen in the commercial asphalt product is simply a commercial question which is governed by freight and other factors. Pavement mixtures, whether laid with an asphalt containing 20 per cent bitumen in its commercial form, are no better nor worse than mixtures from an asphalt containing 5 per cent, as in each case 10 per cent of extracted bitumen of a specified quality is required and used in the mixture. In the Manhattan borough of New York, and a few other cities of the country, the specifications for asphalt pavements exclude asphalt which, in its commercial form contains less than 20 per cent bitumen. Such specifications do not protect the public against poor pavements, but increase its cost by excluding competition.

As an illustration I need but to cite a case recently in the court at Lincoln, Neb., where, to exclude the use of Trinidad asphalt in the interest of a certain competitor of the company handling that material, the specifications were so drawn as to prohibit the use of any asphalt in the proposed pavements which in its commercial form had less than 20 per cent tarter. The testimony of Chief Inspector Dow of Washington in this case was, that this clause did not insure good asphalt, for its provisions would exclude Cuban asphalt which produced among the best, if not the very best, asphalt pavements laid in Washington. His testimony showed that Cuban asphalt contained only 70 per cent bitumen in its commercial form. While it is well for cities to guard against trusts or any form of combinations, the fact is that asphalt has been and could readily be bought in the open market from numerous sources for several years past, disposed of the trust question and the anti-trust cry so vehemently indulged in by some in relation to asphalt, like the cry of "wolf," should be cautiously listened to by municipal authorities.

Experience of Omaha.

In evidence of the delusive representations as to asphalt trusts, the author of this article had occasion during the year 1904 to visit the cities of Winnipeg, Manitoba and Detroit, Mich., two cities which own their own plants and found that asphalt of every brand were obtainable. The city of Omaha, which is now operating its own repair plant, advertised for bids last spring and received proposals from California, Bermudez and Trinidad Pitch Lake asphalt dealers at prices ranging from \$15 to \$25 per ton. In view of these facts, it is clear that municipal interests are best subserved by providing specifications calling for open competition as to asphalt and asphalt of requisite quality can best be obtained

by providing for the minimum of bitumen in the mixture subject to the boiling naphtha test, which determines the malthene or petroleum components which constitute the cementing quality of asphaltic bitumen.

Effect of Water on Asphalt.

Another feature of considerable comment upon which opinions are as varied as the interests is the claim of susceptibility of certain asphalts to the effects of moisture, and which, for that apparent reason, are used as a basis to exclude such asphalts and thereby favor certain contractors and punish others. From practical contact with the varied features of this question I am led to regard specifications provisions placing power in boards or officers of boards to discriminate on grounds of the above nature as far more dangerous to the honest public service than any possible shortcoming affecting longevity of pavements from such alleged defects. The asphalt pavement does not exist which can withstand continued exposure under water without deterioration. Asphalt pavements when under water a length of time become soft, and the great deterioration resulting from water upon asphalt pavements is the action of wheels and horses' hoofs upon the softened surface. Sandstone, when wetted and exposed to abrasive forces, act like grindstones, wearing away rapidly as the grinding goes on whilst being subjected to moisture. This is equally the case with the bituminous sandstone. Chief Inspector Dow of Washington, who is, perhaps, the ablest exponent and originator of the provision to asphalt not readily affected by water, informed the author of this article last summer, when extending him many courtesies on an inspection tour of Washington pavements, that for the last seven years all gutters on asphalt paved streets in the Capital city had been paved with vitrified brick. Mr. Dow must have concluded that all asphalts deteriorated more rapidly when subjected to water influences and had little faith in the theory that certain asphalts were not readily affected by water, or he would not have urged the exclusion from use of asphalts alleged to be affected and then studiously avoided using those of preferred merit from gutters, where they would be exposed to moisture influences.

Quality of Sand.

Having disposed of the asphaltic features of the mixture, the equally and possibly more important mixture factor is the sand, which comprises, approximately, 50 per cent of the asphalt covering. To bring forcibly to mind the sand factor I need but cite you to a discussion at the recent International Congress of Engineers of the relative value of stones for macadam. One of the speakers, referring to sand stones, said that it should not be forgotten that there are extreme differences in the quality of sand stones. No one who has observed sand stones from various quarries and localities can fail to be impressed with the truth of this statement. Yet few stop to think that sand stones are components of grains of various grades of sands. That being the case, is it not evident that an asphalt pavement surface, an artificial sand stone monolithic covering, is as apt to vary in its qualities, owing to different gradings of sand, as the natural sand stone itself? Extended observations on this subject have clearly shown that to produce the best wearing mixtures sand of certain various graded grains gives better results than other sands.

The problem of how to determine and secure the sand that will grade best, and at the same time prove the toughest and most adaptable to resist wear like the natural sand stone of the best quality, is still only partially solved. Independent of the sand and asphalt, I have already outlined the need of a suitable filler. My in-

formation as to the use of Portland cement for this purpose in place of the natural dust of carbonate of lime was obtained from an interview with Mr. Clifford Richardson, who is doubtless the greatest living expert on asphalt pavements, taken in their entirety. His work entitled, "The Modern Asphalt Pavement," which has since appeared, refers to the good results of a Portland cement filler, but disclaims an understanding of the reason why.

PRIEST IS HELD FOR RANSOM

Two Men and a Woman Under Arrest at Cleveland for Extortion.

CLEVELAND, Aug. 26.—Upon the statement made to the police by Rev. Benedict Rosinski, a Catholic priest of St. Stanislaus church, that he had been held prisoner for twenty-four hours, without food, and forced to sign two notes for \$500 each, and two checks for like amounts, which had been since cashed, besides being robbed of \$30 and some jewelry, two men and a woman were arrested today. The woman is said to have feared the priest to her room in Cedar avenue, by pretending to be ill and in need of spiritual consolation, and the men are said to have rushed in upon them and held Rev. Rosinski prisoner until he had satisfied their demands.

Rev. Rosinski says that he received two telephone messages Thursday, urging him to call upon Jennie Osenki, at 530 Cedar avenue. He had been there but a few moments when Julian Tuszynski rushed in, and declaring himself to be the woman's fiance, demanded that the priest give up \$400 for alienating her affections. With Tuszynski was Leo Czechowski, both of whom, according to Father Rosinski, started at once to beat him and tear his clothes from his back when he refused to give them any money. His jewelry was taken from him, as well as \$50, and he was held as a prisoner for twenty-four hours without food or drink until he consented to sign the checks and notes. These checks, it is said, were cashed by Tuszynski and the woman. Upon return to the room with the money, the priest says he was released. Father Rosinski notified the police and the trio were arrested. The two notes and \$15 were found under a carpet in the woman's room. They are charged with robbery and were bound over the grand jury.

FEVER MAY VISIT 'FRISCO

Completion of Panama Canal May Set at Naught Present Quarantine Provisions.

SAN FRANCISCO, Aug. 25.—Sir Patrick Manson, medical adviser to the British Colonial office and recognized authority on tropical diseases, in a speech before the board of directors of the Merchants' association of this city, outlined his theory that yellow fever may yet become a source of worry here in the changed trade conditions which will follow the completion of the Panama canal, urging the utility of what now passes as quarantine, either in yellow fever or the bubonic plague. Owing to these advances that San Francisco possesses over London for the study of tropical diseases, an advantage due to the fact that it has a colony of 10,000 Chinese as well as many Japanese, Filipinos and Hawaiians, he suggested that a school be established here for the study of tropical medicine. Indianapolis Democrats Nominates. INDIANAPOLIS, Ind., Aug. 25.—Indiana Democrats in convention today nominated John Holtzman for mayor and William M. Fogarty for city clerk. Both nominees are now holding their respective offices.