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Roads - surface treatment

March 1955

Some Steps in the Development of Light Road Oil Mix Road Surfaces in California and the Western States.

By F. N. Hveem*

The following discussion was the subject of a talk prepared for a laboratory luncheon group meeting in April 1938. It seemed that the material might be of interest to those who are not acquainted with the early history of the oil mix type of pavement. It is also believed that it is worth describing some of the steps by which a laboratory test procedure is developed to fit a new type of construction.

The oil mix surfacing is the youngest member of the pavement family, and had its effective beginning in California in 1926. This, however, was not the first use of oil for highway purposes. In a cooperative report issued in 1929, McKesson and Frickstad gave a brief historical sketch which relates that asphaltic base oil and light residues had been applied to dirt roads in California over 40 years ago. In fact the first recorded use was the oiling of the road on Ortega Hill near Summer-land in 1876. In 1902, according to a report by James Abbott in the U. S. Department of Agriculture Year Book, 750 miles of county roads and city streets had been oiled in California.

There was no organized maintenance, however, and when an oil treated earth road become rough it was very rough indeed and much worse than if no oiling had been done at all. As a result, the use of oil was largely discontinued, and it was not until 20 years later that it was again given serious attention.

With the change of administration in 1922, the new Highway Commission and the Chief Engineer, R. M. Morton, concentrated a great deal of attention on the development of tourist highways and interstate connections. The only all-year highway into California then existing was the southern routes through Yuma or Needles and California connections lay across a wide expanse of desert country where water bound roads were a practical impossibility, and high-type paving was prohibitive on account of cost.

The State of Oregon had reported considerable success with bituminous surface treatments in 1923 and 24, and after a study of Oregon methods, California began to apply both light and heavy road oil to the existing water-bound gravel roads. In the desert regions, however, many of the existing road surfaces were not tightly bound up, and the first oil was applied with the idea of developing a "mulch" to eliminate dust, which was to be kept smooth by blading. However, many sections where the existing natural material was treated with oil contained enough fine sand or dust to compact readily, and it was soon found that long stretches of hard, smooth surface could be developed by the use of relatively light asphaltic oil corresponding approximately to the present SC-2 grade.

*Materials & Research Engineer, California Division of Highways.

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In 1926 the first planned work was done mixing the oil with a graded aggregate, between Victorville and Barstow. A smooth riding, hard, dustless surface was created and attracted a great deal of attention and favorable comment. The fact that this first job was highly successful was undoubtedly a very good thing for the future development of cheap highway surfacing. However, as in most similar cases, engineers were so impressed with the success that many become over optimistic. The fact that in this one instance a highly satisfactory road was built by means of mixing the ordinary roadbed material with cheap oil of rather low viscosity, led many to believe that equally successful surfaces could be constructed almost any place, and that no particular attention need be given to the character of the aggregate, grading, dryness, or any number of things which the engineer was accustomed to worry about in other types of construction.

Two more sections built in 1927, both in desert regions, seemed to confirm this belief, so that in 1928 a scattering of contracts were let throughout the State in order to determine how many materials and localities were favorable for this new cheap road surface.

When the "dust had settled" at the end of the construction season in 1928, it appeared that the law of averages was still in operation, and a great many failures and unsatisfactory results had been accumulated along with a few more successful jobs. The suspicion was growing that perhaps there were rules to this game as well as to most others. I recall that when I was first assigned as Resident Engineer on an oil mix surfacing contract in the spring of 1929, I asked Mr. Withycombe whether or not there was any truth in the rumor moisture in the aggregate would cause trouble. He said that he did not believe it did any good. I asked him how much could be tolerated, and his reply was "Not very damn much." That was about the extent of the specification on which I had to operate. Perhaps that is not strictly true - I had forgotten that we did have a stain test. At any rate, it was becoming generally realized that more information was needed.

The McKesson-Frickstad formula was evidently not providing enough oil, as many plant mix jobs had raveled, because of the lack. As I was the Resident Engineer on the first work of this kind within District VI, it seemed to me that it would be a good opportunity to measure some of the variables and find out which, if any, were significant. Therefore we weighed, measured, observed, and tested everything that seemed to be even remotely connected with the job. While many of the observations turned out to be meaningless, we did find quite clearly that when the aggregate contained more than 1-1/2% of moisture, the pavement would rut, groove, and give all evidences of instability, whereas with moisture less than 1-1/2%, a hard, smooth surface was invariably obtained. It was also found that when the percentage of sand and fine material was increased, it was necessary to increase the amount of oil in order to maintain a uniform appearing mixture. Likewise, when the fines were reduced, it was necessary to reduce the oil.

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While this fact was new only to me, and was an old story to experienced paving men, nevertheless, having read somewhere that the surface area of aggregates was the only factor that changed consistently and definitely with changes in grading, the thought occurred that perhaps the amount of oil required in the mixture bore some relation to the amount of surface that had to be covered. After some trouble, surface area constants were secured and the various mixtures analysed in terms of equivalent surface area. It was then found that we had unknowingly obtained about the same coverage factor for all mixtures, whether coarse or fine. When the oil content was adjusted to give about the same appearance, we were unconsciously providing about the same film thickness or coverage of oil on the rock and sand particles.

This investigation brought about contact with the Laboratory, and it appeared that the Laboratory was also having troubles trying to explain why oil mix jobs built on the same specifications and perhaps inspected by the same engineer were giving wide differences in results. It was becoming increasingly evident that the procedure held considerable possibilities for construction of cheap road surfaces, and also had considerable possibilities for trouble.

The State of Arizona had also begun oil mix construction, and by 1929 had run into a brand of trouble which had not yet become noticed in California. Certain oil mix sections patterned after the California method had done well until they were hit by a rain. The surface softened and became muddy, was splashed up by passing cars, and large portions of the oil road ran off into the side ditches. This was a little disconcerting, and the Arizona Laboratory began an investigation. Julian Powers who was then Materials and Research Engineer suspected that the oil might be emulsifying, and sought in the literature for a test to measure emulsification. He ran across a procedure established for the testing of demulsibility of steam cylinder oil, and applied the procedure to samples of the road oil mixed with fine dust from the pavements which had failed. This test indicated marked differences in the quality of the dust between good and bad sections.

Powers continued to call this test the "demulsibility test" but when later adopted here, the name was changed to the "Water Asphalt Preferential Test" by which name it is now described throughout the United States although it has long since fallen into disuse.

Further investigation by Powers, assisted by Wayne O'Harra, brought out the fact that the compacted oil mixtures from the failed sections would show marked swell when placed under water. Samples from California roads which had shown considerable failure were subjected to these two tests and it was quite clear that many of our troubles could be traced to the use of aggregate having a high affinity for water, with the result that when moisture came in contact with the road, the oil would displace and the surfacing virtually disintegrate. It all seems very much a matter of course today, but

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prior to that time the Resident Engineer was usually blamed for the failures. Among other results the laboratory studies have lifted a considerable burden of reproach from the field men, who were trying to make roads with materials that were very definitely unsuitable for the purpose.

For the purposes of this discussion, I do not believe it is necessary to enumerate the similar development for each of the several test methods and laboratory procedures which have been devised to prevent the recurrence of failures. I should like to emphasize, however, the principle that all laboratory procedures should be developed only to enable the construction forces of the Division of Highways to secure the best type of construction at the lowest possible cost. Field methods and types of construction change, and it is necessary that Laboratory procedures be constantly studied with a critical eye to see whether they have any real meaning in terms of results being obtained. Any laboratory test that does not have a direct bearing on the service rendered by the material or which does not aid the field in doing better work, is seriously in need of revision. The performance of a test is not an end in itself.

It is by no means a simple matter to devise laboratory methods or test procedures which in a brief time will indicate accurately the changes which a construction material will undergo when exposed to the complex destructive action of sun, rain, heat, cold, and highway traffic. Attempts to establish correlation should not cease, and while it is probable that precise agreement will never be reached, nevertheless we should not be satisfied while there remains any uncertainty.

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