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CRACKED VERSUS UNCRACKED ASPHALTIC MATERIALS

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CRACKED VERSUS STRAIGHT RUN ASPHALTS IN ROAD MIXES

Facts obtained from a study of the literature on the subject of cracked and straight run asphalts, from research in this laboratory, and observation of roads in service may be summarized as follows:

1. In general, cracked asphalts harden more rapidly and deteriorate sooner than straight run asphalts, although it cannot be said that all cracked asphalts are necessarily inferior (1, 3, 4, 7, 8, 9)*

2. Cracked asphaltic products, especially those of the liquid slow curing type, apparently resist stripping better than straight run products (8).

3. Cutbacks of cracked asphalts do not, in general, produce as durable mixes as those of straight run asphalts (6).

4. The properties of cracked asphalts are influenced greatly by the source of the crude and the degree of cracking in the still. Mixed base crudes usually do not produce as good material as the asphaltic oils of the south and west. Excessive cracking at high temperatures produces greater heterogeneity of the product (14).

5. The viscosity of cracked asphalt is more susceptible to temperature change than that of straight run asphalt (6, 11).

6. The present identification tests do not differentiate between good and poor asphaltic products, either of the cracked or straight run types. Various accelerated weathering tests have been devised for this purpose, some of which have shown fair correlation with service behavior. Such tests, however, are not infallible in predicting with certainty the durability to be expected of an untried material (9, 11).

* Numbers in parentheses refer to literature cited at the conclusion of this summary.

7. Cracked asphaltic products can be used successfully in many cases, but the chances of obtaining a satisfactory job are less than when using straight run asphalts (7, 8, 9, 13).

In view of the facts set forth above, it is recommended that the use of cracked asphalt should be avoided until such time that asphalt technology has advanced to a point where it is possible to detect a good or bad asphalt material by laboratory procedure.

1. Public Roads, Journal of Highway Research, Vol. 18, No. 5 July, 1937. "Laboratory Exposure and Simulated Service Tests of Slow Curing Liquid Asphalts." R. H. Lewis and W. O. B. Hillman, Division of Tests, Bureau of Public Roads.

   A series of laboratory exposure and service tests on 3 uncracked, 2 cracked, and 1 blend of uncracked and cracked road oils of the SC-2 viscosity grade showed that weathered mixtures made with uncracked oils retained plastic qualities while those made with cracked oils became friable and crumbly. Tests indicated that cracked oils tend to harden more rapidly than uncracked.

2. American Petroleum Institute, Proceedings, Sec. III, Eighth Mid-Year Meeting. Vol. 19 M (III) 1938, p. 83. "Identification and Properties of Straight-run and Cracked Residua", A. H. Batchelder and H. B. Wallman.

   Essential differences in composition and behavior of cracked and straight run residua particularly with respect to chemical stability which are not indicated by present testing methods except qualitatively by the Oliensis Spot Test led to this research and establishment of test to quantitatively differentiate between straight run and cracked asphalts.

3. Proceedings of the Montana National Bituminous Conference, 1939. "Cracked vs. Uncracked Road Oils" R. G. Clark, Chief Chemist, New Mexico State Highway Testing Laboratory.

   Cracked Road Oils were shown to reach their maximum binding properties in 20 months curing after which the mixtures made from them lost strength and deteriorated. Uncracked oils retained their binding properties and showed no signs of deterioration even after 36 months. Results based on weathered and unweathered laboratory test specimens and on actual field experience.

4. Ibid: "Durability of Asphaltic Materials". J. R. Benson, Bituminous Engineer, Kansas State Highway Commission.

Conclusions state that Positive Spot Test materials tend to be more susceptible to weathering than negative Oliensis Spot Test materials. A survey of over 60 projects shows that uncracked rapid curing and medium cutbacks were superior to cracked materials with respect to evaluation of surface failures and defects.

5. A. S. T. M. Proceedings, 1937, Vol. 1937, Pt. II "The Constituents of Asphaltic Materials versus Accelerated Weathering." R. R. Thurston.

Accelerated weathering tests on series of asphalts show that durability by these tests was seriously decreased with asphalts made from a highly cracked residuum.

6. Association of Asphalt Paving Technologists - Proceeding Dec. 1932. C. M. Baskin "Progress Report of the Committee on Investigation of Liquid and Semi-Liquid Asphaltic Material for Low Cost Road Construction.

Cracked asphalts are similar to coal tar in that they are extremely susceptible to temperature change and much lower in viscosity at elevated temperatures than equivalent straight run asphalts.

There is an element of instability possible in products of the cracking reaction which have been found to cause undesirable qualities in the product. Also, subsequent processing of the cracking process may radically affect the behavior of the product when made into a cutback. Subsequent oxidation of the cracked product may also materially affect its quality.

7. A. A. P. T. Proceedings, Jan. 1935
E. F. Kelly, "Symposium on Specification Requirements for Asphalt Cements".

It is generally agreed that some asphalts produced by cracking processes are highly unsatisfactory materials for paving materials. It is however difficult to justify the broad statement that all cracked asphalts are necessarily inferior but it can be said that it may be dangerous to use cracked materials because some of them are poor and there are no adequate means of differentiating between these and the ones which may be good.

8. Proceedings Highway Research Board. 17:328-333. 1937
E. F. Kelly, "Report of Committee on Characteristics of Asphalts".

Answers to a questionnaire on service of asphaltic road materials indicates that trouble is not limited to any particular types or grades but appears to be more prevalent with cracked than with uncracked products. Resistance to the stripping action of water is much more pronounced in cracked than uncracked products and this is especially true for the slow curing liquid types.

9. A. A. P. T. Proceedings, January, 1942.
V. A. Endersby, F. H. Stross, and T. E. Miles "The Durability of Road Asphalts".

Both cracked and straight run asphalts vary greatly in their durability as road binders. A number of test sections were laid down in a company parking lot, and breakdown of the surface was accelerated by using lean mixes, open grading of aggregate, filler surface of high oil demand, and no seal coat. Of these test sections, all of the worst ones contained cracked products; in the first 34 sections, there were two cracked asphalts that showed good durability. In between the best and worst materials lay both cracked and straight run asphalts of various performances. A method of test devised to simulate accelerated weathering gave fairly good indication of durability in service.

10. "The Measurement of the Oxidation Stability of Road Asphalts"
(Anderson, A. F.; Stross, F. H. and Ellings, A.
Shell Development Company, Emeryville, California)

Road failures other than those due to construction are largely due to hardening of the asphalt. Experiment cited to show that cracked asphalt hardens more rapidly than uncracked asphalt. This is much more true at higher temperatures, however, and the rate of hardening tends to become the same at ordinary temperatures. (Perhaps most of the trouble comes during the original mixing operations.)

In a series of 8 asphalts used in the investigation 4 were cracked and 4 uncracked. Service ratings of the cracked oils were in general considerably poorer than those of the uncracked oils.

11. "Changes in Characteristics of Slow Curing Asphaltic Oils"
E. A. Finney and T. Wolesynski, Proceeding Association of Asphalt Paving Technologists, 1940.

Investigation of 16 cracked and uncracked oils indicates that in general the heating time required to produce 100-penetration residue is less in the case of the cracked oils and that the ductility of this residue at 4°C. is less than in the case of uncracked oils. In general, the percentage of asphaltenes is higher in the cracked oils, and their temperature susceptibilities (viscosity indexes) are greater. The work indicates that accelerated weathering tests have merit in differentiating the durability qualities of both cracked and uncracked products.

It is evident that an asphaltic oil aggregate surface may change gradually from a flexible to a semi-rigid or rigid state over a period of years. The rate of transformation is dependent upon the inherent properties and constituents of the mixture. It was found that at the rigid state the pavement had lost at least 25 percent of its original bituminous content and in most cases the inherent binding and cementing properties of the binder had practically disappeared. Thus, in establishing criteria for judging bituminous materials on the basis of their service behavior and durability, it is evident that the following factors must be taken into consideration, namely, the amount of oily constituents and their rate of dissipation, the cohesive and adhesive properties of the bitumen when aged, the petrogenic characteristics of the mineral aggregates and the inherent properties of the bituminous mixture.

12. "Asphalt from the Cracking Process"
(Egloff, Gustav and Morrell, Jacque C. Ind. & Eng. Chem., Ind. Ed. Vol. 23, No. 6, pp. 679-80, June 1931)

The production of cracked asphalts is reported and discussed. Such asphalts meet A.S.T.M. D102-24T and D103-24T specifications except for slight departures in solubility in carbon tetrachlorides. High ductilities are claimed, due to reduction in amounts of suspended carbonaceous or pitchy material. Air-blown products have higher softening points and lower penetrations and ductilities than residues from steam distillation.

13. City of Lansing.
Experiences in the Use of Cracked Oils.

The City of Lansing has used cracked asphaltic oils of SC-3 and SC-4 grades between 1931 and 1942 in the construction of surface courses on gravel streets. These oil aggregate surfaces have given excellent service without reseeling whenever laid on a good foundation.

14. Herbert Abraham
"Asphalts and Allied Substances." Fourth Edition, 1931, pp 453-460. D. Van Nostrand Company.

Processing and source of the crude oil have a considerable effect on characteristics of residual asphalts. Mixed base crude oils are not as susceptible to overheating as purely asphaltic petroleums, but the latter are free from the grease like substances found in carelessly prepared residua of the former. Methods are given for detecting carelessly prepared residual asphalts.