

INTERIM REPORT #2
PREDICTING MOISTURE-INDUCED DAMAGE TO ASPHALTIC CONCRETE —
FIELD EVALUATION PHASE

by

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(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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SUMMARY

The Virginia Department of Highways and Transportation is one of seven state and federal agencies participating in a field evaluation of a stripping test method developed under NCHRP Project 4-8(3), "Predicting Moisture-Induced Damage to Asphaltic Concrete". In the Virginia portion of this field phase of the project, an evaluation is being made of the effectiveness of the method in predicting the degree of stripping that will occur on a 950-ft. (290-m) test section constructed with an asphaltic concrete believed to have a tendency to strip.

The test method was used on specimens prepared in the laboratory and on cores taken immediately after construction of the test section in an attempt to predict the stripping susceptibility of the mix. On the basis of the results of those tests it was predicted that stripping would occur over a long period. Tests on cores being taken periodically show decreasing strength values that probably are a result of progressive stripping, that was very evident in cores taken at 22 months.

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INTRODUCTION

This report has been prepared as fulfillment of the working plan requirement that an interim report be submitted 36 months after construction of the Virginia test section included in the field evaluation phase of the National Cooperative Highway Research Program Project 4-8(3), "Predicting Moisture-Induced Damage to Asphaltic Concrete". In this evaluation phase, the test method for predicting the susceptibility of asphaltic concrete mixtures to stripping developed in the initial phase of Project 4-8(3) is being evaluated and refined.

The Virginia Department of Highways and Transportation was one of seven state and federal agencies selected to install 1,000-ft. (300-m) test sections of pavement using an aggregate with a history of stripping. The test method was used on laboratory specimens to predict the stripping that would occur in the pavement, and tests cores being taken periodically are used to monitor damage that is occurring. The data obtained from all participants will be used by the NCHRP contractor to evaluate and possibly modify the test method.

A description of the Virginia test section and the testing procedure was included in the first interim report.* This present report presents data obtained since the installation of the test section.

PURPOSE AND SCOPE

The purpose of this project is to provide field and lab data to be used in the evaluation of a newly developed stripping test. The test was performed on laboratory specimens to predict potential stripping and on cores from a field test section to monitor the stripping. The test section is being inspected periodically for possible stripping failures.

*Maupin, G. W. Jr., Interim Report, Predicting Moisture-Induced Damage to Asphaltic Concrete — Field Evaluation Phase, August 1977.

TEST INSTALLATION

On May 6, 1976, a 950-ft. (290-m) test section was constructed on Greenwood Drive in Portsmouth, Virginia, using an asphaltic concrete mix containing a granitic aggregate known to be susceptible to stripping. The pavement consists of 1.5 in. (3.8 cm) of S-5 asphaltic concrete surface mix, 5.5 in. (14.0 cm) of I-2 asphaltic concrete base mix, 6 in. (15.0 cm) of crushed stone, and a 6 in. (15.0 cm) cement stabilized subgrade. The location of the test section and description of the materials are described in the interim report cited above. The bottom 2.5 in. (6.4 cm) of the I-2 base mix is being analyzed in this study because, generally, the bottom layer of the asphaltic concrete is the first portion affected by stripping. The traffic loading for the test section is approximately 5,000 18-kip (80 KN) equivalent single axle loads per year. The annual precipitation and freezing index (degree Fahrenheit days below 32°F) are approximately 40 in. (102 cm) and 160°F days (89°C days below 0°C), respectively.

LABORATORY PROCEDURE

Laboratory Specimens

Specimens were prepared in the laboratory with aggregate and asphalt cement obtained from the asphalt plant during the construction of the test section. The specimens, prepared with a density comparable to the field density, were tested initially and after storage for 2, 5, and 10 months. It was thought that tests on the stored specimens might allow a closer prediction of stripping in the field than would the tests on freshly made specimens.

Cores

Cores were obtained immediately after construction and at 4-month intervals for 2 years; and they will continue to be taken at 6-month intervals until the spring of 1981. Some of the first cores taken were stored in the laboratory and tested after 2, 5, and 10 months. The average void content of those initial cores was 6.1% and periodic corings have indicated no decrease in voids as a result of traffic loading.

Test Procedure

Two types of moisture preconditioning were used on the cores and lab specimens in an attempt to duplicate the stripping damage that occurs in the field. One set of specimens were preconditioned by vacuum saturation; another set were vacuum saturated, frozen, and placed in a 140°F (60°C) water bath. The latter are referred to as freeze-thaw specimens. A third set were tested dry (unconditioned).

Resilient modulus tests were performed at 72°F (22°C) and 55°F (13°C), and indirect tensile tests at 55°F (13°C). A detailed description of the preconditioning and testing procedure is given in the previously cited interim report.

RESULTS

Stiffness or Strength Ratios

The stiffness or strength ratio is the ratio of the preconditioned stiffness or strength to the dry stiffness or strength. Lottman suggests that a ratio of the preconditioned value to the unconditioned value might be used to predict the stripping susceptibility of a mix.

Cores were taken immediately after construction and specimens were fabricated in the laboratory and tested to predict the stripping that would ultimately occur. The vacuum saturation and freeze-thaw preconditioning were used to simulate short-term and long-term stripping, respectively. The cores and specimens were tested after storage times of 0, 2, 5, and 10 months to determine if stripping is predicted more accurately by allowing specimens to age before testing. The ratios of the laboratory prepared specimens for the initial tests (0 months) in the freeze-thaw preconditioning were 0.26, 0.22, and 0.13 less than the ratios of the cores, respectively, for the resilient modulus ratio at 72°F (22°C), resilient modulus ratio at 55°F (13°C) and tensile strength ratio at 55°F (13°C). Therefore, the results on the laboratory specimens indicated a potential for more severe stripping than did the results from the cores taken from the test section. If the predictive test is used to accept or reject an aggregate, an allowance will have to be made for the apparently lower values obtained on lab specimens.

Cores were taken periodically for tests to determine the trend of stripping degradation in the pavement. Figures 1 and 2 illustrate the aging and stripping effect on the resilient modulus ratio at 72°F (22°C) and 55°F (13°C) test temperatures, respectively. The cores were tested in the vacuum saturated condition to simulate what would normally be the weakest pavement condition. There appears to be a trend of decreasing resilient modulus ratio after the 9-month tests. The ratio at 25-months displayed a sudden increase, but it is believed to be caused by a 2-month dessication period necessary for drying the cores. Ideally, if the test method is to be highly useful, the trend will continue downward and approach the original long-term predictions of the lab specimens and cores. These long-term predictions are plotted at 60 months on Figures 1 and 2.

Figure 3 illustrates the effects of stripping and aging on the tensile strength ratio. There was a trend for the tensile strength ratio to decrease from the 9-month tests through the 22-month coring tests, which followed a severe winter, and then a slight increasing trend through the summer months, which possibly was caused by a drying and healing phenomenon. The next coring, which is scheduled to be performed after a second severe winter, will possibly show a continuing decreasing trend which may eventually approach the predicted long-term (60-month) tensile strength ratios. The trend of the tensile strength ratio will be observed closely because the tensile strength test could be adapted to field use easier than the resilient modulus test.

Figure 4 displays the effect of aging and stripping on the resilient modulus at 72°F (22°C) of unconditioned cores taken periodically from the test section. The resilient modulus increased from 160,000 psi (1.10 GPa) immediately after construction to 420,000 psi (2.90 GPa) after 16 months; decreased to 250,000 psi (1.72 GPa) at 25 months; and then increased to 370,000 psi (2.55 GPa) at 29 months. It is possible that these cyclic trends are associated with the seasons; however, results of tests on additional cores to be taken periodically will hopefully clarify this matter.

The effect of aging and stripping on the resilient modulus at 55°F (13°C) is illustrated in Figure 5. The trend is similar to that of Figure 4, except that the increase for the 29-month modulus was not as pronounced.

The unconditioned tensile strength increased from 47 psi (0.32 MPa) immediately after construction to 82 psi (0.57 MPa) at 16 months of age, as is illustrated by Figure 6. The

strength then decreased to 70 psi (0.48 MPa) at 29 months. Progressive stripping was observed in the cores that displayed the decreasing trend in strength. The trend of tensile strength should become more apparent as the pavement ages.

Visible Stripping

A visual examination of 12-month cores revealed some stripping. After the severe winter of 1978, cores were removed from the roadway and stripping was very evident (Figure 7). The next set of cores, scheduled to be taken in the spring of 1979, are expected to show additional stripping caused by the past winter.

CONCLUSIONS

1. The resilient modulus and tensile strength ratios of cores taken periodically reached a maximum after 9 months, and now appear to be decreasing because of progressive stripping.
2. The indirect tensile strength of cores taken periodically and not preconditioned reached a maximum at 16 months, and is presently exhibiting a decreasing trend.
3. Stripping was very apparent in the 22-month cores.

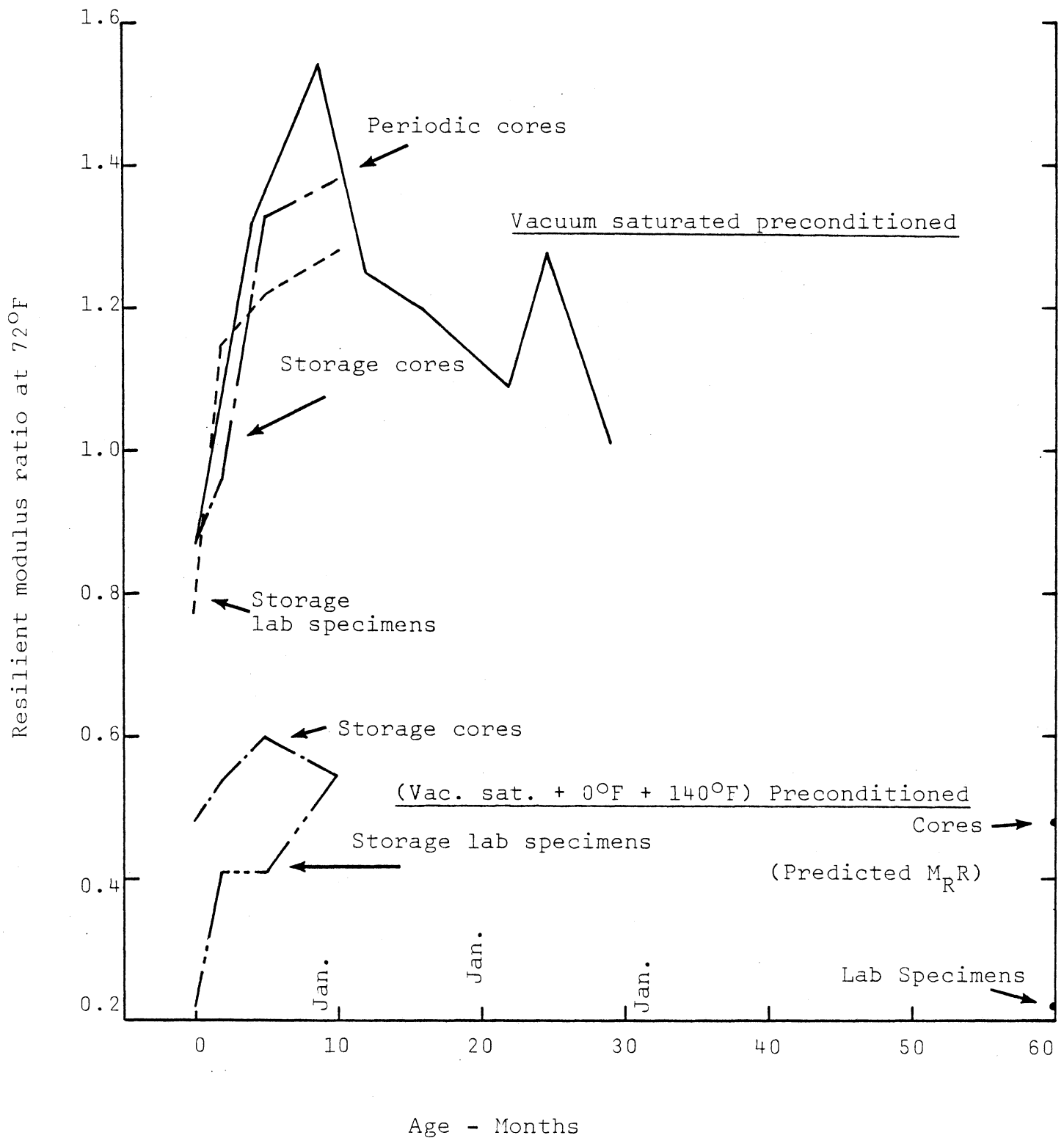


Figure 1. Resilient modulus ratio at 72°F (22°C) vs. age.

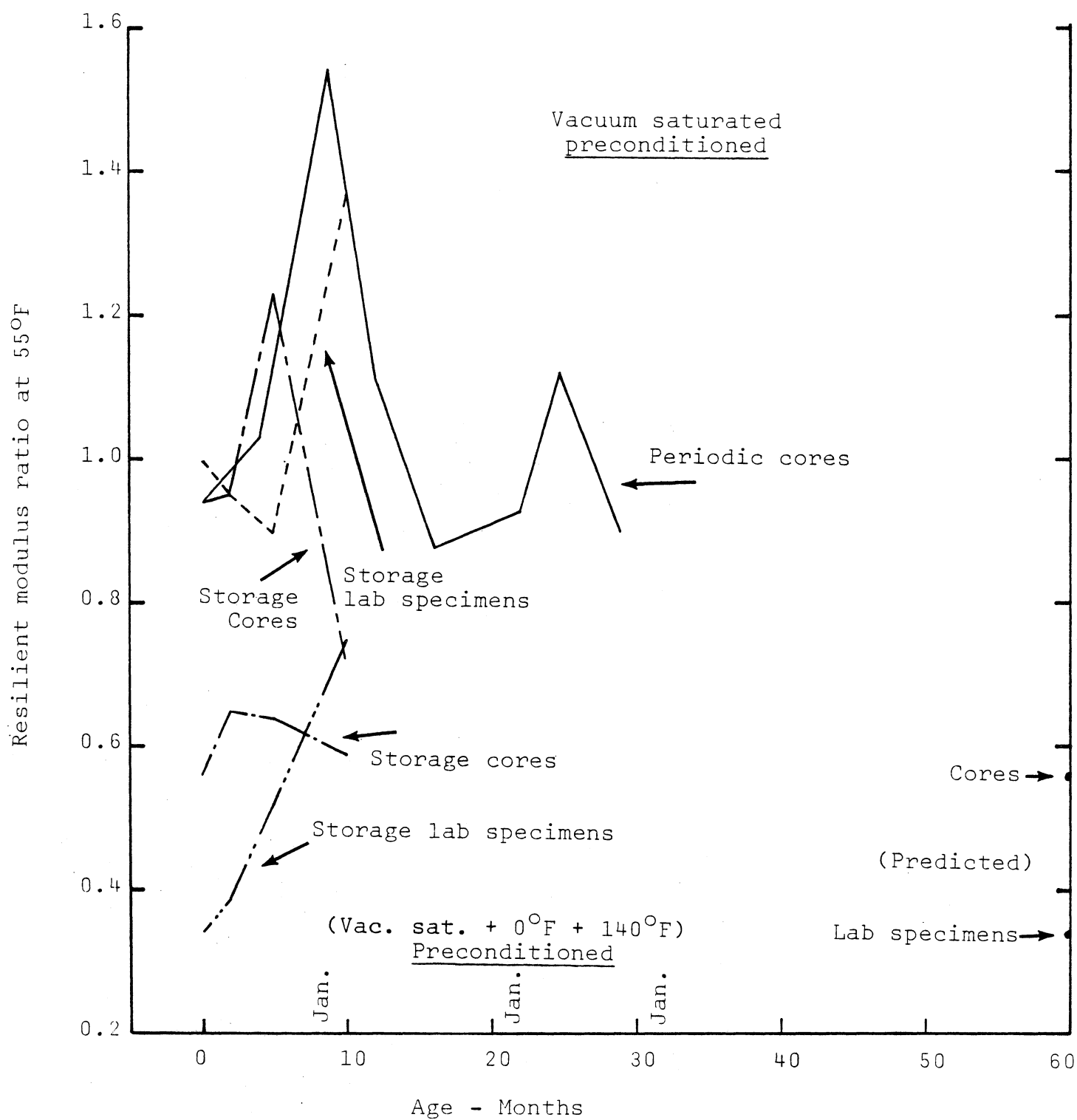


Figure 2. Resilient modulus ratio at 55°F (13°C) vs. age.

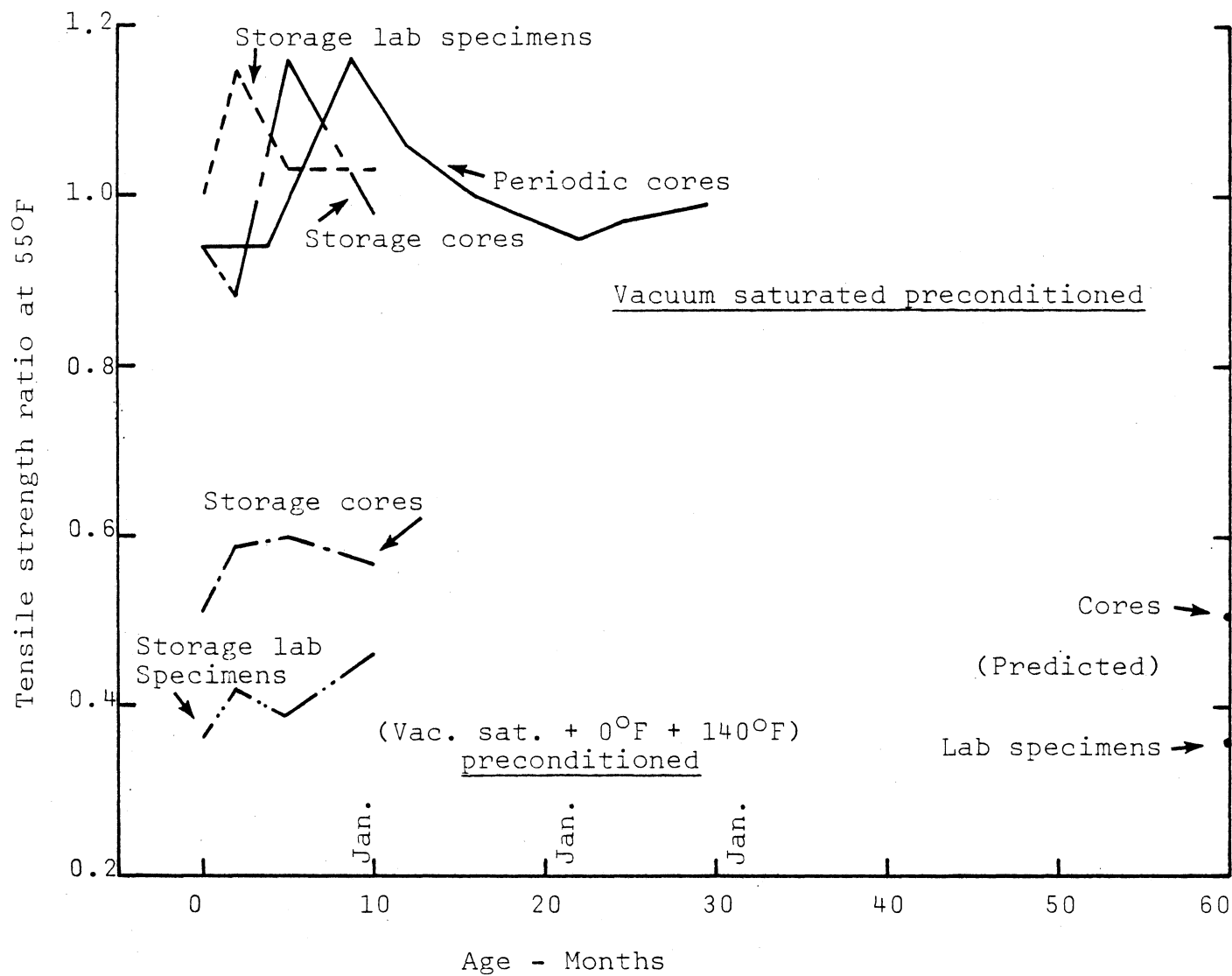


Figure 3. Tensile strength ratio at 55°F (13°C) vs. age.

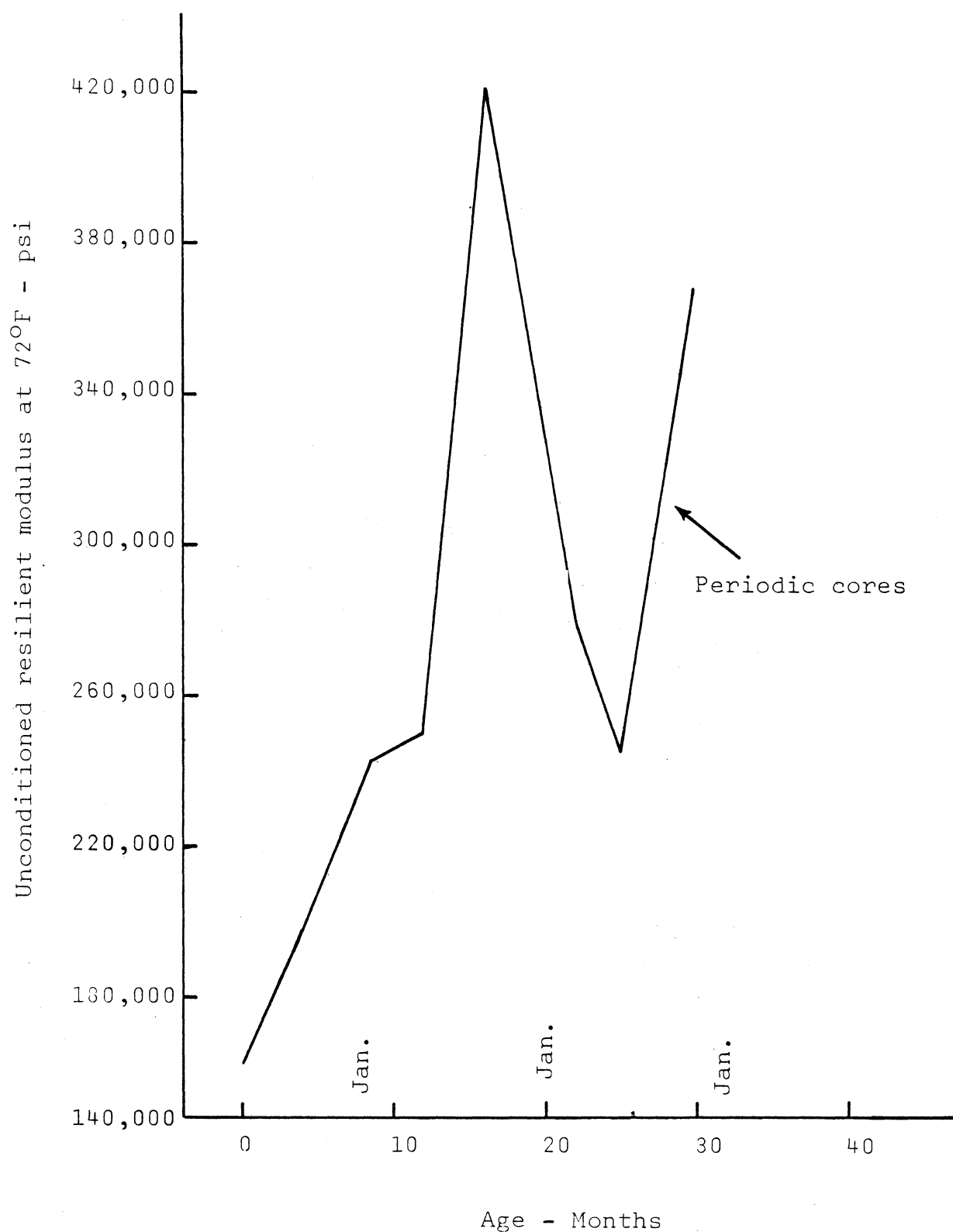


Figure 4. Unconditioned resilient modulus at 72°F (22°C) vs. age.
1 psi = 6.89 kPa

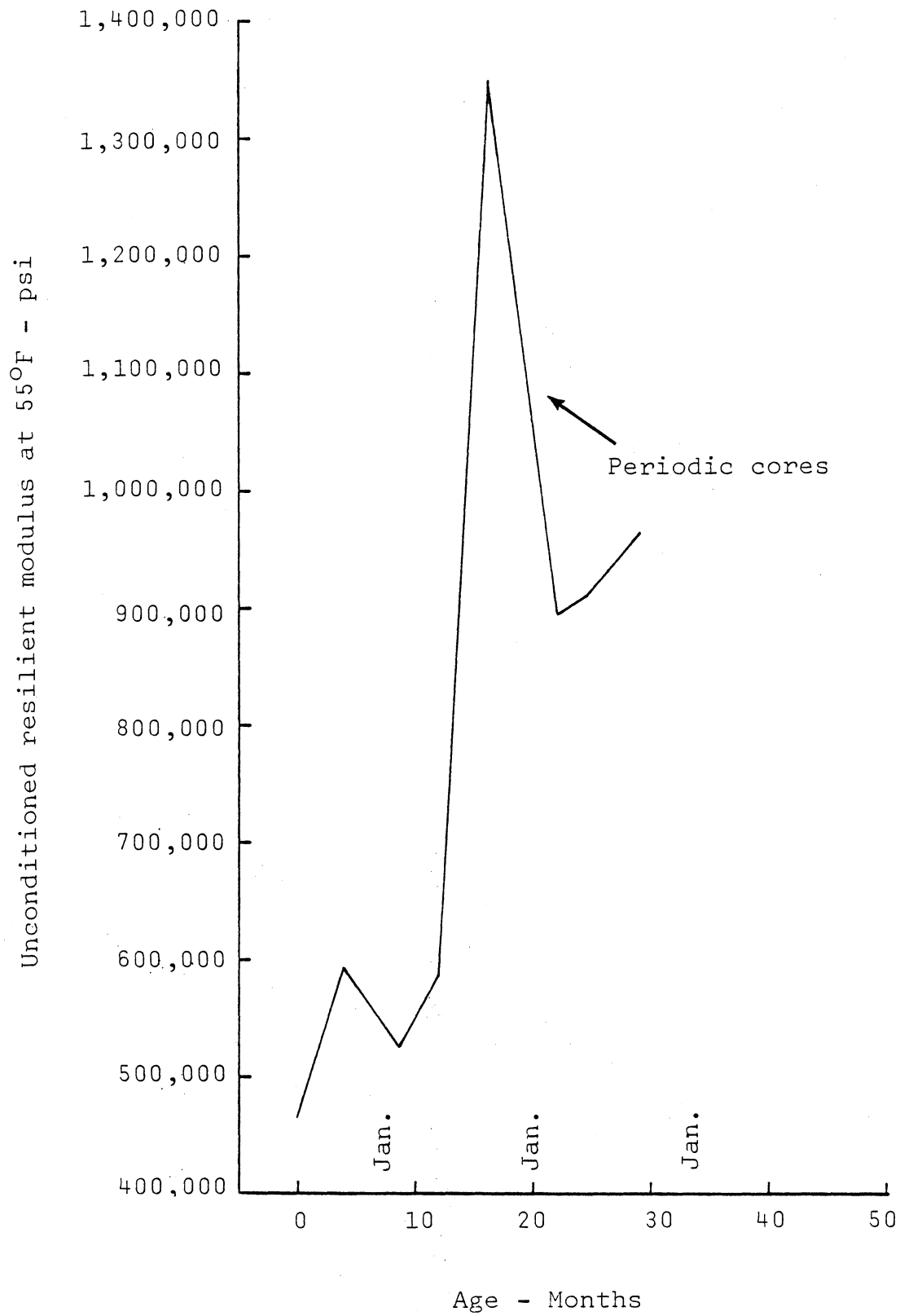


Figure 5. Unconditioned resilient modulus at 55°F (13°C) vs. age.
1 psi = 6.89 kPa

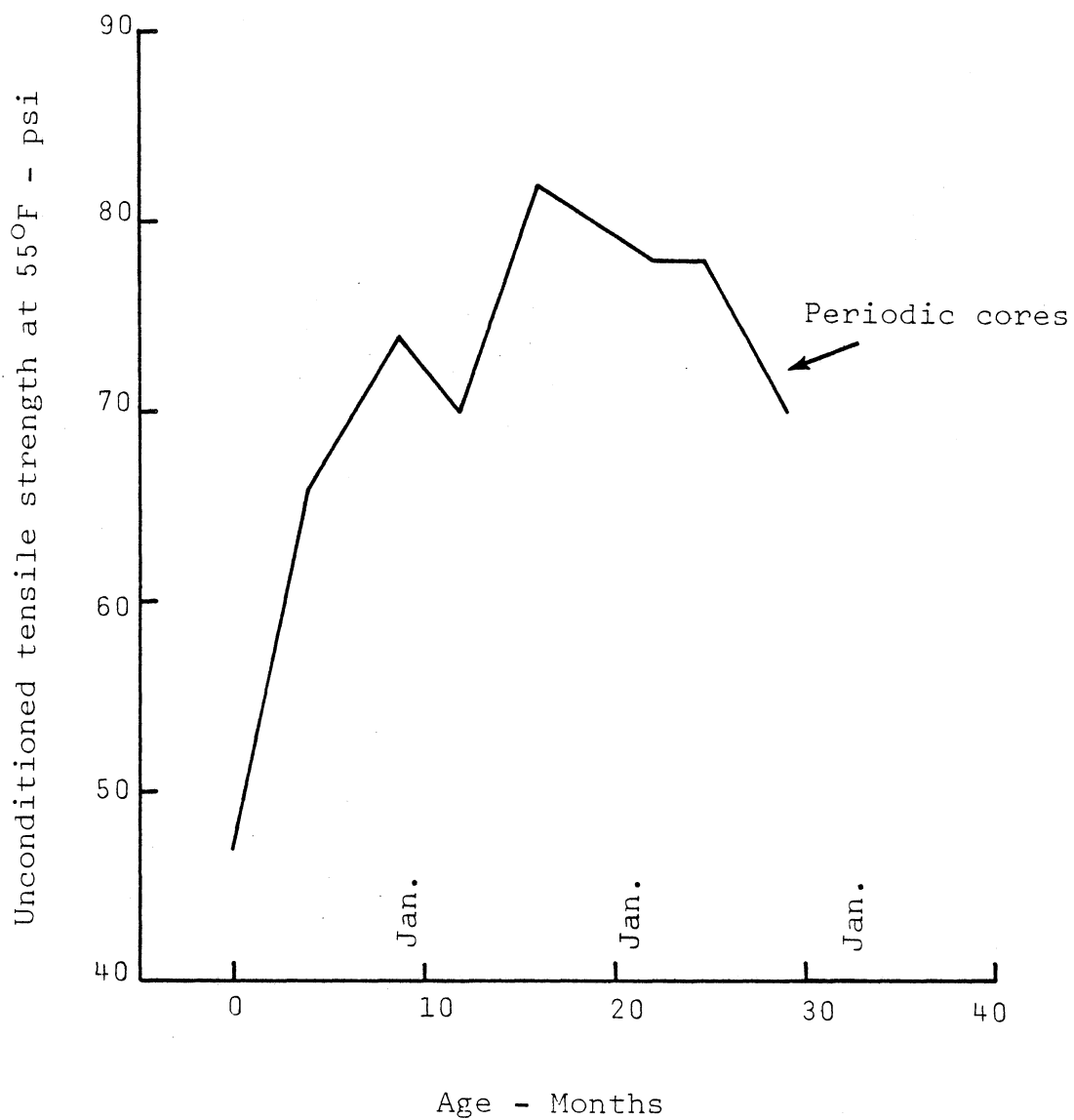


Figure 6. Unconditioned tensile strength at 55°F (13°C) vs. age.
1 psi = 6.89 kPa

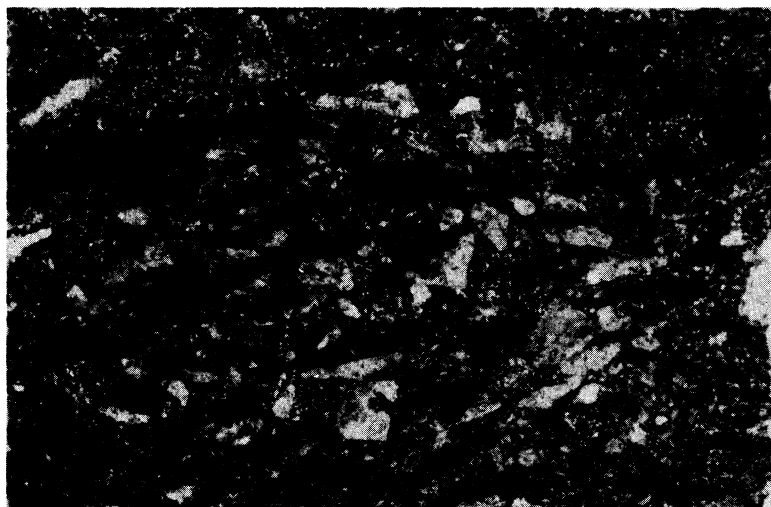


Figure 7. Stripping in 22-month cores.