Saskatchewan Highways and Transportation

RESEARCH in Review

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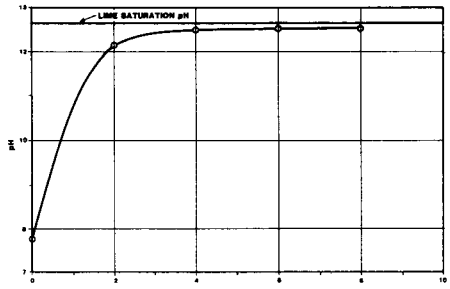
Lime Modified Clay Research Program

by D. Sweeney and D. G. Fredlund

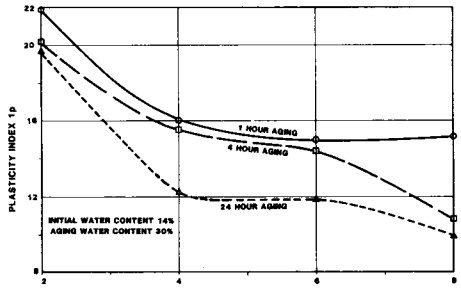
In the spring of 1985 a four phase Lime Modified Clay research program was initiated by Saskatchewan Highways and Transportation to better understand the performance of lime modified soils native to Saskatchewan. The study was conducted by the Civil Engineering Department at the University of Saskatchewan under the guidance of Professor D. G. Fredlund. The four phases of the research program were:

1) Literature Search
2) Laboratory Testing Program
3) Design Mix and Field Construction Procedures
4) Field Test Section

Phase 1 of the research program consisted of an extensive literature review.



pH VERSUS LIME PERCENTAGE FOR SAMPLE MIXED WITH A SOIL TO WATER RATIO OF 1 TO 5 (FROM "THE EFFECTS OF LIME ON THE PROPERTIES OF REGINA CLAY", MASTER'S THESIS BY D.A. SWEENEY, UNIVERSITY OF SASKATCHEWAN, 1988)



Effect of Aging on Plasticity Index (from "The Effect of Lime on the Properties of Regina Clay", Master's Thesis by D.A. Sweeney, University of Saskatchewan, 1988)

Douglas Sweeney of Clifton Associates Ltd. completed his Master's thesis as part of the research program (Phase 2). The title of his thesis was "The Effect of Lime on the Properties of Regina Clay".

The primary objective of the laboratory testing portion of the research program was to determine the effects of various variables, such as lime percentage, on the engineering properties of Regina Clay. Secondly, to establish appropriate testing methods for determining the durability of lime treated Regina Clay. The variables studied included lime percentage, water content, aging period, compactive effort and curing period. The durability of lime modified Regina Clay was also studied under environmental influence such as wet dry cycles and freeze thaw cycles.

The major findings from the laboratory investigation on lime modified Regina Clay include:

1) Lime modification of Regina Clay increases the strength, but does not contribute significantly to the long term durability of the treated clay.
2) Lower lime percentages (i.e. one to four percent) are not sufficient to produce a subgrade that will withstand environmental stresses such as freeze-thaw and wet-dry cycles. The research shows that Regina Clay treated with four percent lime was more durable than the two percent lime treated soil. Higher percentages of lime referred to as "stabilization" may be required to provide a long term, durable subgrade.

One other notable product of the laboratory research program is the development of a procedure to determine the lime content in the field. This is a useful tool in quality assurance in the construction of lime-treated roads. The procedure is based on the observation that there is a relationship between the percentage of lime, pH and plasticity index.

Phase 3 of the program involved the assessment of current construction methods for lime treated highway subgrades. Construction of lime modified highway subgrades on Highway No. 339-01 and 334-02 near Briercrest, Saskatchewan were monitored and documented by staff from the University of Saskatchewan. As a result of these site observations and the findings of the laboratory testing program, a document outlining design mix and construction procedures was prepared.

Phase 4 of the research program is to construct a field test section incorporating the new design mix and construction procedures outlined in Phase 3 and to confirm the findings of the laboratory testing program. The Department is looking into the possibility of constructing a suitable test section in the near future.

As a result of the Lime Modified Clay research program, a better understanding of the performance of lime modified soils native to Saskatchewan is apparent. Many of the questions raised during the initial stages of the research program have been answered.

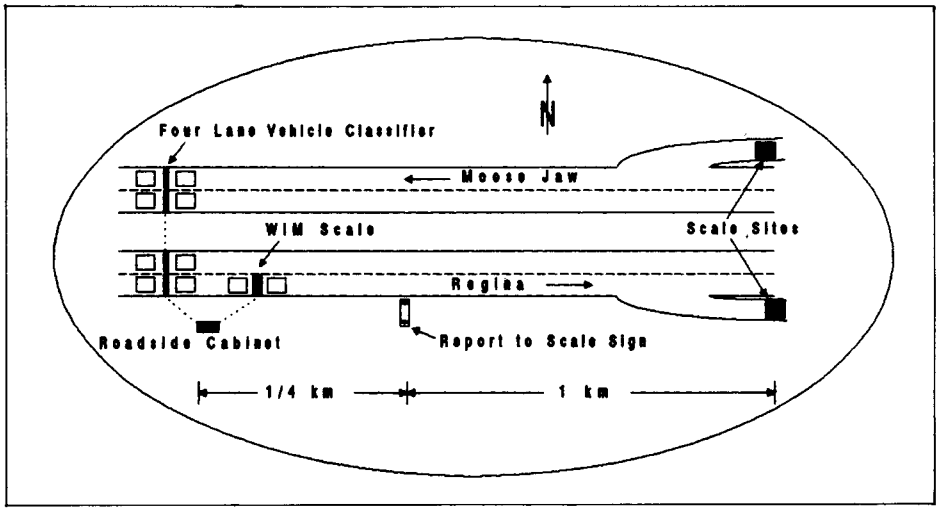
Regina WIM

In September of 1986, a Weigh-In-Motion (WIM) site was installed in the eastbound lane on Highway No. 1, approximately 15 kilometres west of Regina. For each vehicle in the driving lane, the number of axles, weight of each axle, spacing between axles, gross vehicle weight, vehicle speed, time and date are recorded. These records have been collected, stored and studied for a period in excess of two years. This information provides not only valuable traffic information but more importantly a database for the research and development of WIM systems in Saskatchewan.

The WIM system demonstrated at this location incorporates load cell technology. As a vehicle passes over the load cell, the load (or weight) of each axle is converted into an electrical impulse. This electrical impulse is then measured by a computer which converts the signal into an axle weight. The proper conversion factor is determined by adjusting the WIM weights to match the known weights of several test vehicles driven across the WIM system during a calibration exercise.

For a WIM system to be useful, it must have an accuracy within tolerable limits. Presently, the University of Regina has been commissioned to establish the level of accuracy of this WIM location. Preliminary results look promising in terms of gross vehicle weight, speed and classification comparisons. However, it does not appear that high speed WIM's such as this one can measure individual axle weight consistently. Inconsistencies such as this do not undermine the integrity of the equipment or concept, it merely illustrates the difficulty in trying to measure the weight of a moving, bouncing vehicle at highway speeds. A crude analogy is trying to weigh yourself on a bathroom scale while walking across it without stopping.

The WIM system installation west of Regina is providing relatively consistent data on vehicle classifications, speeds and gross vehicle weight which can be useful for long term planning of road transportation facilities.



Site layout

Research Musings

I would like to extend a thank you to all those individuals who had submitted research proposals to the Research Prioritization Committee. Unfortunately only one third of the submissions were selected for execution by the committee due to a limitation in funds. The interest shown by the department in the program has been extremely encouraging and I look forward to your continuing contribution in the future.

The Research Prioritization Committee is to be complimented on the excellent job done in putting together the program for this current fiscal year. The Committee consists of representatives from each of the five divisions within the department.

It is hoped that the establishment of this Committee will help us to achieve a number of objectives including the co-ordination of research throughout the department, eliminating and/or minimizing the duplication of efforts, getting the best return for our research investment and improving technology transfer. As of this date, we are well on our way to successfully approaching these objectives.

The research into high speed Weigh-In-Motion and Automated-Vehicle-Classification systems indicate that useful information can be gathered on the type and characteristics of vehicles using the highway system. This information should assist Highway Engineers to better plan and design highway facilities in the future.

Over the past ten years the department has devoted a good deal of time and resources into the use of lime as a soil modifier. The research conducted by the Department of Civil Engineering at the University of Saskatchewan indicates that certain conditions must be satisfied to ensure the success of lime modification. The department plans to construct a suitable field test section to assess the recommendations presented by the University.

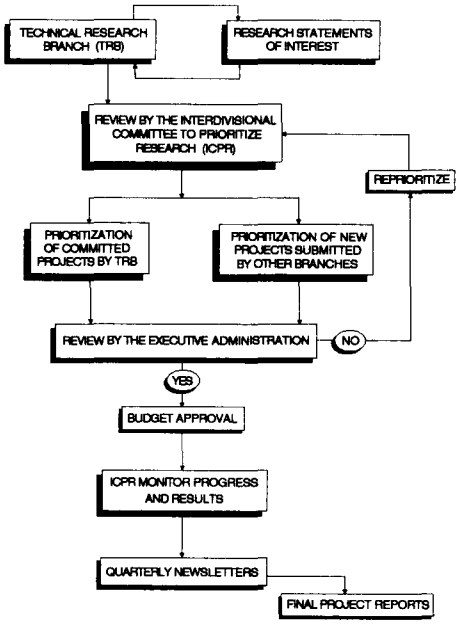
Kudos to Doug Powley, Dennis Johns and all others who have contributed to the success of this project.

The next issue of Research In Review will include a detailed report on the findings obtained from the various studies conducted to date with the new instrumentation in the Test Track facility.

P. M. L. Pearson
Executive Director

Interdepartmental Committee to Prioritize Research

The 1989-90 fiscal year brings with it new research projects to add to those carried over from last year. Each of these projects is headed by a project leader who oversees an interdivisional working committee of three to six specially skilled members.



How a proposal becomes a project.

Proposed Projects

- **Use of Chemical Agents to Improve the Effectiveness of the Motor Grader Blade as a Maintenance Tool** This project combines improving the performance of the Sandvik blade in maintenance mix salvage operations with assessing the performance of asphalt rejuvenating agents in cold pavement recycling in the hopes of developing a less costly, longer lasting oil treated surface.

- **Slurry Seal Test Section** A Slurry Seal product is being investigated for its ability to eliminate occurrence of flying rocks on roadways as well as correcting surface texture deficiencies.

- **Calibrating Benkelman Beam for New Temperature Curves** This project investigates the field applicability of the Benkelman Beam Curves in correcting for the effects of pavement temperature, asphalt concrete stiffness and pavement type.

- **Technology to Improve Maintenance Worker Safety** This study investigates the use of technology to increase the safety of highway workers in work zones.

- **Methods to Forecast Traffic Loadings on Highways** The working committee undertaking this project will augment existing information concerning pavement design by developing a better way for projecting the growth of truck axle passes.

- **Comparing Road Salt Gradation with Melting Effectiveness** In this study, salts are run through a nest of 5 sieves and classified as fine, coarse, or mixed depending on the residue. The relative effectiveness of the various gradations of salt in melting ice on the road is then determined by sprinkling different salts on pans of frozen water.

- **Road Profiler — Research and Development** The committee involved in this project is working on a vehicle mounted, high speed instrument to better measure pavement surface profile characteristics. This sophisticated unit is comparable to the K.J. Law unit and the South Dakota Transportation instruments.

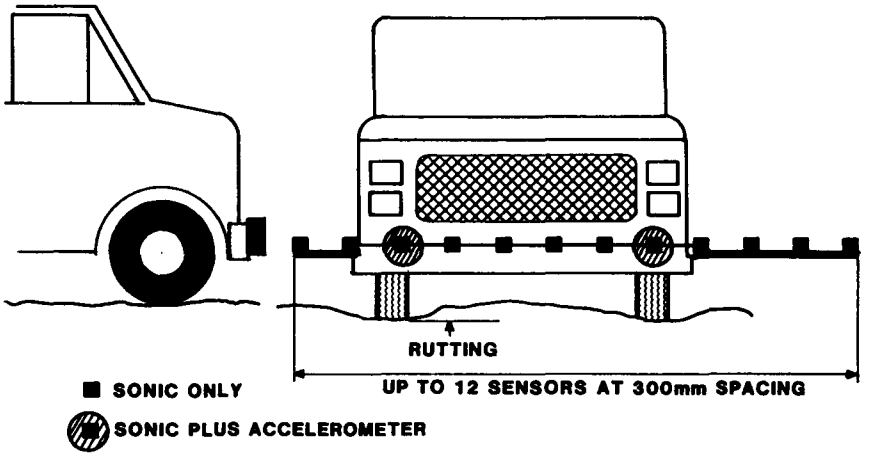
- **CRM, PURD, Profilometer and Dipstick Correlation** This correlative study allows for ride/roughness numbers to be obtained from a calibration of the Profilometer, Dipstick, CRM and PURD.

- **Measurement of Traffic Sign Reflectivity** This study establishes performance criterion for the nighttime reflectivity of traffic signs so that maintenance needs, fabrication standards, and policy changes may be determined. It is mainly concerned with the lifespan of the signs' effectiveness which varies according to sign location.

- **Moisture/Density Study of In Situ Limed Subgrades** In this "at site" study, 6 moisture/density tubes, 50mm by 3m, will be interred on existing lime roadway (shoulder) subgrade to monitor moisture density changes. Two separate nuclear gauges, moisture and density, are used to monitor road stability across the seasons so that the cracking of soil may be better understood.

- **Premium Asphalt Test Section** A newly developed asphalt cement which has been promoted as an equivalent to polymerized asphalt will be compared to both regular and polymerized asphalt for its performance and cost effectiveness.

- **Modifying Cable Guard Barriers for Pavement Rehabilitation** The committee will look at modifications to the current Cable Guard Barrier design to facilitate increases in pavement surface height resulting from pavement rehabilitation.



CONCEPTUAL DESIGN FOR ROAD PROFILOMETER

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- **Traffic Actuated Deer Crossing Warning Systems** In an effort to reduce the number of deer related highway traffic accidents, this project's working committee tests the effectiveness of Swareflex reflectors, a shiny metallic rectangle posted near the highway, as warning devices for deer.

- **Deer Creek Landslide Investigation** The mechanisms involved in the Deer Creek Slope failure are investigated so that landslides can be better understood and improved remedial measures developed.

- **Lime Modification Study** This study represents a possible continuation of an existing program with the University of Saskatchewan to study Soil Lime Modification.

- **Site Investigation Manual and Field Drilling Program Development** This joint effort with the University of Saskatchewan is a continuation of research into the development of the field drilling program as well as a compilation of data to better understand site investigation and slope stability. The updated manual will facilitate investigations into these research areas.

Carry-over Projects

- **C.S. 2-09 Test Section** This project investigates the relative performance of various thickness of asphalt concrete and sealed granular base pavements.

- **Capacitance Mat Development Study** This project focuses on the development of a thin, rubber encased film, 2'' x 12', which can be placed on the road to determine vehicle configurations and weights. This new Weigh-in-Motion system could be very beneficial for its low cost and portability.

- **Tensiometer Study** In this project, the cables on all existing cable barriers are being tested to ensure that their tensions are within set tolerance limits. The project will also assess the current tension requirements to determine if any changes/improvements can be made.

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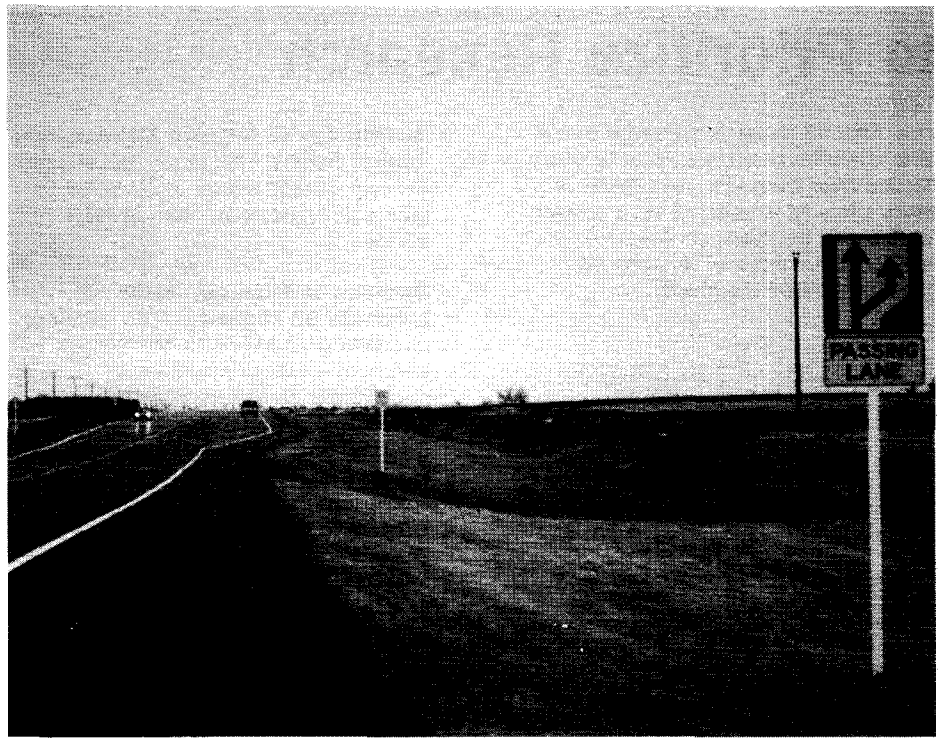

Passing Lane, Highway Number 1 East.

- **Test and Evaluate Low Cost Traffic Counters** This committee is testing and evaluating portable traffic counters for use in the grading of the traffic information collection program.

- **Assessing Operating Characteristics of Passing Lanes** The effectiveness of existing passing lanes on No. 1 Highway is being studied to determine whether more passing lanes are needed and/or any design changes are required.

- **Soil Suction Experiment in Test Track** In this joint effort with the U of S, means of correlating data gathered from soil suction gauges to the strength of the subgrade are being investigated. This is being done to facilitate soil monitoring and eliminate soil sampling and testing when establishing moisture content in subgrades.

- **Estevan Technology Package** A low speed Weigh-in-Motion unit is being incorporated into the normal operations of static weigh stations. This innovative project will be featured in a future edition of the Newsletter.

- **Polymerized Asphalt Test Section** This test section was developed for comparing the performance of polymerized asphalt to the performance of conventional asphalt in reducing pavement distress caused by temperature extremes. It is believed that using this modified asphalt will result in lower long term maintenance costs and increased pavement life.

- **Rutting Study** This study determines whether a correlation exists between traffic data, asphalt properties, and asphalt performance. As well, it works to develop a model which will be able to predict rutting potential during the design stage of road construction.

- **British Falling Cone Pentrometer Evaluation** The falling cone pentrometer will be tested for its reliability and reproductibility in the measurement of soil consistency. Its performance will be correlated to Atterberg Limits and compared to presently used technology in order to determine the most cost efficient method of classifying soils.