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VERGLIMIT EVALUATION (BOULDER)

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Final Report
February, 1989

Prepared in cooperation with the
U.S. Department of Transportation
Federal Highway Administration

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16. Abstract

Verglimit is a proprietary product that incorporates a special ice-melting chemical (largely calcium chloride) into the asphalt paving mix. This report reviews the performance of an experimental application of a 167 foot test section of Verglimit pavement placed on a city street in Boulder, Colorado in August of 1985. The site was evaluated for three years following construction and was photographed with time-lapse cameras for two winters.

The subject pavement has proven to be durable but the ice-retardant effects were rarely apparent. This may have been due to periodic sanding and salting of the project location by city maintenance forces. The report recommends the use of Verglimit in high-hazard locations that tend to experience early icing. A previous Colorado test site, which failed due to ravelling, indicates that the material is construction sensitive and care should be taken during its design and placement to achieve proper compaction. Surface slickness during the first few days following construction must also be addressed during construction.

Implementation: Copies of this report have been distributed to all CDOH maintenance districts and to other interested public agencies who may be interested in using the material. The Research Branch will informally investigate the performance of other Verglimit overlays in the region and update its recommendations as needed.

17. Key Words	18. Distribution Statement
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A Final Report

I. BACKGROUND

A. What Is It?

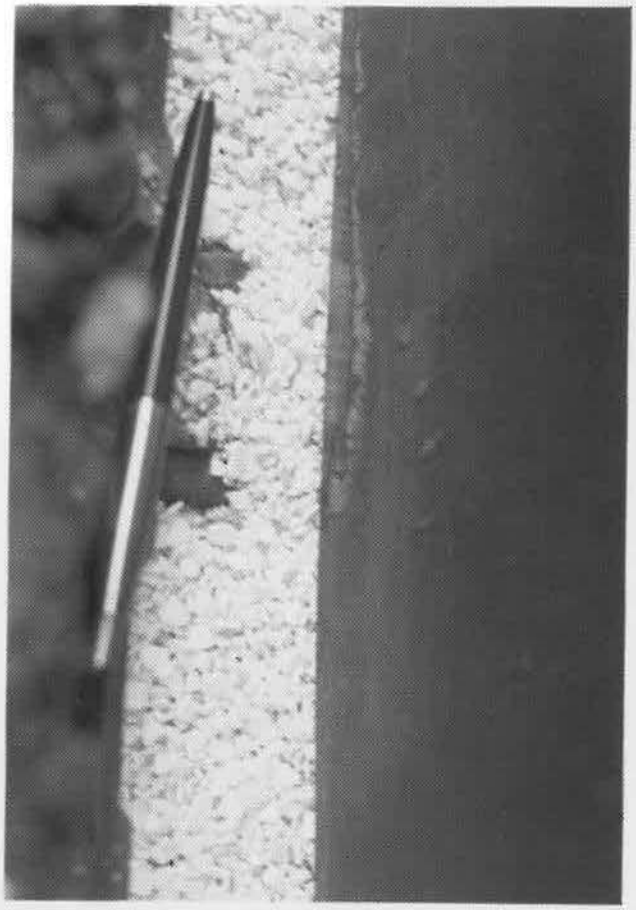
Verglimit is a proprietary asphalt additive that is intended to retard the formation of snow and ice on asphalt pavements.

The material consists of lightweight flakes of an ice-melting agent (see Photo A) that is added directly to the asphalt mix during the normal production cycle. Although its actual composition is a trade secret, it is thought to consist largely of calcium chloride and sodium hydroxide (caustic soda) encapsulated with linseed oil to prevent the over-absorption of water. It was developed and first marketed in Europe. The material is manufactured by Chemische Fabrik Kalk, GmbH in West Germany and distributed by Verglimit SA of Geneva, Switzerland. Although still made in Europe, the material is now being widely used in the United States and Canada and has a performance record on this continent in excess of ten years.[1] The name Verglimit comes from the French expression "limité le verglas" — to end road ice.

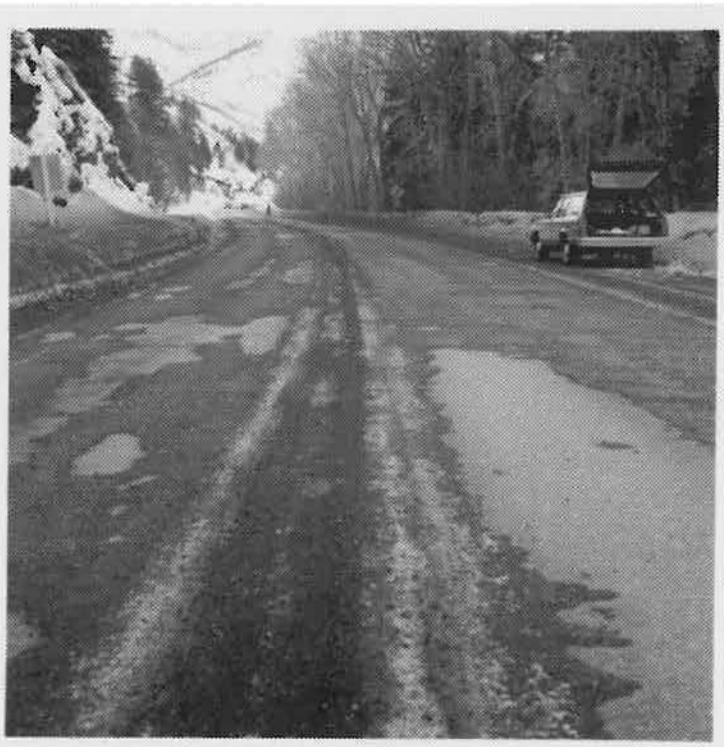
The manufacturer recommends using Verglimit as an asphalt additive in a pavement overlays with a minimum thickness of 2.0 inches.

Product literature has listed a variety of claims for the material. These include:

- the elimination of ice-traps caused by preferential early icing;
- the elimination of ice sticking to the road surface and the formation of "black ice";
- a reduced need for conventional road salting;
- the elimination of the need for preventative salting;
- better protection of steel supporting structures;
- a minimal or non-existent environmental impact due to storm runoff;
- continuous wintertime effectiveness; and
- a reduced risk of negligence suits for public agencies.



(A) Verglimit flakes



(B) Severe ravelling observed from the center of the section looking northwest on SH-82 (February, 1984)

B. Research by Others

Verglimit test sections have been in place in Europe since 1974 and nearly that long in Canada and the United States. File searches show that at least 15 states and a number provinces have performed field trials of Verglimit in asphalt pavements.

Although reports have been generally favorable, research by others into the properties of Verglimit have raised concerns that pavements with Verglimit may:

- be difficult to design, test, and place with proper compaction;
- have a short service life;
- be susceptible to ravelling and stripping;
- lose effectiveness as the pavement ages;
- damage supporting steel structures;
- absorb ambient moisture resulting in unacceptably low skid numbers; and
- be too expensive to justify its use in most locations.

In addition to field trials, the laboratory properties of Verglimit have been extensively tested by the FHWA's Office of Engineering and Highway Operations R&D. These tests were designed to measure the properties of pavements with Verglimit in terms of their resistance to rutting, moisture damage, and low-temperature cracking, and to evaluate tests available for measuring mix properties.[2] These studies have found that the addition of Verglimit increases the moisture susceptibility of a mix while providing a slight reduction its temperature susceptibility.

C. Previous Colorado Research

In 1981, the Colorado Department of Highways (CDOH) placed a 100 ton section of Verglimit-treated pavement on a hazardous section of State Highway 82 near Snowmass, Colorado (elevation 6900 ft) in Pitkin County. The site was in a shady location near the Roaring Fork River, and was prone to becoming snow-packed. The material was placed fairly late in the season, and had an average lift thickness of 1½ inches. It was placed with conventional paving equipment by state maintenance forces using a mix batched in a commercial plant in Grand Junction, Colorado 115 miles away. The pavement was the subject of a Research Branch study at that time. Although the pavement performed well in controlling snow and ice, it failed within six months due to extensive ravelling

as shown in Photo B.

The principal investigator's report[3] stated that there were slick areas on the adjacent pavement from Verglimit and moisture being tracked by traffic; these areas required sanding by state maintenance forces. Ravelling began very soon after construction and, despite maintenance patching of the sections where pop-outs had occurred, the new pavement wore down to the old mat in many areas. Time-lapse cameras showed that the Verglimit did a good job in preventing the buildup of snow and ice; and local maintenance personnel reported that the snow that did build up was easily removed from the roadway.

The investigator speculated that the early failure of this overlay may have been due to one or more of the following construction problems:

1. over mixing of the Verglimit during batching;
2. too low an AC content in the design mix;
3. placement with too high a void content; or
4. the material may have reacted with the aggregate in pavement.

Further placement of this material was not recommended without strict adherence to the manufacturer's recommendations for mixing and that effective measures be used to control slickness.

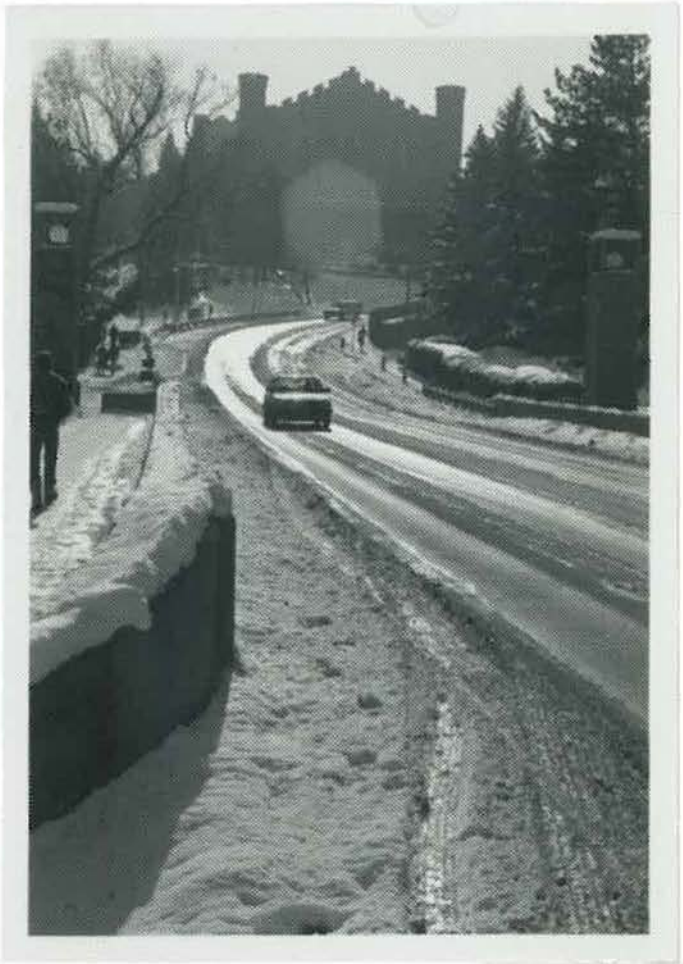
II. COLORADO'S TEST SECTION

A. Boulder

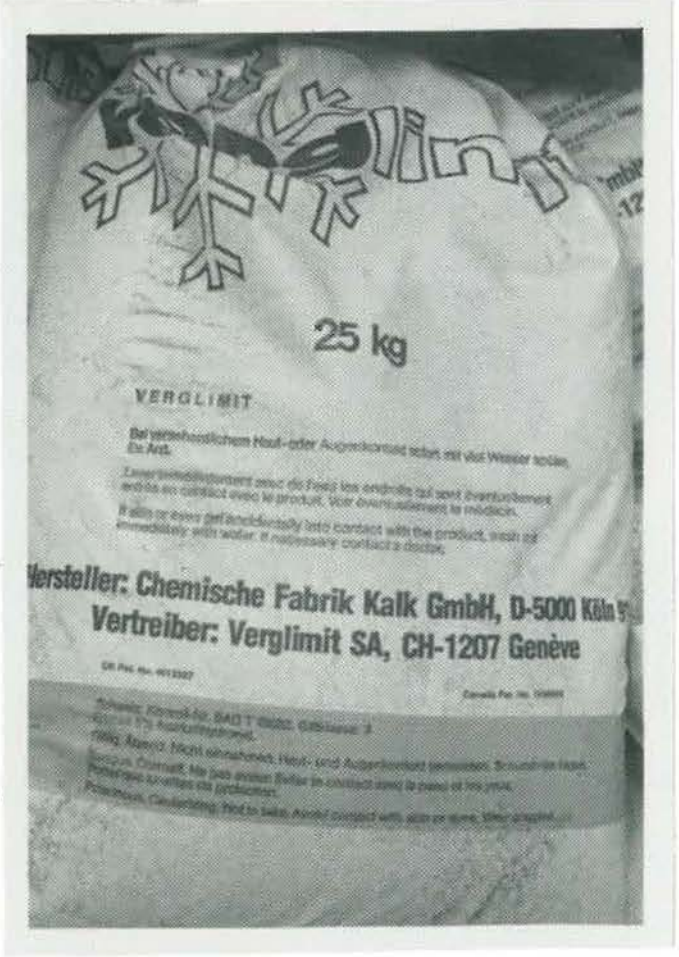
1. Site Description

In 1985 the CDOH placed a second experimental pavement. Verglimit was added to 72 tons of mix in the pavement reconstruction associated with a bridge replacement project on a city street in Boulder, Colorado (elevation 5400 ft). The bridge approach was a hazardous area due to the steep grade and blind corner approaching the site. See Photo C and Figures 1 and 2. The federal aid municipal project, BRM 007(2), was contracted and administered by the Colorado Department of Highways.

The Verglimit site was built on the south approach to the new structure. The pavement at each end of the new bridge had to be replaced due to changes in the vertical alignment of the roadway when the structure was raised. The south approach is a steep (-11% grade) city street which has a 15 mph warning sign posted in



(C) 17th Street Bridge in Boulder



(D) Verglimit sacks

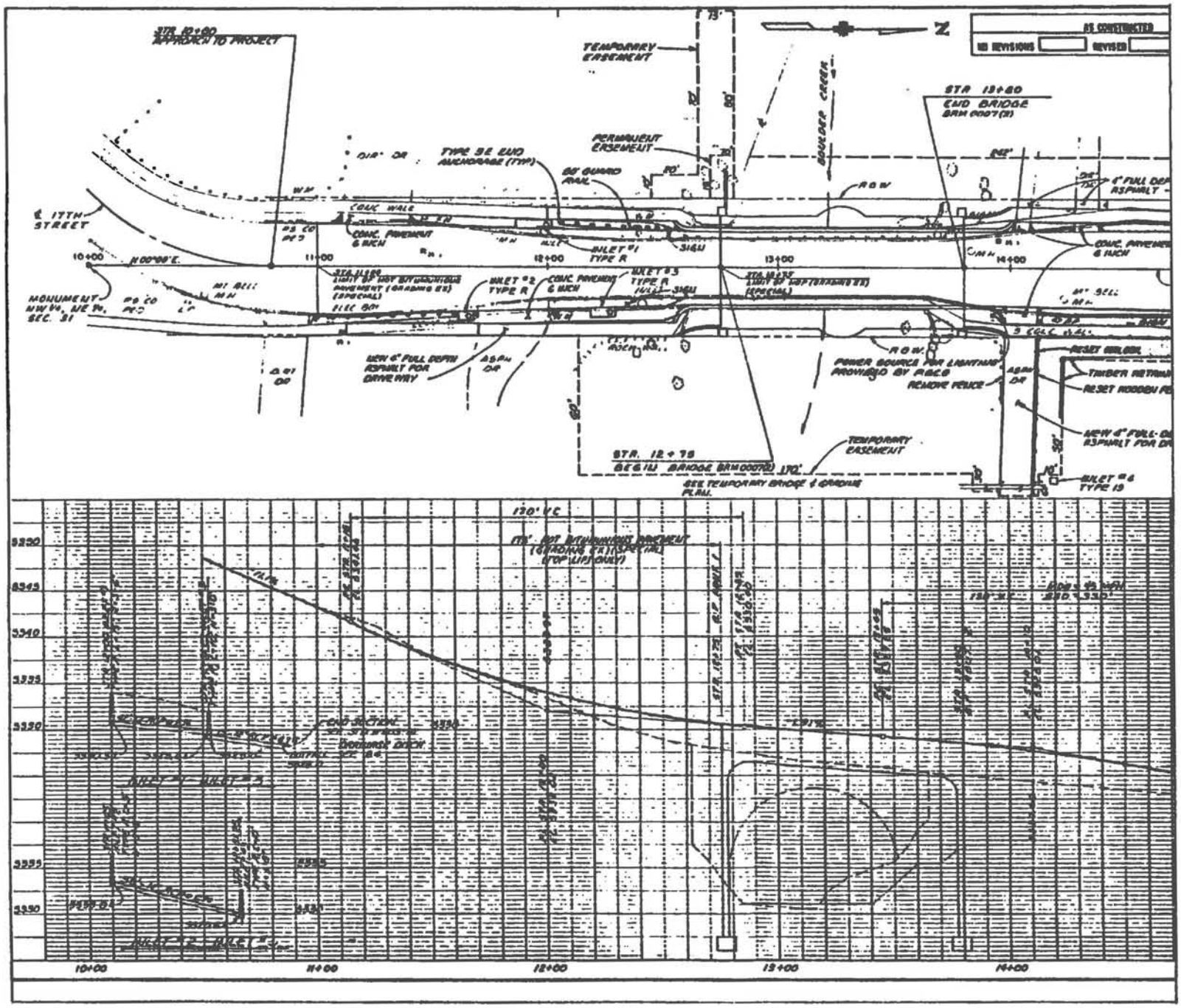

STA 10+00
APPROACH TO PROJECT
TEMPORARY EASEMENT
PERMANENT EASEMENT
BOULDER CREEK
STA 13+60
END BRIDGE
BRK ROOT (T)
TYPE 9E END ANCHORAGE (TYP)
36" GUARD RAIL
R O W
℄ 17TH STREET
CONC WALK
CONC. PAVEMENT & INCH
INLET #1 TYPE R
INLET #2 TYPE R
INLET #3 TYPE R
10+00
11+00
12+00
13+00
14+00
MONUMENT NW Cor. NE Pt. SEC. 21
NEW 6" FULL DEPTH ASPHALT FOR DRIVEWAY
ASPH DR
POWER SOURCE FOR LIGHTING PROVIDED BY R&GS
REMOVE FENCE
TEMPORARY EASEMENT
STA. 12+78
BEGIN BRIDGE BRK ROOT(B) 170'
SEE TEMPORARY BRIDGE & GRADING PLAN.
INLET #4 TYPE 13
TIMBER RETAINING
RESET RIBBON FENCE
130' V.C.
8350
8345
8340
8335
8330
8325
8320
10+00
11+00
12+00
13+00
14+00

Figure #1

VERGLIMIT TEST SITE BRM 007(2) IN BOULDER

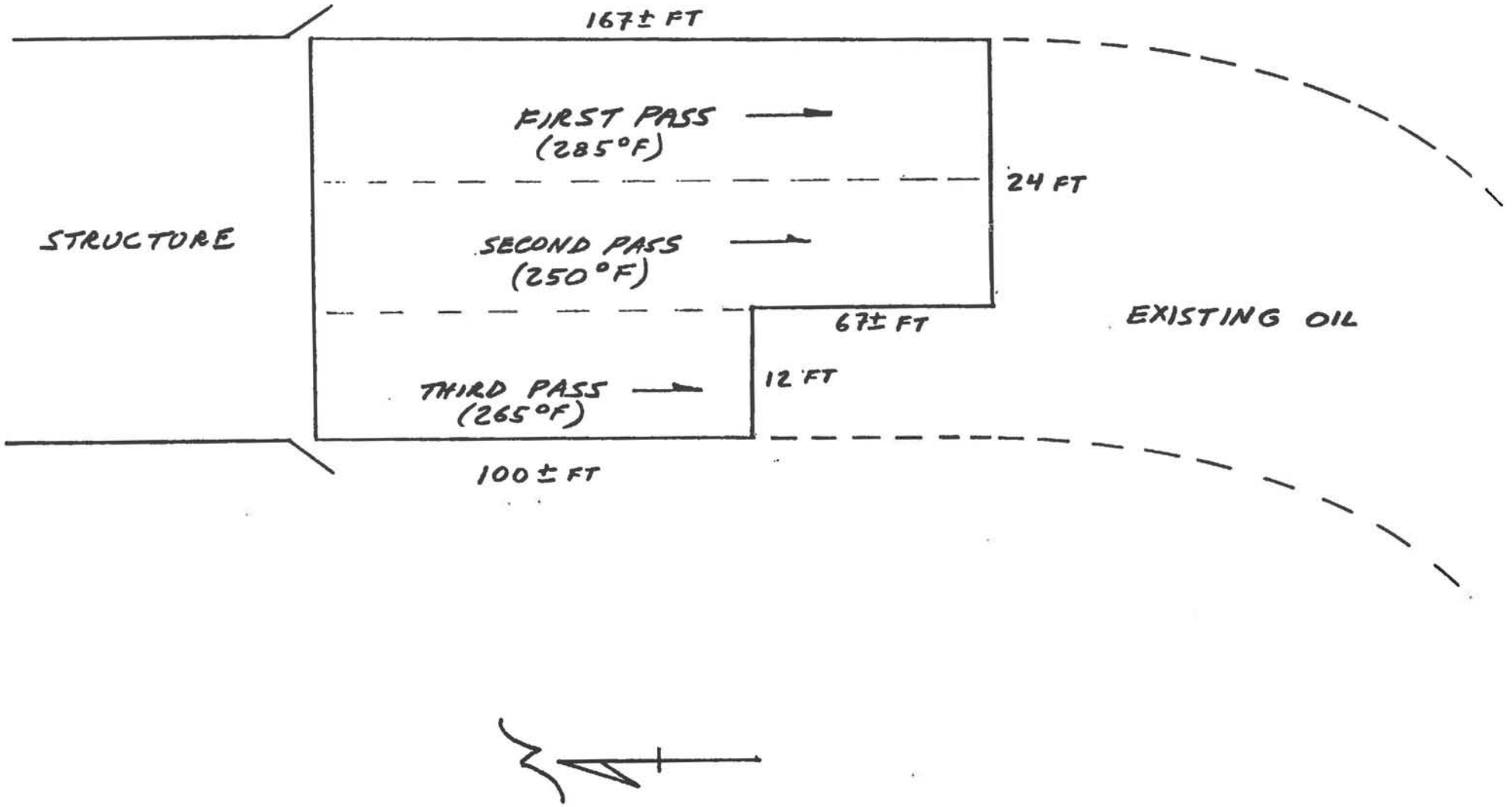


Figure #2

advance of the approaching curve. Only the southern bridge approach had Verglimit placed in the pavement — the opposite bridge approach was paved with a conventional mix (HBP Gr E) and this section was used as a control.

Unfortunately, for the purposes of this study, the loss of control experienced by the northbound (downhill) vehicles on the Verglimit site appeared to be occurring on the approaching curve and not on the surface that was to contain the additive. This prevented analyzing before and after traffic accident data as an indicator of the effectiveness of the material. During visits to the site many vehicles (and bicycles) were seen exceeding the recommended limit by a large margin. During the day traffic volumes were seen to fluctuate widely due to the closeness of the site to the University of Colorado campus (less than a block to the south) and a local junior high school campus (a block to the north). Jaywalkers and physical education classes jogging by add to the distractions a motorist could encounter at this location.

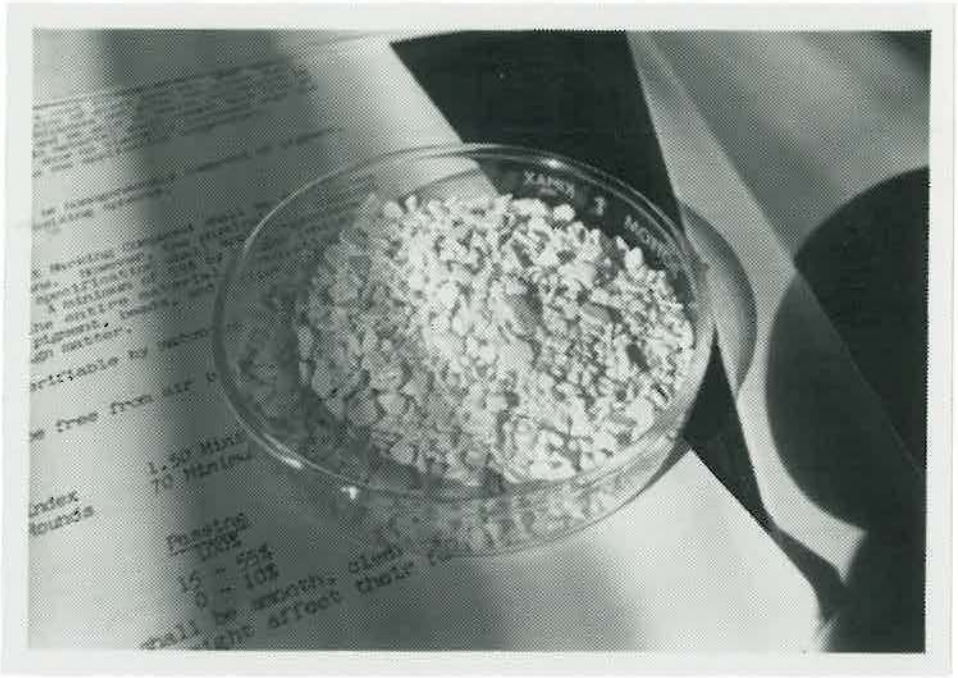
2. Construction

The test site was built on August 29th, 1985. The typical Verglimit section consisted of 5.0 inches of HBP Grading E over which 2.0 inches of Verglimit-treated HBP Grading E was placed. The design mix called for 6.2% AC-10 with Verglimit incorporated at the rate of 6.0% by weight of mixture. A liquid anti-stripping additive, Techni-Hib 7176, was also used on all of the pavement placed on this project. The complete mix design may be found in Appendix A.

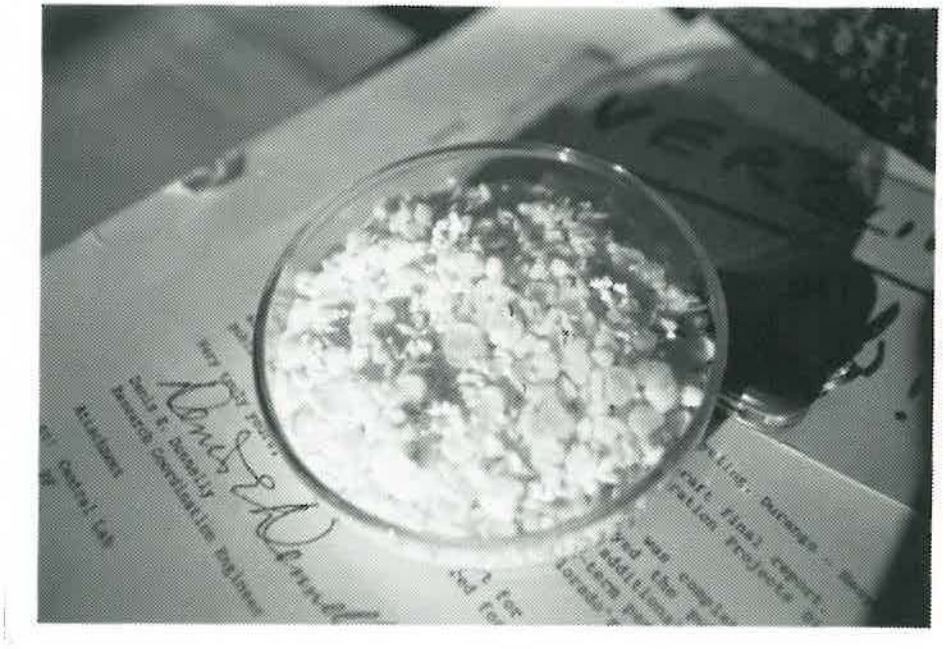
The asphalt mix was produced by Flatiron Paving at the local Valmont plant in Boulder. It was a coal-fired batch-type plant. The Verglimit came in 67 pound waterproof bags that were marked poisonous in three languages (see Photo D). A note in German identifies it as a Class 3 poison containing 5% sodium hydroxide (Naturiumhydroxide). In English the warning reads "Poisonous. Cauterizing. Do not take. Avoid contact with skin or eyes. Wear goggles.".

One of the bags that had been left open absorbed moisture from the air or possibly from a light rain. These flakes had begun to swell and look wet and partially dissolved as shown in the petri dish sample in Photos E and F. When handled (something that is not recommended), the flakes left the hands feeling slippery and caused a burning sensation after several minutes. The material was difficult to wash off and felt like fresh chicken fat on the skin.

Using protective clothing, goggles, gloves, and a respirator, workers emptied the bags through a half-inch screen onto the batch plant conveyor (Photos G and H). The screening was recommended by

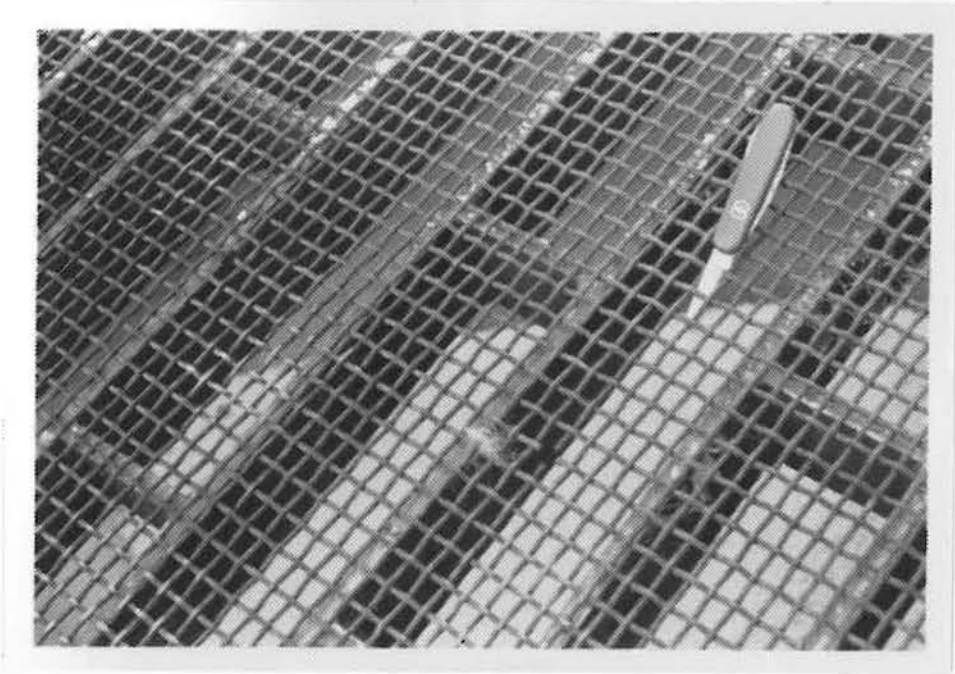


(E) Fresh sample of Verglimit flakes



(F) The same sample after exposure to air

(G) Loading Verglimit into the hopper. Note the use of protective clothing, goggles, and gloves.



(H) Screen over the loaded hopper

the vendor, who was present during the batching operation, but this was probably only a precaution since no material was retained on the screen. Although the material looked clean, it did release some dust when the bags were emptied.

The flakes were added to the pug mill as the last part of the batching process. The operator was allowed to mix the Verglimit just long enough to coat the flakes. This was for 17 seconds in this operation — somewhat longer than the 10 seconds recommended in the product literature. At the end of the mixing period white flakes could no longer be seen in the mix. We were told that further mixing would tend to crush the flakes and that this would be detrimental to the performance of the pavement. The mix temperature at the plant was 330°F.

Generally, the paving operation went well with few difficulties. The ambient temperature at the site was 90°F. The preceding mat was placed in the same operation; nevertheless, the mat was tacked with an emulsified asphalt. As shown in the sketch in Figure 1, three passes were needed to complete the 36 foot width of the test section. The first pass had a laydown temperature of 285°F which was as recommended. The next two passes were placed at lower temperatures — 250°F and 265°F, respectively.

Breakdown rolling was with a rubber-tired roller followed by a steel-wheeled roller. Initially, the mix stuck to the wheels of the rubber-tired roller. The sticking stopped after the tires warmed up and they were moistened with water. The steel-wheeled roller caused some shoving of the first pass (see Photo I). This could have been due to the roller being too heavy, the grade being too steep, or because the roller was placed on the mat too soon. The contractor waited longer before using the steel-wheeled roller on the next two passes and there were no further problems.

The project plans called for placing 68 tons of mix. Seventy-two tons had been placed when the contractor ran out of the special mix. The third pass was just over half completed when this happened and the remainder of the pass was completed with a standard paving mix. Subsequent cores showed that the top mat was somewhat thicker than the 2.0 inches specified on the plans. Typical evaluation cores were 9.0 inches deep with the top 2.75 inches having Verglimit.

The surface appeared "open" in some small areas in the first pass (see Photo J), and these spots were resealed the following day with tack coat, an emulsified asphalt SS-1H diluted 50:50 with water. A special effort was made to achieve density around utility covers. Since there was no calibration available for the nuclear density gauge, density rings were placed in the mat during paving to check for proper compaction. These were pulled and tested the following day. They showed that the specified

(I) An area of shoved pavement on the east side of the roadway

(J) Open surface area that was subsequently sealed

compaction (95% of the standard) had been achieved.

Broken Verglimit flakes could be seen in the surface after rolling. Because of concerns about the pavement becoming slippery, a light coating of sand was rolled into the surface at the end of the day's paving and the road was not opened to traffic for the next six days. The sand coating was swept up the morning after paving at which time the open spots on the surface were sealed. A "SLIPPERY WHEN WET" sign was erected and left up for several weeks following construction on the northbound approach.

The paving operation lasted until 7:30 pm. Overall, quality control was tight enough to ensure a specification product placed in accordance with the manufacturers specifications.

Other than having a somewhat brownish appearance, nothing unusual was noticed about the pavement until the sixth day following paving when, after light rain during the night, the surface began to "sweat". The surface then felt a little oily and very small pits could be seen in the surface where the Verglimit flakes had been embedded and now (presumably) had been washed away (see Photo K). At that time, city crews were attempting to stripe the roadway in preparation for its opening the following morning. The self-adhesive plastic marking tape being used would not bond to the part of the roadway that had the Verglimit-treated mat (see Photo L). The tape had to be pulled up and that section of the roadway was painted with conventional striping paint some months later.

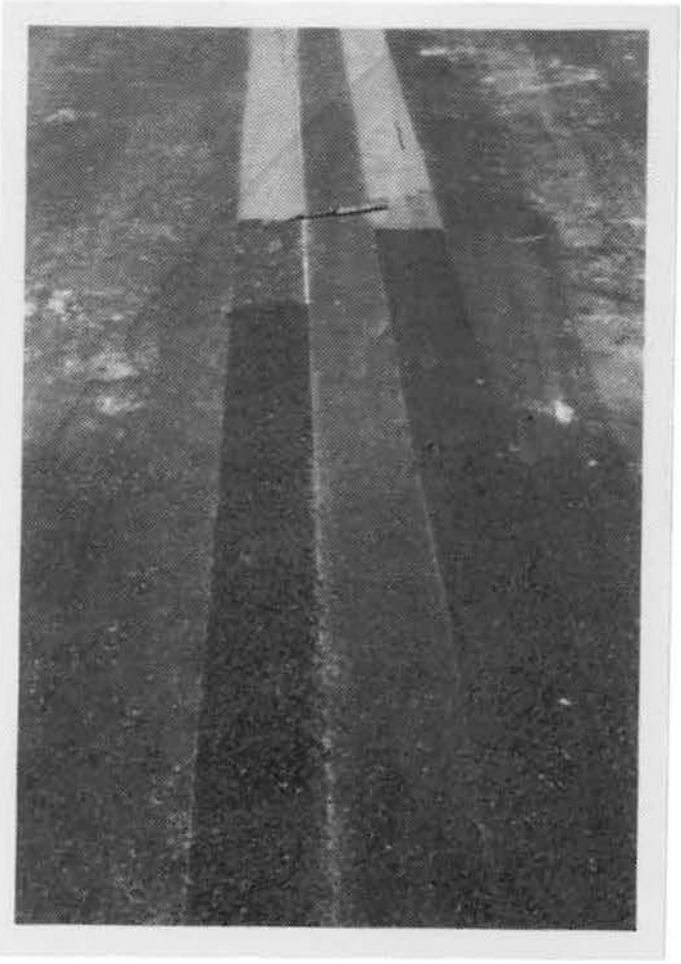
3. Follow-Up Testing

Thirteen days following paving, a skid trailer was scheduled for testing the site. Since the initial readings were normal for a new pavement, no subsequent skid tests were scheduled.

Despite the City of Boulder's intentions to continue to salt and sand this street as part of its snow and ice control program, it was hoped that there would be a noticeable difference in the formation of snow and ice on the test site. Accordingly, a simple system of time-lapse motion picture cameras were set up at two locations — one at each end of the project.

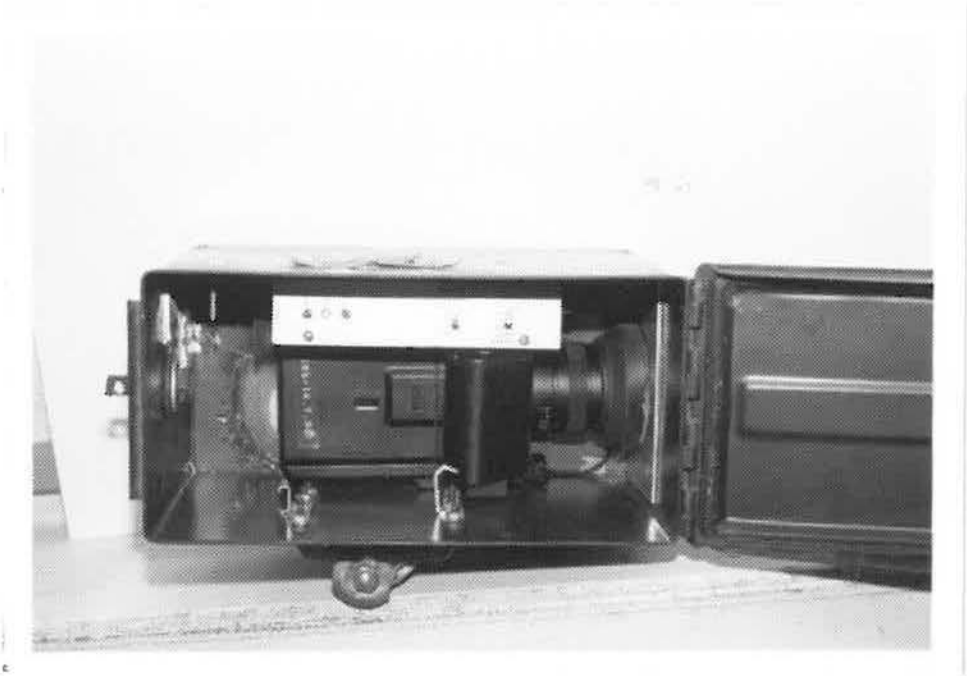
A standard Super 8 film format with a conventional home-movie camera was used with the camera's single-frame exposure setting. A NE555/6-based timing circuit was wired to trigger a single exposure approximately every ten minutes 24 hours a day. The entire unit was powered by alkaline D cells and was compact enough to fit into a small weather-tight "ammo" box with a clear window placed at the end that could be mounted on utility poles at the site (see Photos M and N).

(K) Detail of pavement surface after the first rain



(L) Section where the pavement marking tape did not adhere

(M) Time-lapse camera mounting on light pole



(N) Camera, timer, and battery pack mounted in an ammo can

In theory, the cameras could have operated for two weeks without intervention, but they were normally serviced weekly. A similar arrangement (except using an AC power supply) had been used to record the performance of the Verglimit pavement placed in Snowmass in 1981. Originally, the plan was to operate the cameras for three winters, but the system proved to be troublesome and expensive to operate, and its use was discontinued after the second winter. The problems appeared to be due to low output from the battery-based power supply during very cold weather; both cameras would function normally when brought inside for service.

In addition to time-lapse photography, the test pavement and the nearby control section were cored annually to examine the changes in the material properties of the mix.

There was some concern on by the department's materials testing lab about the possibility of some of the normal tests damaging or clogging equipment. However, this did not turn out to be a problem.

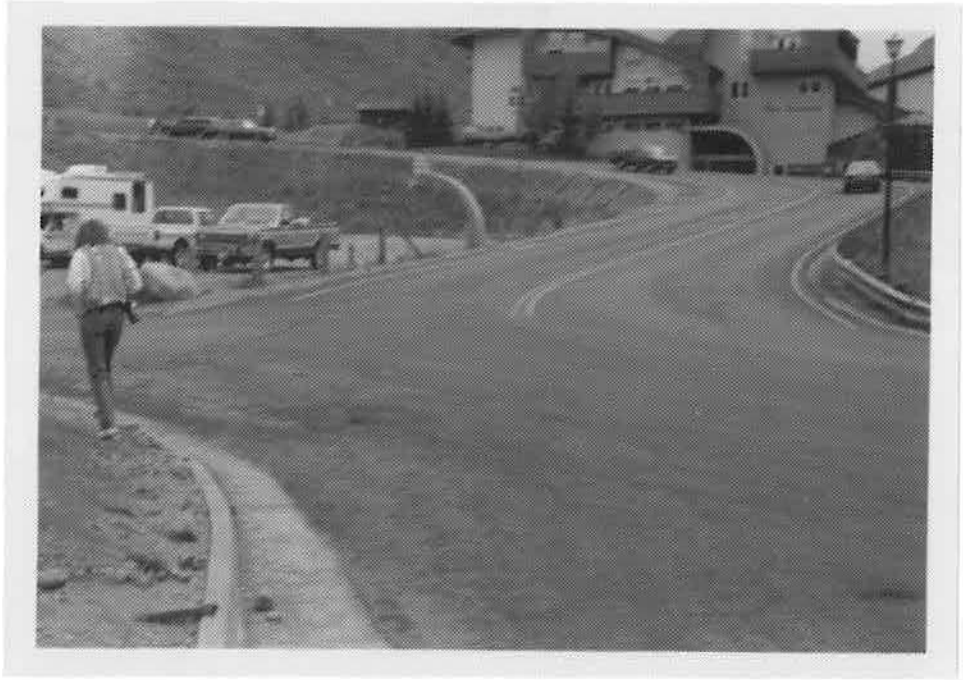
A cored sample was also inverted into a beaker of water to see how much calcium chloride might enter the surface runoff in a test described in Appendix C.

B. Vail

In 1986, the year following the construction of the test section described above, product vendor and the Town of Vail announced that they had placed 520 tons of Verglimit-treated pavement at three location within Vail at an elevation of 8200 feet.

There was no opportunity for state research personnel to visit the site before or during construction. The city engineer, Bill Andrews, provided this information at the time:

> The three sites were identified as the Blue Cow Chute, the Village Center Road, and the East Lion's Head Drive. See Photos O, P, and Q.
>
> Each of the sites was on a steep approach grade to the interstate frontage road that runs through the town. All of the pavements were placed between July 8th and July 10th and consisted of a 1½ inch overlay over an existing pavement. An exception was one of the sites (the Blue Cow Chute) in which most of the existing pavement was replaced by a standard mix before being overlaid. All of the sites had a total thickness of at least 5.0 inches of asphalt (old, new, and Verglimit).
>
> The mix placed contained 5½% of Verglimit by weight.



(O) Blue Cow Shute

(P) Village Center Road looking downhill

(Q) East Lion's Head Drive

(R) Village Center Road looking uphill -- car park on the right

The work was contracted to B&B Excavating. They batched from a nearby plant in Edwards, Colorado. The placement temperature was estimated to be 280°F on the average with a truck at the lower end of the Blue Cow Chute being placed at 250°F. This load was reported to be noticeably more difficult to compact. A single truck was also reported as having been rejected because it was too cold to be placed.

Breakdown rolling was with a rubber-tired roller. This was followed with a steel-wheeled roller. Despite steep grades (up to about 10%), no shoving of the mat was noticed. Shortly after laydown the mats were flushed with water.

The pavement was reported to be slick during the week following paving. There were frequent rains during this period. Although there were no motor vehicle accidents, there were three bicycle accidents reported with minor injuries in two cases.

This investigator was able to visit the site five weeks after construction and yearly thereafter. It had rained earlier during the day of our first inspection and the pavement appeared "blotchy" where traffic had not run over it in the medians and shoulders. In areas where traffic was heavy, the pavement appeared slightly more flushed but there was no bleeding. Overall, the pavement appeared to be in very good condition with no obvious signs of stripping, ravelling, or rutting.

Although not included as a formal part of this Verglimit evaluation, these pavements were of interest for two reasons. The city uses dry cinders to sand their streets with no added salt; and one of the sites (Village Center Road) feeds a parking lot in such a manner that vehicles entering the roadway tend to spin their wheels as they climb the grade to the nearby frontage road (see Photo R).

C. Other Colorado Sites

There have been several other placements of Verglimit-treated pavement in Colorado as of this date. In 1987 Vail decided to pave some additional sites with Verglimit. The three added sites were all short sections on steep grades similar to the work done in 1986. Due to the late construction and distance to Vail from Denver, these sites were not included in the study.

The City and County of Denver (elevation 5300 ft) also repaved five intersections with Verglimit in 1987. Again, the CDOH Research Branch did not have the opportunity to visit the sites before or during construction or to review the pavement design.

The vendor reported unsatisfactory quality control during construction with a low percent of Verglimit additive and temperatures too cool for proper compaction. These sites were not included for this reason, but they were visited during a snowstorm the winter following placement. There was no visible difference in the accumulation of snow and ice at that time.

Several other Colorado governmental organizations have expressed an interest in the material or said that they intend to place a section of treated pavement. Future investigators may wish to enquire after these. They include:

The City of Glendale;

The Town of Breckenridge;

The City of Thornton;

The City of Colorado Springs;

The U.S. Air Force Academy;

The Department of Defense's NORAD facility at Cheyenne Mountain; and

CDOH District Five Maintenance (Durango)

With the exception of Glendale, which is surrounded by Denver, none of these organizations is considering placing the material over a bridge deck; the interest appears to be in curves and steep grades.

III. FINDINGS

A. Boulder

1. Appearance

After three years the pavement still looked good. There has been little or no cracking in either the test or control pavements on the Boulder site. The city did some patching on the Veglimit test section while doing utility work. They also managed to stripe the Verglimit section with standard pavement marking paint. One could pick up large flakes of the paint with the point of a pocket knife indicating that there were still some adhesion problems. Nevertheless, the painted shoulder and center stripes were not showing unusual wear from traffic.

The pavement still has a blotchy look to it for several days after a rain. This lasts longer on the shoulders where there is

less traffic (see Photo S). There is no sign of rutting. The pavement does deviate from a flat surface under a straightedge, but these depressions are small (less than 0.25 inches), irregular, and do not coincide with the wheelpaths. They are probably roller marks on the tender pavement from the original paving operation.

When visited during dry times in the winter, the test section appeared to have more salt stain than other city pavements, but this could have been due to the extra salting and sanding that the location was receiving.

There is also no noticeable indications of ravelling or surface deterioration. This is also true in the few areas that shoved during paving or were sealed the following day because they appeared open. Visually, the pavement looks as if it will have a normal service life.

Scrapes and dents on the project guardrail and damage to adjacent shrubbery are indications of continuing loss-of-control problems on the northbound approach to the site. A typical report accident from the city if reproduced in Appendix B. Accident reports showed a loss of control before the vehicle reached the Verglimit test pavement.

2. Skid Numbers

Due to the short section and the continuous closure of the roadway, skid data could not be established for the first week following construction when this type of pavement is suspected of being more slippery. As stated earlier, the skid numbers for the test site at 13 days were in the normal range for a new pavement and were comparable to the readings for the older asphalt and new pavement on the other side of the newly constructed bridge.[4]

(S) Detail near shoulder of East Lion's Head Lane

(T) Time-lapse frame showing salting by city maintenance

TABLE ONE

SKID NUMBERS WITH A K.J. LAW LOCKED-WHEEL TRAILER, 11 SEPT 1985

Location	Speed (MPH)	Skid Number
Southbound Bridge	39.3	54.1
Northbound Bridge	40.1	52.3
Southbound Approach Curve	29.2	58.2
Northbound Approach Curve (first run)	38.3	45.4
Northbound Approach Curve (second run)	30.1	51.1
Southbound Veglimit	42.5	49.6
Northbound Verglimit	38.3	45.4

Skid numbers are plus or minus 2.0 due to low test speeds.[5] All skid numbers were taken on a continuously wetted surface.

3. Time-Lapse Photos

Initially, the data generated by time-lapse photography was somewhat of a disappointment. This was not only due to frequent system failures but due to the mild weather experienced during the winter of '85 – '86. During this first winter very cold weather only occurred between mid-November and mid-December and the cameras did not operate well during this period. After this time there were no continuously cold periods through the rest of the winter. There was little snow after mid-December until a large spring storm in late March which melted quickly in the warm weather.

Weather patterns were more normal during the winter of '86 – '87 and a beefed-up camera power supply and more frequent system checks gave more consistent photo sequences.

The first two winter's time-lapse shots were analyzed during the spring of 1987. The movie film could not be interpreted directly when shown on a projector — the speed was too fast. This was also true when played back at the slowest projector speed setting at reduced illumination. The problem was solved by

showing the film at a slow projector speed and recording this with a conventional VCR video camcorder. When the VHS camcorder tape was played back using a slow motion freeze-frame feature each frame could be analyzed and photographed again with a 35 mm still camera. The image in this last playback was the most useful but the picture quality was mediocre at best.

All of the usable cine film was condensed into a 30 minute video tape. The tape shows that the city frequently sanded and salted the site during snow and ice conditions (see Photo T). Exposures that showed the Verglimit was actually working to melt snow or ice before the adjacent untreated sections were rare. Of 55 potential occurrences where preferential test section melting could have been shown, only four showed definite signs of preferential melting. Most of these only lasted for two or three exposures (less than 30 minutes). Two photographs of "working" pavement are shown in Photos U and V.

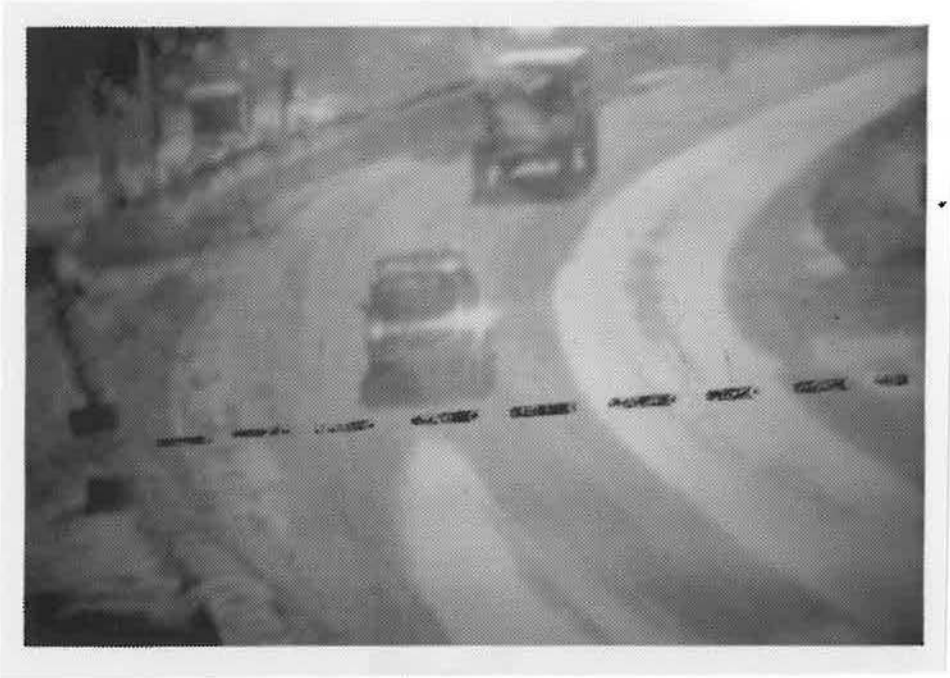
There were no signs of snow or ice being easier to plow or completely remove from the Verglimit treated section.

4. Lab Tests

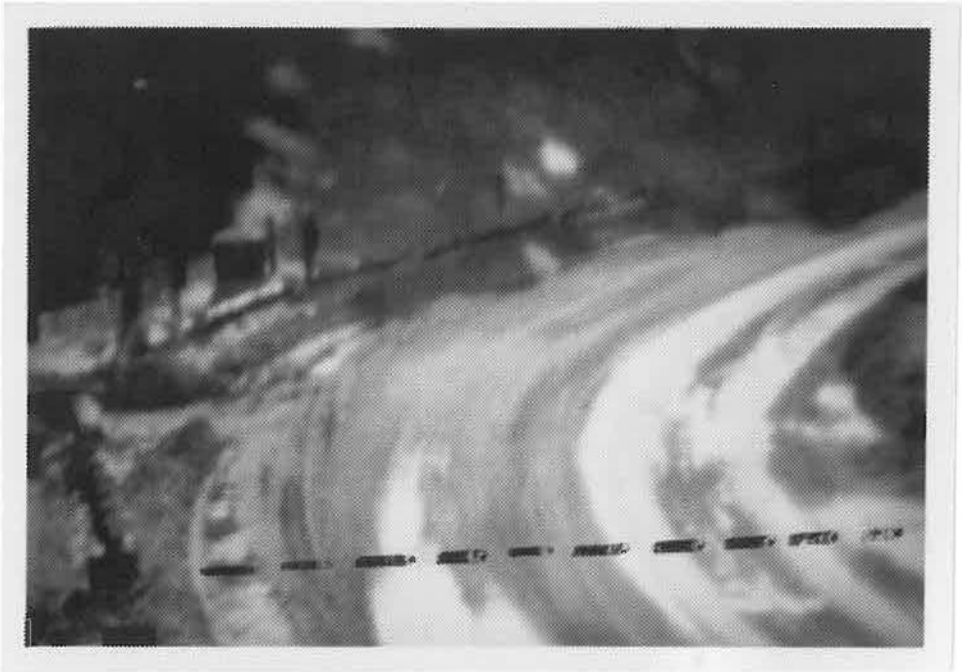
Even three years after construction, Verglimit cores would remain damp for weeks after extraction. Small pits could be seen on the sides of the core from where the drill water had dissolved the embedded flakes (see Photo W). There was no noticeable tendency for the top lift to debond from the remainder of the core.

Tested material from the density rings showed an in place compaction of 95.3% of the standard which meets the requirements of the project specifications for density.

The Colorado Department of Highways used a modified form of the Lottman test as a predictor of stripping potential. The test, CPL 5109, involves saturating and freezing a four-inch core sample and comparing its strength with an untreated control. The results are the percent of tensile strength retained (TSR) by the treated sample; a design TSR of 70% is normally required for the type of mix used here. The CDOH did not use the modified Lottman for design until 1986. The project design mix was run using an earlier Immersion-Compression test (see Appendix A) which had an index of retained strength of 68. The results of modified Lottmans on extracted cores are summarized here:



(U) Time-lapse frame showing early melting
Approximate boundary is marked



(V) Time-lapse frame showing early melting
Approximate boundary is marked

(W) core with pits from disolved Verglimit

(X) Testing with silver nitrate

TABLE TWO
Anti-Strip Tests

Test Date	Number	Dry Strength	Condition Str	TSR	Remarks
3/3/86	B-11	20.95	1.25	6.0%	Verglimit
3/3/86	B-10	33.15	14.66	44.2%	control
9/15/87	B-567	99.	94.	95.0%	Verglimit remolded
9/15/87	B-568	97.	90.	93.0%	control remolded
7/22/88	B-334	40.	20.	51.0%	Verglimit
7/22/88	B-333	51.	27.	53.0%	control

These test results indicate that the pavement stability increases with age and that remolded specimens are more stable than existing pavement. These results are not consistent with field observations and seem unreasonable. A pavement with a working TSR of 6% should have shown immediate signs of stripping or ravelling. A more likely explanation is that the modified Lottman test is not an appropriate indicator of stripping potential for Verglimit-treated pavements or that cores are sensitive to post-extraction storage and handling conditions which were not controlled in these samples.

Other lab tests are summarized in these tables:

TABLE THREE
Asphalt Content (% AC)

Date	Verglimit	Control	
6/85	6.2	5.6	design optimum
9/85	6.49	--	production sample
3/86	6.66	5.21	from core
9/87	6.53	5.99	from core

TABLE FOUR
Specific Gravity of Specimen

Date	Verglimit	Control	
6/85	2.32	2.37	design
9/85	2.34	--	production sample
3/86	1.90	2.22	from core
9/87	2.140	2.207	from core
7/88	2.222	2.231	from core

TABLE FIVE
Voids in Specimen (%)

Date	Verglimit	Control	
6/85	3.32	3.28	design
9/85	2.12	--	production sample
9/85	2.39	--	production sample
3/86	20.43	9.56	from cores
9/87	11.1	9.0	from cores

TABLE SIX
Stability Values (Hveem)

Date	Verglimit	Control	
6/85	38	35	design
9/85	43	--	production sample
3/86	12	27	from cores
9/87	--	--	
7/88	31	27	from cores

TABLE SEVEN
Strength Coefficient

Date	Verglimit	Control	
6/85	.44	.44	design
9/85	.44	--	production sample
3/86	.25	.35	from core
9/87	--	--	
7/88	.40	.44	from core

TABLE EIGHT
Resilient Modulus (X1000)

Date	Verglimit	Control	
6/85	406	353	design
9/85	642	--	production sample
3/86	344.6	241	from core
9/87	833	832	from core
7/88	508	526	from core

TABLE NINE
Immersion-Compression/ Modified Lottman (TSR)

Date	Verglimit	Control	
6/85	68	100	design I-C
9/85	73	--	production I-C
9/85	86.7	--	production (Lott)
3/86	6.0	44.2	from core (Lott)
3/87	95	93	remolded core
7/89	51	53	from core (Lott)

TABLE TEN
Viscosity/Penetration

AC-10F (Techni-Hib 7176), Vis @ 140

Date	Verglimit	Control
3/86	3758/44	2284/67
9/87	6488/33	3952/43

TABLE ELEVEN
Gradation

From Verglimit production sample 9/85:

Screen	Sample	Job Mix	
1/2	100	100	
3/8	93	0	
4	65	66	
8	48	48	
16	39	0	
100	14	0	
200	10.2	6.0	(minor deviation)

In order to get an indication of the amount of calcium chloride that was leaching from the surface of the mix during rain and snow storms, the department's Chemical and Bituminous Unit devised a simple soaking test to determine how much calcium dissolves from the extracted cores for various periods of time. The results showed that the total amount calcium chloride dissolving from the extracted cores was very small and only amounted to about twice the amount that was found in the control section which did not have Verglimit. The test procedure and results are described in Appendix C.

B. Vail

Evaluations at the Vail sites consisted of visual examinations only. The appearance of the sections was much the same as the Boulder site. Blotches on the road turned white when tested with silver nitrate (an indicator of chloride) as did the road surface in the wheelpaths which did not have a blotchy appearance (see Photo X). There were no signs of significant cracking, ravelling, or rutting. There was also no damage from skidding tires at the car park exit on Village Center Road (see Photo Y). Overall, the three pavements appear to be holding up very well.

As stated earlier, the Town of Vail does not add salt to their road sand. The City Engineer said that neither he nor his maintenance crew have actually noticed instances where these pavements were seen to have been melting snow or ice. Nor was the need for sanding these sections reduced during the snow season.

C. Cost

Verglimit-treated pavement has an in-place cost that is approximately three times that of a normal pavement. The costs for the Boulder site could not be accurately determined because of the small quantities and combined bid items.

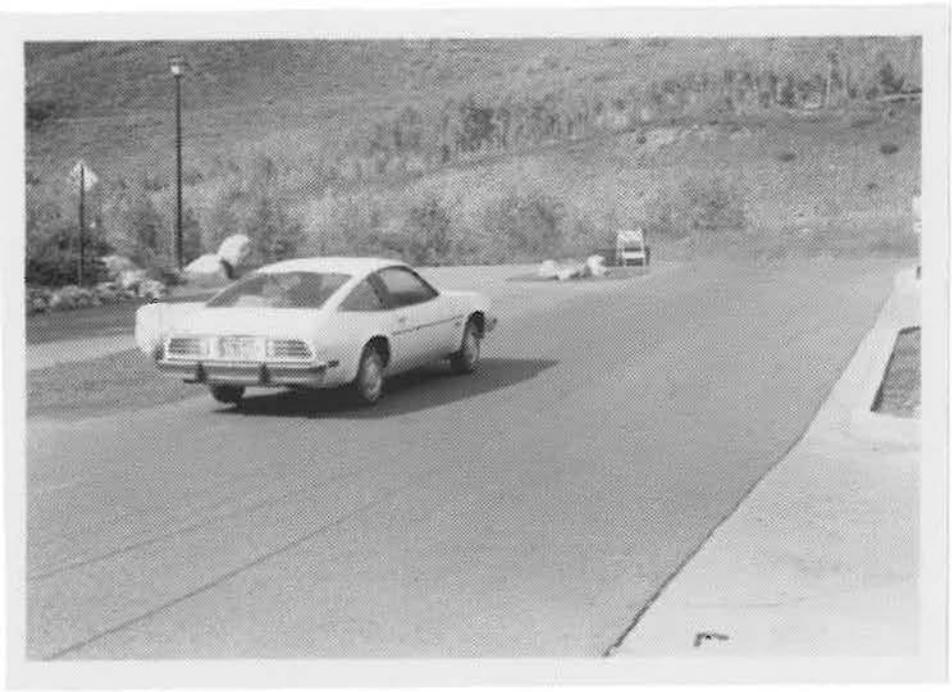
The Town of Vail, who bought their own Verglimit, reported that their in place cost for normal pavement to be $ 32.00/ton versus an in-place cost for the Verglimit-treated pavement to be $ 36.00/ton. At that time the additional cost for Verglimit itself was $ 1434.00 for 2205 pounds (a metric ton). Assuming a placement rate of 110 pounds/ton (5½%) this yields an additional cost of $ 71.53/ton for a total cost of $ 107.53/ton. The town purchased a total of 28 metric tons of Verglimit for a total cost of $ 40,152.

These figures are generally consistent with the findings of other agencies.

IV. CONCLUSIONS

A. Durability

Clearly, this study indicates that Verglimit-treated pavement can be long-lasting and durable. The performance of the sections laid down in both Boulder and Vail indicate that properly constructed Verglimit-treated pavements will have a normal service life. Even though all of the Boulder and Vail sites were on steep grades and probably suffer from spinning tires through at least part of the winter, none of these surfaces showed unusual wear.



(Y) Car park exit after three years

Lottman moisture susceptibility tests indicate that the modified Lottman test may not be a good indicator of stripping resistance for these pavements. Lab work by others has indicated that the addition of Verglimit will increase the moisture-susceptibility of a pavement, but the few field samples taken at the Boulder site were not able to confirm these findings.[2]

The cause of the early failure of the test pavement at Snowmass was most likely due to improper construction.

The variability of some of post-construction test results on extracted cores indicates that tests such as voids, density, strength, modulus, and stability may vary due to uncontrollable factors such as drilling time and pre-test storage.

B. Snow and Ice Reduction

The ice and snow melting abilities of these pavements is less certain. The Boulder site was not a good one to test Verglimit's ice melting performance. The ice melting capabilities of the pavement monitored in Boulder were subtle at best. There are several possibilities: either the material has little ability to melt snow and ice, or the effects were masked by routine sanding and salting operations, or some combination of both of these effects. Other users may have similar problems in observing the ice melting effects of the material since it is most likely to be used in areas that already receive frequent sanding.

Because of the short length the Boulder test pavement, the reputed ability of Verglimit in preventing "black ice" from bonding to the surface of the road could not be confirmed.

The obvious effectiveness of the pavement in melting snow and ice in the Snowmass test section may have been due to higher voids in the placed mix. The Vail site apparently was not as effective in melting snow as was the Snowmass site. However, since there was no formal observation program, it is possible that preferential melting was simply not noticed. The performance of the Snowmass and Boulder sites indicate that there may be a relationship between in-place voids and the amount of salt that leaches from the pavement and also a corresponding relationship between asphalt content and pavement durability.

Verglimit is not likely to eliminate the need for regular winter snow and ice control, including sanding/salting, at any location. However, a complete elimination may not be needed in most applications. Although not demonstrated at the Boulder location, the material may very well add a small but significant safety margin for sites, such as shaded areas, that show preferential early icing or that are too remote for prompt wintertime maintenance.

C. Slickness

Surface slickness after paving is still an unknown factor. The experience in Boulder and Vail indicates that the danger of a slippery road is largely past after several weeks. The largest hazard may be that a newly laid Verglimit pavement is no more slippery than any other wet pavement but that the pavement remains wet far longer after a rain, dew, or fog and that the unexpected reduction in surface friction can cause problems for an inattentive driver. Motorists should be warned of this possibility.

D. Environmental

The corrosive properties of the material were not addressed by this study; however, nothing found by this investigator in the published results of research done to date that would indicate that there is a significant risk of damaging underlying structural members (on bridges) or the roadway environment (from surface runoff). The simple soak test done in this study indicates that very little material is leaching from the surface of a Verglimit pavement.

The raw Verglimit appears to be safe enough to handle if the recommended precautions (protective clothing, dust avoidance, etc.) are taken.

V. RECOMMENDATIONS

Verglimit is recommended as a treatment for any location that tends to experience early icing due to geometry, a shady location, or freezing fog (such as a bridge over water), especially those which have a skidding history because of this tendency. Steep grades, such as the applications reported on here, may be a worthwhile, but are not necessarily an optimal use for the material.

Due to its cost, it is not recommended for very long stretches of highway (more than a mile) under normal circumstances. Its use should be discretionary by an agency and targeted for the top mat of short sections of roadway that have high accident rates involving skidding.

Verglimit is not recommended for use in lieu of normal wintertime snow and ice control. It should only be a considered a supplement to sanding and/or salting operations.

Since the material is most likely to be selected for use in an area that already has a significant skidding potential, the vendor's recommendations for mitigating a slippery surface by

flushing with water and/or using a sand blotter should not be ignored. At the time of construction the vendor recommended blotting with sand (and then swept up) or flushing with water before permitting traffic to use the roadway. It appears that either method may still leave a slippery surface. BOTH treatments are recommended by this investigator.

A pictorial "SLIPPERY WHEN WET" sign (W8-5) posted in advance of a new pavement for a period of no less 15 days following construction or until several days after the first precipitation event (whichever is longer) is recommended. The color of the field should be the same highway orange used in other construction warning signs described in Part VI of the "Manual on Uniform Traffic Control Devices for Streets and Highways".[6] Since a treated pavement can remain wet well after other adjacent surfaces have dried, a sign with the printed text "SLIPPERY WHEN WET" would be misleading and is not recommended.

Failures of the material in earlier tests in Colorado and other states indicate that the material is "construction sensitive". Placement is not recommended without a reasonable expectation of achieving a specification product. This is particularly true regarding mix temperature, ambient temperature, and compactive effort. Blade patches are not recommended nor is placement during adverse weather or very early or late in the paving season.

Project personnel should be warned of the caustic nature of Verglimit and be aware of needed safety measures when handling the material. The fresh road surface should not be touched until it has been flushed or blotted.

Inclusion as a standard specification is not recommended; the material should be included as a special provision on a project by project basis as needed.

VI. IMPLEMENTATION

Copies of this report will be distributed to all CDOH maintenance districts and to other interested public agencies who may be interested in using the material. The Research Branch will informally investigate the performance of other Verglimit overlays in the region and update its recommendations as needed.

Notes

1. The current marketing representative for the United States is

Ray Undernehr
P.O. Box 14866
Albuquerque, New Mexico 87191
U.S.A.
(505) 294-8602

for buyers in Canada the material is marketed through the North American distributor

P.K. Innovations
466 Burlington Street East
Hamilton, Ontario
Canada L8L 4H9
(416) 528-7023

2. Report number FHWA-RD-88-173, Laboratory Evaluation of Verglimit and PlusRide, by K.D. Stuart and W.S. Mogawer is in a draft form at the time of this writing. When published copies may be obtained from

Office of Engineering and Highway Operations R&D
Federal Highway Administration
6300 Georgetown Pike
McLean, Virginia 22101-2296

3. Report number CDOH-DTP-82-6, Performance of an Ice-Retardant Overlay, Final Report, October, 1982 is available from the

Colorado Department of Highways
Technical Transfer Unit
Colorado Department of Highways
4201 East Arkansas Avenue
Denver, Colorado 80222
(303) 757-9220

4. Skid numbers for pavements incorporating Verglimit have been extensively reported on by other agencies. See research report FHWA/NY/RR-86/132, "Performance of Two Ice-Retardant Overlays" by James H. Tanski of the New York State Department of Transportation, Engineering Research and Development Bureau.

5. Interpretation of skid numbers is somewhat subjective; the CDOH Division of Transportation Development uses these guidelines for interpreting skid numbers values:

10	Lowest Possible
35	Slippery
40	Questionable
45 - 55	Average Highway Readings
60	Very Good
80	Causes Severe Tire Wear

6. The MUTCD, as it is commonly known, is approved by the FHWA as the national standard for all public highways. The use of the manual (as modified) has been adopted by statute for use in Colorado and most, if not all, other U.S. states. Copies are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

APPENDIX A

Mix Design (Boulder)

STATE OF COLORADO
DEPARTMENT OF HIGHWAYS
DIVISION OF HIGHWAYS
DOH Form No. 43
Revised: June, 1980

JOB-MIX FORMULA MODIFICATION ORDER

Contractor Bebo Construction
Date August 22, 1985
Project No. BRM 0007(2)
Location 17 th Street Bridge

The Job Mix Formula(s) As Defined In Subsection 401.02 Of The Standard Specifications For Plant Mix Pavements, Based Upon The Following Reason: No enviromental factor will be appilied.

Is Hereby Modified From That Shown With The Plans To The Following:

BOTTOM LAYER(S), Grading ___ Includes ___ % Mineral Filler.
For Construction Mix Design, see DOH Form 157 # ___
on Project No. ___.

AGGREGATE SOURCE: ___
Designated O
Undesignated O

	Project Provisions	Modification No. ___
Passing ___ Sieve	___ %	Sieve ___ %
Passing ___ Sieve	___ %	Sieve ___ %
Passing ___ Sieve	___ %	Sieve ___ %
Passing Number 4 Sieve	___ %	Sieve ___ %
Passing Number 8 Sieve	___ %	Sieve ___ %
Passing Number 50 Sieve	___ %	Sieve ___ %
Passing Number 200 Sieve	___ %	Sieve ___ %
% Asphalt by Weight	___	___
Asphalt Grade	___	___

PIT I.D. ___
Mineral Filler Type (If Any)
Asphalt Source (Refinery)
Asphalt Additive Required:
Yes O No O
ASPHALT ADDITIVE
Brand ___

Temperature of Mixture When Emptied From Mixer ___ °F (Spec. 401.15)
Specific Gravity of Lab Specimen: ___ % Compaction Required: ___ % (Spec. 401.17)

TOP LAYER, Grading EX Includes 6 % XXXXXXXXX Veralimit
For Construction Mix Design, see DOH Form 157 # 17969
on Project No. BRM 0007(2).

AGGREGATE SOURCE: Flatiron Pavina
Designated O
Undesignated ⊗

	Project Provisions	Modification No. 1
Passing ___ Sieve	___ %	Sieve ___ %
Passing ___ Sieve	___ %	Sieve ___ %
Passing 1/2" Sieve	___ %	Sieve 100 %
Passing Number 4 Sieve	___ %	Sieve 66 %
Passing Number 8 Sieve	___ %	Sieve 48 %
Passing Number 50 Sieve	___ %	Sieve ___ %
Passing Number 200 Sieve	___ %	Sieve 6 %
% Asphalt by Weight	___	6.2
Asphalt Grade	___	AC 10

PIT I.D. White Rocks
Veralimit
Mineral Filler Type (If Any)
Conoco
Asphalt Source (Refinery)
Asphalt Additive Required:
Yes ⊗ No O
ASPHALT ADDITIVE
Brand Techni-Hib 7176

Temperature of Mixture When Emptied From Mixer 330 °F (Spec. 401.15)
Specific Gravity of Lab Specimen: 2.32 % Compaction Required: 95 % (Spec. 401.17)

Distribution
White.....Contractor
Pink Copy.....Staff Materials Branch
Blue Copy.....District Office
Green Copy.....District Materials Engineer
Canary Copy.....Resident Engineer
Orange.....Staff Construction Branch
FHWA.....Photo Copy

CENTRAL LAB CONCURRENCE ___ Date ___
Name

Signed [signature] Date 8/22/85
Authorized-Project Engineer

Signed [signature] Date 8-21-85
Approved - Dist. Materials Engineer

Received ___ Date ___
Contractor's Authorized Representative

STATE OF COLORADO
DEPARTMENT OF HIGHWAYS
DIVISION OF HIGHWAYS
DOH Form No. 43
Revised: June, 1980

JOB-MIX FORMULA MODIFICATION ORDER

Contractor Bebo Constr. Project No. BRM 0007(2)
Date May 17,1985 Location 17th St. Brg. - Boulder

The Job Mix Formula(s) As Defined In Subsection 401.02 Of The Standard Specifications For Plant Mix Pavements, Based Upon The Following Reason: Enviromental Factor of -.1 appilied. Another 43 will be submitted for HBP(special). (Softumbo)

Is Hereby Modified From That Shown With The Plans To The Following:

0.14
6.0 - 24/21

BOTTOM LAYER(S), Grading EX Includes 0 % Mineral Filler.
For Construction Mix Design, see DOH Form 157 # 13626
on Project No. C 07-0072-13.

AGGREGATE SOURCE: Flatiron Paving
Designated ○
Undesignated ●

Project Provisions			Modification No. 1	
Passing ____	Sieve	____ %	Sieve ____	%
Passing ____	Sieve	____ %	Sieve ____	%
Passing 1/2"	Sieve	____ %	Sieve 100	%
Passing Number 4	Sieve	____ %	Sieve 68	%
Passing Number 8	Sieve	____ %	Sieve 52	%
Passing Number 50	Sieve	____ %	Sieve ____	%
Passing Number 200	Sieve	____ %	Sieve 7	%
% Asphalt by Weight		____	5.6	
Asphalt Grade		____	AC - 10F	

PIT I.D. White Rocks
None
Mineral Filler Type (If Any)
Conoco
Asphalt Source (Refinery)
Asphalt Additive Required:
Yes ● No ○
ASPHALT ADDITIVE
Brand Techni-Hib #7176

Temperature of Mixture When Emptied From Mixer 280 °F (Spec. 401.15)
Specific Gravity of Lab Specimen: 2.34 % Compaction Required: 95 % (Spec. 401.17)

TOP LAYER, Grading ___ Includes ___ % Mineral Filler.
For Construction Mix Design, see DOH Form 157 # ____
on Project No. ____.

AGGREGATE SOURCE: ____
Designated ○
Undesignated ○

Project Provisions			Modification No. ___	
Passing ____	Sieve	____ %	Sieve ____	%
Passing ____	Sieve	____ %	Sieve ____	%
Passing ____	Sieve	____ %	Sieve ____	%
Passing Number 4	Sieve	____ %	Sieve ____	%
Passing Number 8	Sieve	____ %	Sieve ____	%
Passing Number 50	Sieve	____ %	Sieve ____	%
Passing Number 200	Sieve	____ %	Sieve ____	%
% Asphalt by Weight		____		
Asphalt Grade		____		

PIT I.D. ____
Mineral Filler Type (If Any)
Asphalt Source (Refinery)
Asphalt Additive Required:
Yes ○ No ○
ASPHALT ADDITIVE
Brand ____

Temperature of Mixture When Emptied From Mixer ____ °F (Spec. 401.15)
Specific Gravity of Lab Specimen: ____ % Compaction Required: ____ % (Spec. 401.17)

Distribution
White..... Contractor
Pink Copy.... Staff Materials Branch
Blue Copy.... District Office
Green Copy.... District Materials Engineer
Canary Copy.... Resident Engineer
Orange..... Staff Construction Branch
FHWA..... Photo Copy

RECEIVED MAY 17 1985 HISTORY

CENTRAL LAB CONCURRENCE ____ Name ____ Date ____

Signed Hal Toland Authorized Project Engineer Date 5/17/85

Signed [signature] Approved - Dist. Materials Engineer Date 5-21-85

Received Fred Baldwin Contractor's Authorized Representative Date 5/17/85

Division of Highways
State of Colorado
Form DOH 18-0 Rev. 3/85

Date received 6- 2-85
District # 4

Project Number: BRM 0007(2)
Location: 17th St. Bridge

Lab # 264x, 265x

Field Sample #: 17969

LABORATORY DESIGN FOR HOT BITUMINOUS PAVEMENT

Pit name White Rocks
Item 403 GRADING EX CONTRACTOR Beebo Const.
CONSTRUCTION

AC 10 (VERGLIMIT)

SIEVE ANALYSIS (percent passing)

Test Nos.	264x	265x	AS Used	Job Mix
% used	94.	6.		
1	100.	100.	100.	_____
3/4	100.	100.	100.	_____
1/2	100.	100.	100.	100
3/8	92.	100.	92.	_____
4	64.	100.	66.	66
8	45.	100.	48.	48
16	35.	100.	39.	_____
50	18.	100.	23.	_____
100	12.	100.	17.	_____
200	6.9	100.0	12.5	6 ±

TEST RESULTS

Percent bitumen	5.5	6.0 6.2	6.5	7.2
Rice Value	2.43	2.41	2.40	2.37
Sp. Gr. of specimen	2.30	2.32	2.33	2.33
Voids in specimen	5.32	3.84 3.3	2.55	1.43
Stability value	40.	38.	39.	11.
Cohesiometer value	274.	272.	254.	218.
RT value	102.	101.	100.	70.
Resilient Mod. (X1000)	426.8	406.9	405.8	292.2
Strength coefficient	.44	.44	.44	.25

IMMERSION-COMPRESSION

Percent bitumen	6.2	6.2
Specimen PSI Wet	224.	214.
Specimen PSI Dry	341.	315.
% Absorption by Wt.	1.21	.98
% Swell by volume	.47	.00
Index of Ret. Strength	66. *	68. *
% Additive used	.00	.40
Asphalt additive type		Techni-hib 7176

* RET. STRENGTH CUT OF SPECIFICATION

TEST RUN FOR DISTRICT INFORMATION. SEE SPECIAL PROVISIONS FOR PROJECT SPECIFICATIONS.

Optimum asphalt content _____ Lab Sp. Gr. at optimum _____

Asphalt grade _____
Additives added :
Asphalt: % _____ type_____
Aggregate: % _____ type_____

Distribution:
Staff Construction
District Engineer - Materials Engineer
Construction Engineer
Resident Engineer (2) _____
6/10/85

Environmental factor should be determine at the time of construction

Gary Eckhardt 757-977
Flexible Pavement Engineer

Division of Highways
State of Colorado
Form DOH 38-0 Rev. 3/85

Date received 6-20-85
District # 4

Lab # 264x

Project Number: [illegible]
Location: 17th St., Montrose

Field Sample #: 17969

LABORATORY DESIGN FOR HOT BITUMINOUS PAVEMENT

Pit name White Rocks
Item 403 GRADING EX CONTRACTOR Beebo Const.
CONSTRUCTION

AC 10 Conoco

SIEVE ANALYSIS (percent passing)

Test Nos.	264x	AS Used	Jnt Mix
% used	100.		
1	100.	100.	
3/4	100.	100.	
1/2	100.	100.	100
3/8	92.	92.	
4	64.	64.	64
8	45.	45.	45
16	35.	35.	
50	18.	18.	
100	12.	12.	
200	6.9	6.9	6

TEST RESULTS

Percent bitumen	5.3 5.5	5.8	6.3	6.8
Rice Value	2.45	2.43	2.41	2.39
Sp. Gr. of specimen	2.36	2.38	2.38	2.38
Voids in specimen	3.92 3.28	2.23	1.20	.36
Stability value	40.	40.	35.	12.
Cohesiometer value	229.	266.	270.	178.
RT value	100.	102.	99.	68.
Resilient Mod.(X1000)	350.6	354.7	308.9	231.8
Strength coefficient	.44	.44	.44	.25

IMMERSION-COMPRESSION

Percent bitumen	5.5
Specimen PSI Wet	404.
Specimen PSI Dry	405.
% Absorption by Wt.	.72
% Swell by volume	.08
Index of Ret. Strength	100.
% Additive used	.40
Asphalt additive type	Techni-hib 7176

Optimum asphalt content 5.5 Lab Sp. Gr. at optimum 2.37

Asphalt grade AC 10
Additives added :
Asphalt: % 0.4 type TECHNI-HIB 7176
Aggregate: % _____ type_____

Distribution:
Staff Construction
District Engineer - Materials Engineer
Construction Engineer
Resident Engineer (2) _____
6/10/91

Environmental factor should be [illegible]
at the time of construct[illegible]

Gary Eckhardt
Flexible Pavement[illegible]

Hot Bin Gradations - Verglimit
August 29, 1985
(information provided by Flatiron Paving Company)

	Bin #1 Coarse	Bin #2 Interm	Bin #3 Fines	BLEND	
1/2"	100	100		Coarse	12.5%
3/8"	55	98		Intermediate	37.4%
#4	6	41	100	Fine	50.1%
#8	3	6	95		
#50	2	4	36		
#200	1.6	2.8	12.9		

Gradation of the mix without Verglimit:

	Actual	Job Mix Formula
1/2"	100	100
3/8"	94	
#4	66	66
#8	50	47
#50	20	
#200	7.8	6.5

Verglimit Batch Weights:

Coarse	540#
Intermediate	1650#
Fine	2200#
Verglimit	300#
Conoco AC-10	310#
Total	5000#

Asphalt content 6.2%
Verglimit content 6.0%
Discharge temperature 310 °F
Mixing time before Veglimit addition 20 - 30 seconds.
Mixing time after Verglimit addition 15 - 18 seconds.

STATE OF COLORADO
District Four Materials Lab
Greeley, Colorado

54.01

Project BRM 0007(2)

Location 17th Street Bridge - Boulder

Field Sheet No. _____

Date September 4, 1985

TEST REPORT

Shown below are results of two asphalt rings taken from the roadway on the above-captioned project. This material contained Verglimit and was supplied by Flatiron-Boulder.

Ring #	1	2
Field Specific Gravity	2.21	2.21
Lab Maximum Specific Gravity	2.32	2.32
% Relative Compaction	95.3	95.3

Minimum compaction required was 95%.

District Lab results by R.M. Driver

cc: H. Toland - Boulder
J. Kiljan - Research
J. Hutchison - Consultant
File

Kenneth L. Wood
District Materials Engineer

APPENDIX B

Sample Accident Report

Sept 26 9:30

Mail To:
Dept. of Revenue
ACCIDENT RECORDS
4201 E. Arkansas Ave
Denver, Colo. 80222

STATE OF COLORADO
INVESTIGATOR'S
TRAFFIC ACCIDENT REPORT

SHEET 1 OF 1 SHEETS

STATE ORIGINAL NUMBER ✓ DR-447 (1/81)

ROAD CODE

CITY ORIGINAL NUMBER 2585A

DATE OF ACCIDENT 9-6-85 | TIME 0035 | DAY OF WEEK FRIDAY | CITY Boulder | COUNTY Boulder

LOCATION: ROUTE, STREET, ROAD: 1200 Block of 17th

MILES ___N ___S
FEET ___E ___W
AT INTERSECTION WITH

OF ROUTE, ST, RD, MILEPOST

TOTAL VEHICLES	NUMBER KILLED	NUMBER INJURED	RAILROAD CROSSING	CONST ZONE	WILD GAME	PUBLIC PROPERTY OR PUBLIC EMPLOYEE	PRIVATE PROPERTY	INCOMPLETE REPORT
1	0	1						

DATE NOTIFIED OF ACCIDENT 9-6-85 | TIME 0036 | DATE ARRIVED AT SCENE 0037 | TIME | INVESTIGATED AT SCENE | PHOTO TAKEN | DISTRICT NUMBER

OFFICER NUMBER 491 | SIGNATURE [illegible] | DETAIL III | OFFICER NUMBER | SIGNATURE | DETAIL

DATE OF REPORT 9-6-85 | LAW ENFORCEMENT AGENCY Boulder PD | REVIEWER [illegible] | CODE

VEH #1 OR ___ PARKED ___ PEDESTRIAN # ___	VEH #2 OR ___ PARKED ___ PEDESTRIAN # ___
LAST NAME [redacted] MI	LAST NAME FIRST MI
STREET ADDRESS 2130 Walnut	RES. PHONE None
CITY Boulder STATE CO ZIP CODE 80303	BUS. PHONE None
DRIVER LIC. NO. B435-4726-4188 STATE Ill SEX M AGE 21 DATE OF BIRTH 7-2-62	
VIOLATION(S) INATTENTIVE Driving	
VIOLATION CODE(S) 7-4-52	CITATION NUMBER(S) A30350	COMMON CODE(S) 171
YEAR 1973 MAKE Volkswagon	MODEL Beetle	BODY TYPE 20
REGISTRATION NO. CGN583 STATE Ill	VEH. IDENT. NO. 1332029422
VEH. OWNER LAST NAME [redacted] FIRST [redacted] MI	
STREET ADDRESS 7352 W. Cook CITY River Forest STATE Ill ZIP CODE	
VEHICLE TOWED BY BT+W, Boulder	
DAMAGE SEVERITY: 1-SLIGHT 2-MODERATE 3-EXTREME	DAMAGE SEVERITY: 1-SLIGHT 2-MODERATE 3-EXTREME
Allstate	
20 Undercarriage ___	20 Undercarriage ___
OWNER OF DAMAGED PROP. LAST NAME Reedy FIRST Clyde MI R	OWNER OF DAMAGED PROP. LAST NAME FIRST MI
ADDRESS 1203 17th CITY Boulder STATE CO ZIP CODE 80303	ADDRESS CITY STATE ZIP CODE

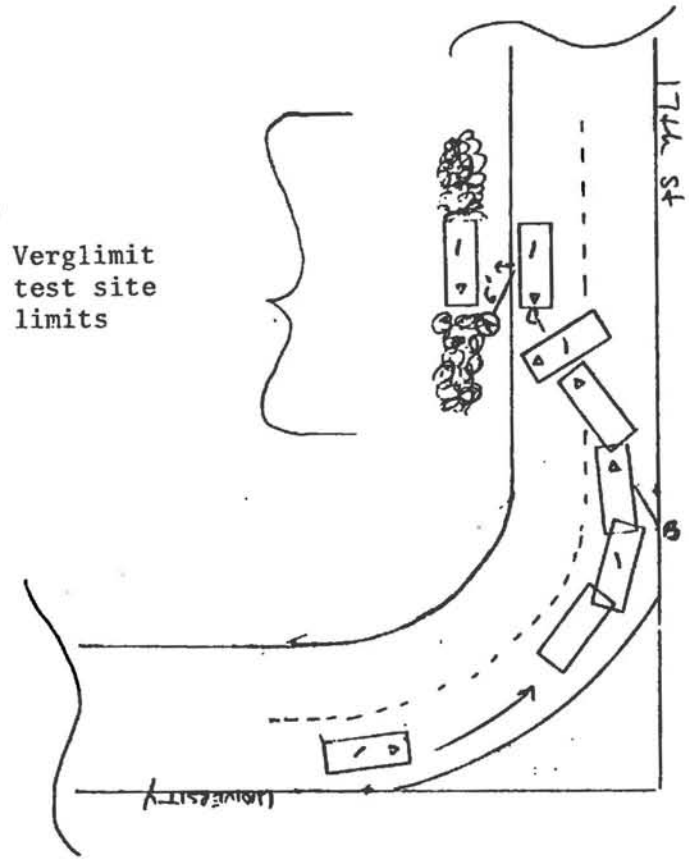
DESCRIBE ACCIDENT

Veh. #1 was E. Bound on University, and lost control as it turned N. bound, on the curve, where University turns into 17th St. The veh lost control, went broadside, hit the curb on the S. bound lane of 17th and overturned. The veh. landed on its side and came to rest on a section of Hedge at 1203 17th (Reedy). The veh was put upright by witness and other people in the area and passenger [redacted] was taken out. According to witness and passenger ([redacted]) driver of #1 was going between 30-40 mph prior to the accident. Tire skids were clearly visable showing the path taken by the veh

INDICATE NORTH BY ARROW

WITNESS: Rowan Martian Laing
1135 Lincoln PL
Boulder, CO
PH. 444-4629 (Home)
449-2180

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	1	1	2	2	1						
2	1	3	2	1	2	1	1	A-1		M	[redacted] 2130 Walnut, Boulder
3											
4											
5											
6											
7											
8											



N

A. Telephone pole @ 76/46

B&C 75 FT skids
NOT TO SCALE

APPENDIX C

Calcium Content (Boulder)

Calcium Content (Boulder)

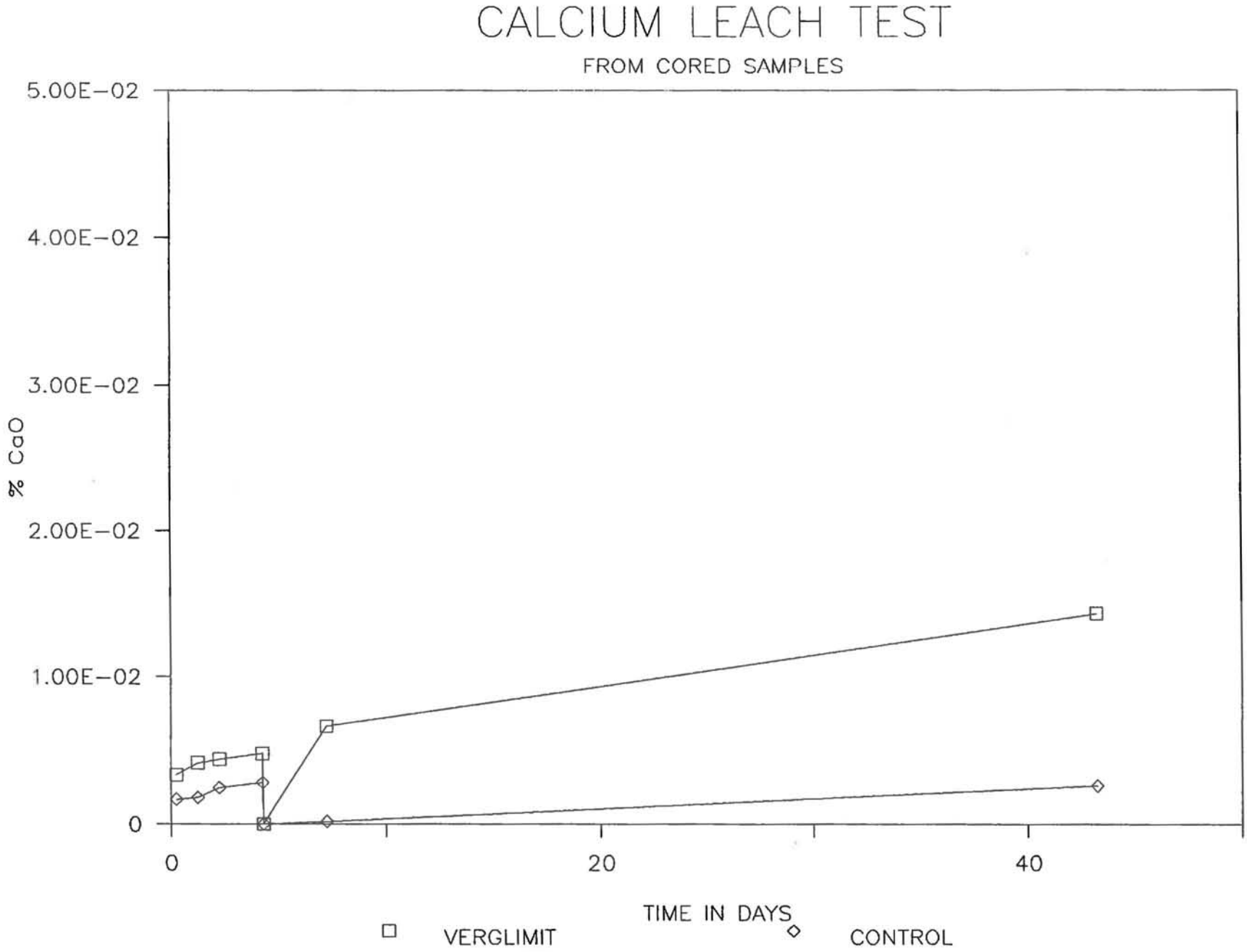
An informal test was devised by the department's Chemical Lab to provide an indicator of the amount of chloride leaching that was taking place from the surface of the Verglimit-treated pavement during precipitation events.

A four-inch (10.2 cm) diameter core was inverted into a large beaker and flooded with 200 ml of distilled water. This amount of water wetted the lower half of the core's surface and all of the 2.75 inch (7.0 cm) Verglimit-treated overlay. A control sample was treated in a similar manner.

After soaking the core a known period of time, 50 mls of water were extracted from both the test and control beakers and quantitatively analyzed for calcium content using a classical titration method. After the first four extractions (four days), each beaker was empty. They were refilled with an additional 200 ml of distilled water and tested again after another three days (seven days total). The samples were left to soak for another month (43 days total) and tested one more time. By this time the Verglimit sample was swollen and cracked in a number of locations due to the expansive qualities of the embedded Verglimit.

The measurements after six hours (see the table below) are thought by this investigator to be the most indicative of the relative leaching to be expected from a typical rain or snow storm. The results show an overall low rate of calcium chloride leaching in the same order of magnitude as the untreated control sample.

ELAPSED TIME	VERGLIMIT %CaO	CONTROL %CaO	DIFFERENCE
6 HRS	3.320E-3	1.670E-3	1.651
30 HRS	4.124E-3	1.780E-3	2.338
54 HRS	4.390E-3	2.456E-3	1.934
4 DAYS	4.789E-3	2.790E-3	1.998
4 DAYS	--------	--------	(re-saturated)
7 DAYS	6.670E-3	0.180E-3	6.490
43 DAYS	14.300E-3	2.600E-3	11.700


CALCIUM LEACH TEST
FROM CORED SAMPLES
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0
% CaO
0
20
40
TIME IN DAYS
VERGLIMIT
CONTROL