I. Construction Innovation Forum • NOVA Award Nomination

Instructions

Step 1 Enter a Descriptive Name for the Process/Method/Technique you are nominating on line A of this page.

Step 2 Complete this page,
"I. Construction Innovation Forum • NOVA Award Nomination"
a. Be sure to provide original signatures in Section B and E on this page. Your nomination cannot be reviewed without them.
b. If you need additional space for names and addresses you may attach additional pages for names and address information. You may attach extra pages only for sheet I.

Step 3 "II - Innovation Description" — attach one (one only) 8-1/2" X 11" page that gives a succinct written description of the innovation. Put the name of the innovation at top of page. Tell us what you think is innovative about this. You should include:
- What the innovation is
- Why it is innovative
- What it changed or replaced
- Where and when it originated, has been used, and is expected to be used in the future
- If the nomination is for an innovative project, specifically identify its innovation.

Please type, with 1" margins, 10 characters per inch, 6 lines per inch.

Step 4 "III - Innovation Illustration" — attach one (one only) 8 1/2" X 11" page that contains one or more photographs, drawings, tables, graphs, clauses, etc., that visually describe the innovation. Do not submit more than one page of visuals. The jurors will see only one sheet for review. Put the name of the innovation at top of page.

Other You must submit 12 (twelve) sets of sheets I, II and III (a total of 36 pages).

Nominations are due September 15 mailed or delivered to:
The Construction Innovation Forum, 1000 Campus Drive, Suite 100, Ann Arbor, MI, USA 48104-6792, Phone: 313-995-1855, Fax: 313-995-5002

A. Name of Innovation: Sika® Rapid-1, Hardening Accelerator Concrete Admixture

B. Person(s) and /or Organization(s) Primarily Responsible for the Innovation (Those to whom the NOVA Award should be presented.)

Mark F. Noble
Executive Vice President - Construction Products
Sika Corporation
201 Polito Avenue
Lyndhurst, New Jersey 07071
(201) 933-8800

Signature

(Signature(s) indicate acceptance of the nomination and consent to have CIF research and make presentations on the innovation for the purpose of jurying and publicizing awards.)

C. Other Primary Sources of Information on the Innovation: (in addition to the persons nominated above.)

Dr. Norman Blank
Vice President - Technology
Sika Corporation
201 Polito Avenue
Lyndhurst, New Jersey 07071
(201) 933-8800

Phone:

Todd C. Spindler
Marketing Manager - Concrete
Sika Corporation
201 Polito Avenue
Lyndhurst, New Jersey 07071
(201) 933-8800

Urs Hussy
Director - Product Management
Sika Corporation
201 Polito Avenue
Lyndhurst, New Jersey 07071
(201) 933-8800

D. Independent Reference(s) familiar with the use of the Innovation

Mr. Charlie Liebert
Hampton Roads Prestress, Inc.
33211 Lee's Mill Road
Franklin, Virginia 23851
(804) 562-0590

Phone:

Mr. John Rotondo
Rotondo Precast (Oldcastle Group)
5115 Massaponax Church Road
Fredericksburg, Virginia 22407
(703) 898-6300

Dr. Farhad Ansari, Ph.D.
New Jersey Institute of Technology
University Heights
Newark, New Jersey 07102
(201) 596-3663

E. Person(s) making nomination:

Todd C. Spindler
Marketing Manager - Concrete
Sika Corporation
201 Polito Avenue
Lyndhurst, New Jersey 07071
(201) 933-8800

Phone:

Signature

(Signature(s) indicate familiarity with the the innovation and sign(s) that information contained in the nomination is correct to the best of one's knowledge.)

Sika® Rapid-1, Hardening Accelerator Concrete Admixture

Sika® Rapid-1 is a new HARDENING ACCELERATOR concrete admixture that allows the development of very early high strengths in concrete using common mix components.

Until now, set accelerators have been commonly used to develop early strengths in concrete. These products, however, generally result in shortened work times (early stiffening of the concrete), lower slumps (difficult to place and consolidate), and decreased ultimate strengths. Sika Corporation's recent development of a HARDENING ACCELERATOR allows placement of fresh concrete without early stiffening, followed by a window of very rapid strength gain after the initial set. Furthermore, Sika Rapid-1 is non-chloride (non-corrosive) and will not limit the long term strength gain of concrete that is often sacrificed (or over designed for) when using set accelerators. The advantages and benefits amount to a placeable concrete (8 inch or greater slumps with acceptable w/c ratios are possible) for improved production with less manpower, and very early high strengths without performance tradeoffs.

In a research project sponsored by the New Jersey Department of Transportation, the New Jersey Institute of Technology and Rutgers University accepted a challenge to develop concrete capable of 3,000 psi compressive and 350 psi flexural strengths in 4 to 6 hours. Their solution is a concrete mix design using standard components (including Type I cement) and Sika Rapid-1. This mix allows the NJDOT to pour full depth concrete ready for traffic or paving operations in under 6 hours. Full depth roadway joint repairs can be completed overnight, from lane closure and substrate demolition, to concrete pouring and lane reopening.

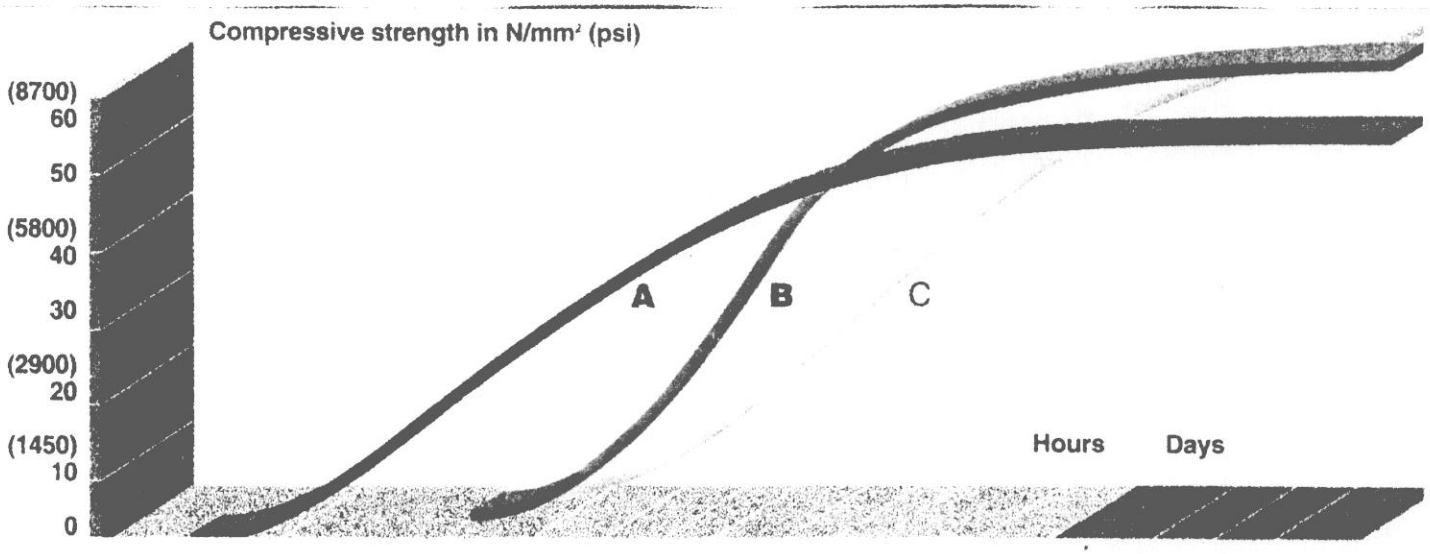
In addition to the benefits for ready mixed concrete, the patented HARDENING ACCELERATOR also offers advantages to precast/prestressed producers. Sika Rapid-1's interaction with the cement hardening process occurs during the hydration phase after initial set, and results in additional internal heat generation. This heat is used to reduce or eliminate the cost of steam curing, and/or shorten curing times. Prestressing, mold release, and shipping times have been significantly reduced for precast manufacturers resulting in two or more production cycles per day for consistent manufacturing performance, accelerated project scheduling, lowered overhead costs, and better profitability.

Used in ready mixed concrete projects such as roadway pours and joint repairs, and in precast/prestressed concrete projects including segmental bridges, tunnel linings, and structural element production, Sika Rapid-1 represents an innovation in specialty concrete admixtures for minimal public disruption, greater productivity, and lowered producer/end user costs!

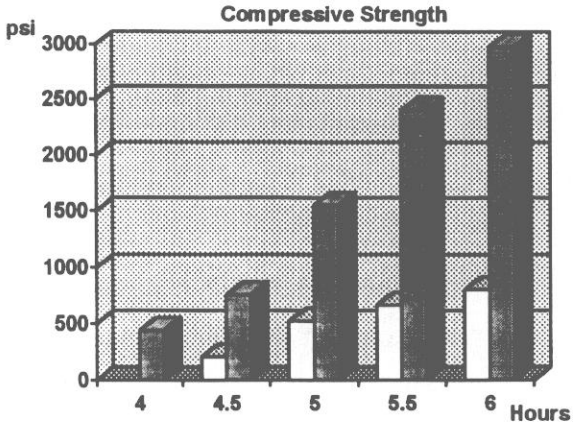
Sika® Rapid-1, Hardening Accelerator Concrete Admixture

Higher early concrete strengths can be achieved through the correct use of specialty admixtures to:

- A Shorten the initial setting time (e.g. by using of a set accelerator in sprayed concrete).
- B Accelerate the hardening process (e.g. by using a hardening accelerator, Sika Rapid-1, in structural concrete.
- C Reduce the water/cement ratio (e.g. by using a high range water reducer).



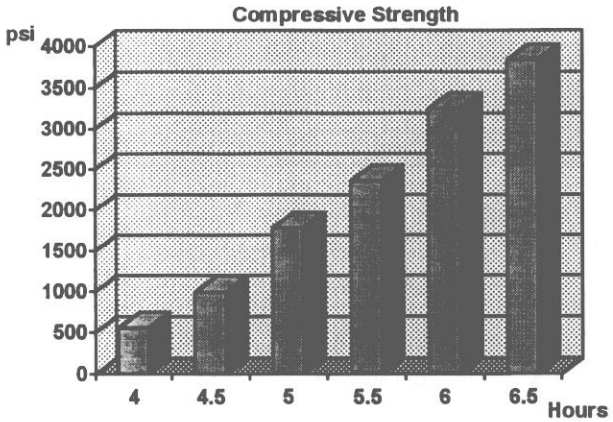
Sample Precast Comparison with Sika Rapid-1



Example Mix Design*:	Control	Rapid-1 Mix
Cement Type III (lbs.)	658	658
Water (lbs.)	274	274
Coarse Aggregate (lbs.)	1710	1710
Fine Aggregate (lbs.)	1313	1313
Air - Sika AEA-15 (fl.oz/cwt.)	0.5	0.5
HRWR - Sikament 300 (fl.oz/cwt.)	14	14
Sika Rapid-1 (fl.oz/cwt.)		20
W/C Ratio	0.41	0.41

* No steam curing.

Sample NJDOT Development Mix



Example Mix Design:	
Cement Type II (lbs.)	752
Water (lbs.)	226
Coarse Aggregate (lbs.)	1746
Fine Aggregate (lbs.)	1313
Air - Sika AER (fl.oz/cwt.)	1.0
HRWR - Sikament 86 (fl.oz/cwt.)	20
Sika Rapid-1 (fl.oz/cwt.)	32
W/C Ratio	.30

Reference Mix SK5G27

AWARD MANAGER'S SUMMARY
Nomination 9727

SIKA® RAPID-1 HARDENING ACCELERATOR CONCRETE ADMIXTURE

The Innovation

Sika® Rapid-1 is a new concrete admixture that hardens concrete and allows very high strengths to be developed in a very short period of time.

When added to concrete mixed from customary components, the Sika Rapid-1 admixture changes the strength-gain vs time curve of the mix. After the initial set, the strength of the concrete rises very rapidly and approaches the ultimate strength earlier than concrete without the admixture. Normal full strength curing takes place after the early strength has been reached.

Set accelerators have been commonly used to develop early strengths in concrete. However, these admixtures generally result in low slumps, early stiffening of the concrete, and decreased ultimate strengths. These problems not only make it difficult to place and consolidate the concrete, but limit the time available for casting.

Unlike set accelerators, Sika Rapid-1 hardening accelerator does not accelerate the set time of the concrete and does not lower the ultimate strength. Instead, it accelerates the gain in the strength of the mix. Rapid-1 also does not limit the long term strength gain of the concrete that is often lost when using set accelerators. Concrete containing Rapid-1 can be normally placed and consolidated without early stiffening, and can be worked upon or accept loads after a few hours.

Sika Rapid-1 was developed in the Sika AG laboratories in Zurich, Switzerland, over a period of years. Dr. Urs Maeder, the head of the Department for Admixtures for Concrete in the R & D Division of Sika AG, led the development of the product. For a long time, calcium chloride was the only admixture that would give concrete an early set, but calcium chloride adds chlorides to the concrete and causes reinforcing steel to corrode. Sika developed Rapid-1 as a non-chloride admixture that exceeds the performance of calcium chloride, aspecially at high temperatures.

Rapid-1 has been in the market in the United States since 1995. The first months of 1995 were devoted to field testing and the product was introduced officially in 1996.

Background

The New Jersey Department of Transportation (NJDOT) funds the Center for Advanced Infrastructure Technology (CAIT) at Rutgers University. The Center conducts research at Rutgers University and at New Jersey Institute of Technology (NJIT). Research projects are jointly selected by NJDOT and Rutgers.

NJDOT planned to start renovating I 295, a heavily traveled expressway in the northern part of the state, and wanted a mix design that would allow full-depth restoration of jointed concrete slabs prior to bituminous overlay, and that could to be done overnight (in about 12 hours). The time period for creating the design was short because NJDOT wanted to start the renovation in the Spring of 1996. In December 1995, NJDOT commissioned NJIT and Rutgers to research the design of a concrete mix that would have a strength of 2500 psi to 3000 psi, a modulus of rupture of 300 psi to 350 psi, and a curing time of 5 to 6 hours. Two research contracts were issued under the CAIT: one to Rutgers with Dr. Maher as Principal Investigator, and the other to NJIT with Prof. Ansari as Principal Investigator.

NJDOT wanted to keep field operations as normal as possible, and their goal was to use Type I cement, normal 3/4 to 1 inch aggregate, and a water/cement ratio of .36 to .40. As a very practical approach to solving a specific problem, Prof. Ansari's group at NJIT did typical laboratory tests of a number of concrete mixes containing various admixtures. NJDOT had worked with Sika on some of their projects, so Sika was asked by NJDOT and NJIT to take part in the research. Sika Rapid-1 hardening admixture was one of those tested, mainly because it is a non-chloride admixture.

The research enhanced the curing process by adjusting the amounts of other admixtures, air entraining, etc. and Rapid-1. The results were that the amount of other admixtures was reduced and that the temperature of the mix was increased. The researchers found that by holding the temperature of the mix to 70 to 75 degrees F. the concrete would set after about 2 or 3 hours and then harden very rapidly. Curing would then continue in a normal manner and normal maximums would be achieved in 28 days.

One of the mixes containing Sika Rapid-1 met the goals of NJDOT and was adopted for the I 295 project.

To establish a means of quality control, a relationship was developed to relate the temperature of the concrete mix to its compressive strength. From concrete cylinder tests, a temperature vs time curve was developed. The area under that curve up to a specified time was defined as the maturity factor of the mix. Then the maturity factor was plotted against the concrete strength. In the field, the temperature is monitored by thermocouples in the concrete, and a time-temperature product is computed which allows the estimate of strength to be determined from the maturity factor curve.

Although the mix selected by NJDOT used Type I cement, Prof. Ansari believes that the use of Rapid-1 can be used with different types of cements and with the more common chloride-based admixtures. A new study is being proposed to NJDOT for a one year project to do this advanced testing, and to prepare a handbook tabulating high early strengths of concretes using different cements, admixtures, and temperatures. Such a tabulation could be used for many design conditions. This project might take longer than the one year, so the contract might be extended. This research will be funded through (CAIT) at Rutgers of which Dr. Ali Maher is the director.

Application

There appear to be two major markets for the Sika Rapid-1 hardening accelerator: "fast track" highway repair and paving; and precast component manufacturing.

Research on the use of Rapid-1 for highways has been carried out at Rutgers University and at New Jersey Institute of Technology. These groups have worked very closely with NJDOT to develop a system for the restoration of pavements in high volume traffic areas. They have developed a concrete mix that achieves high strength in a few hours which allows for bituminous overlay paving and the restoration of traffic within an overnight work period. The concrete strength is controlled with instrumentation consisting of temperature gages embedded in the mix and a lap-top computer to measure curing rates. Traditional concrete cylinders are not needed. The gain in concrete strength is sensitive to temperature, so curing blankets are required to maintain proper curing temperatures.

There is an article in the May 20,1996, issue of ENR, page 25, (See exhibit) about the field tests of the procedure developed at NJIT using the mix containing Sika Rapid-1 hardening admixture. This admixture appears to be one answer to the strong need for high early concrete strengths for highway paving.

Sika Rapid-1 has found a significant applications in the precast/prestressed concrete industry because of its relatively high heat of hydration. During the curing process, Rapid-1's interaction with the cement occurs during the hydration phase, and this interaction generates relatively high internal heat. This heat can then be used to reduce or eliminate the need for an external heat source. Further, the accelerated hardening of the concrete allows mold releasing, prestressing operations, and shipping times to be significantly reduced. In some instances, precast manufacturers may be able to achieve two or more production cycles per day.

Many users of precast elements are highway and transportation departments. There has been a reluctance on their part to permit the use of Rapid-1 in the components specified. Most precasters need to obtain special permissions to use Rapid-1, but it is anticipated that general specification approvals will be forthcoming. If so, the use of

Sika Rapid-1 hardening accelerator for precast components appears to have a high potential.

Notes on Nominated Persons

Mr. Mark F. Noble is Executive Vice President - Construction Products for Sika Corporation. As the head of the construction products division, the development and field testing of the Sika Rapid-1 hardening accelerator concrete admixture took place under his administration.

Mr. Noble was the only person identified on the nomination as being responsible for the Rapid-1 admixture. Others that played a significant role include the following:

Dr. Norman Blank is Vice President - Technology for Sika Corporation. He is in charge of all R & D in the company and had a significant part in the development of Rapid-1 admixture.

Dr. Urs Maeder, Head of the Department of Admixture for Concrete, R & D Division of Sika AG, is primarily responsible for the development of the Rapid-1 admixture.

Dr. Urs Hussy is Director of Product Management Sika Corporation. He is in charge of project engineering in conjunction with Dr. Blank. Mr. Hussy was involved in the testing program begun in 1995 that was designed to fine tune the product to the US market.

Dr. Farhad Ansari, Ph.D., of New Jersey Institute of Technology, was Principal Investigator for the research and development of concrete mixes for New Jersey highway renovation using Sika Rapid-1 hardening admixture. He worked with Dr. Maher of Rutgers University and NJDOT.

Dr. Ali Maher of Rutgers University is Director of the Center for Advanced Infrastructure Technology (CAIT) at Rutgers University. He and Dr. Ansari worked together on the development and testing of the concrete mix for New Jersey highway renovation using Sika Rapid-1 hardening admixture.

Mr. Todd C. Spindler is Marketing Manager for the Sika Corporation. He made the nomination for the Sika Rapid-1 admixture. He has been promoting the admixture to precast/prestressed manufacturers and played a role in the development and testing of the product in the United States.

Opinions of Outside Persons

Mr. John Rotondo is President of Rotondo Precast (Oldcastle Group) of Fredericksburg, Virginia.

Mr. Rotondo says that his company is using Sika Rapid-1 concrete admixture primarily for prestressed highway bridge beams and slabs. They have been getting good results with the admixture.

Their casting bed is outside and subject to the weather. The Rapid-1 admixture generates enough internal heat that steam curing is not needed, and that cracking due to previously experienced temperature variations is greatly reduced. Rapid-1 allows them to obtain up to 4000 psi strengths in about 12 hours, which permits them to cut the prestress tendons, remove the beam to finish curing, and reset the bed for the next beam. Therefore, there is an increase in their production.

Mr. Rotondo feels Rapid-1 is a good product, but that it depends upon the type of aggregate and cement being used.

Award Manager's Comments

It is difficult to separate the Sika product called Rapid-1 hardening accelerator admixture from a concrete mixture of which it is only one component. The goal of both the admixture and the concrete mix is to create a higher strength, workable concrete in as short a time period as possible. The two are interdependent. One cannot reach the goal without the inclusion of the other.

SELECTED INTERVIEW SUMMARIES
Nomination 9727

Todd C. Spindler, Marketing Manager - Concrete
Sika Corporation
Lyndhurst, NJ 07071
Phone Interview by RB Harris, 10/29/96

Sika Rapid-1 Hardening Accelerator Concrete Admixture changes the concrete strength/gain curve. There is a period for the initial set of the concrete and then the strength rises very rapidly. This material does not lower the ultimate strength of the concrete as do high early strength admixtures. The normal full strength curing takes place after the early strength has been reached.

The product was developed in Sika laboratories overseas over a period of years. It has been in the market in the USA for about 1 1/2 years. The first months in 1995 were devoted to field testing and the product was introduced officially in 1996.

There are two major markets for the product: 1) fast track highway repair and paving, and 2) precast manufacturing. Research on the highway aspects is being carried out at Rutgers University (Dr. Ali Maher) and at New Jersey Institute of Technology (Dr. Ansari). There is an ENR article on the product in the May 20,1996 issue, page 25. Mr. Spindler says that the ENR article is slightly in error in the use of some technical terms. "Accelerator" refers to an initiation of an early set, while "hardening accelerator" refers to the fact the gain occurs after the initial set has taken place.

The large and significant application of the product is in the precast market. Rapid-1 adds heat and therefore decreases the curing time. The product has a relative high heat of hydration. In some instances, the heat may be such that no external heat source is needed.

Spindler says that this is a one-of-a-kind product. He knows of no other like it, but he believes that others are probably looking toward the development of a similar product.

Spindler was asked about the role of others on the nomination. Mr. Noble is Executive Vice President and the development took place under his administration. Dr. Norman Blank had a significant part in the development. Mr. Hussy was involved in the testing program.

It was noted by RBH that there was no mention of a DOT contact. Spindler says that there has been contact with NYDOT and NJDOT but that he does not have names to give me. Dr. Ansari can probably supply them.

Prof. Ali Maher, Director
Center for Advanced Infrastructure Technology
Rutgers University
New Brunswick, NJ 08901
Phone Interview by RB Harris, 11/04/96

Prof. Ali Maher is a graduate of the U of M, BSCE 1977, Ph.D. 1988 in Geotech under Woods.

The Sika Rapid-1 admixture was used on a project funded by NJDOT. Sika was asked to become involved. According to the ENR article, the mix was to be in the public domain. Maher was asked about this. He said Sika has not put any restrictions on it. Sika provided the materials and also provided some assistance in making the tests.

There is a Center for Advanced Infrastructure Technology at Rutgers. This Center is funded by NJDOT, and they work with Rutgers to select research projects. One of the ideas was a need to develop a concrete mixture that would harden quickly so that repair on highways could be achieved rapidly. This would save money. Two research contracts were issued under the Center, one to Rutgers and the other to NJIT. Prof. Ansari of NJIT was the counterpart to Dr. Maher.

The concrete mix has been tried by NJDOT on an interstate project in northern New Jersey. The project is now undergoing field testing.

Dr. Maher refers to Mr. Nicolas Vitillo who directed the project from NJDOT. He is the one that approached Rutgers for the need for this project. He has worked very close with those at Rutgers. His phone is 609-530-5966. Maher thinks I should talk to him.

Maher has worked very close with Ansari of NJIT. Ansari has used innovative instrumentation consisting of temperature gages embedded in the mix to measure curing rates. This mix is unique and involves field testing and curing in the field, not just a lab experiment that produced results. There is a need to use curing blankets to hold the temperature up.

They are now starting a one or two year research project to determine definite properties, curing times, and other conditions needed so that a specification can be written to allow the use of the product. This will again be run through the Center and Dr. Ansari will be the PI. Ansari will also be developing a complete instrumentation package for measuring the curing rate of the concrete.

Dr. Norman Blank, Vice President - Technology
Sika Corporation
Lyndhurst, NJ 07071
Phone Interview by RB Harris, 11/04/96

Dr. Blank is in charge of all R & D in the company, so he said he was knowledgeable about the Rapid-1 admixture. The product was developed for fast-track concreting, that is, to allow accelerated hardening of the concrete so that it can be loaded sooner.

Sika was asked by NJDOT and NJIT to take part in their research. Their main initial interest was with regard to the heat buildup. They worked with Prof. Ansari at NJIT.

Dr. Hussy was in charge of project engineering in conjunction with Blank.

Sika developed the material, that is, developed its chemistry, and also helped in developing the concrete mix.

Asked about the "public domain" comment in ENR, Mr. Blank said that it is not in the public domain. The concrete mix, itself, is public. This means that the type of cement, w/c ratios/ aggregates, installation temperatures, etc. are public, but the chemistry of the product is not. It belongs to Sika. Competitors have tried to come up with a similar admixture but have not yet been able to do so.

Blank says that the mix and the admixture can be adjusted to meet the temperature requirements and other field conditions.

Farhad Ansari, Ph.D., Professor
New Jersey Institute of Technology
Newark, NJ 07102
Phone Interview by RB Harris, 11/07/96

The Rapid-1 system is an answer to the strong need for high early concrete strengths for highway paving. In December 1995, NJDOT approached NJIT for help in this because they anticipated the need to renovate I 295. They wanted curing in about 5 to 6 hours, a material with a modulus of rupture of 300 psi to 350 psi, and a strength of 2500 psi to 3000 psi. NJDOT said they were working with Sika on one of their products and wanted Ansari's group to work with Sika. The time period was short because NJDOT wanted to start the renovation in the Spring of 1996.

Ansari said that they wanted to use Type I cement, normal 3/4 to 1 inch aggregate with a water/cement ratio of .36 to .40. This was to keep things as normal as possible. These goals were achieved with the Rapid-1 admixture, mainly because it is a non-chloride admixture.

Ansari says that what they did was to enhance the curing process by adjusting the amounts of other admixtures, air entraining, etc. and Rapid-1. This resulted in reducing the amounts of other admixtures and increasing the temperature. They found that by holding the temperature of the mix to 70 to 75 degrees F. the concrete would harden after about 2 or 3 hours and then set very rapidly. Curing would then continue in a normal manner and normal maximums would be achieved in 28 days.

Ansari's research focused on the design of the mix. They did a number of typical mix tests using cylinders slumps, etc., and related the strength to the temperature. This was a very practical approach to solve a specific problem. He believes that research can be expanded to the use of different types of cements and chloride bases admixtures (which most of them are). They are planning a new study with NJDOT for a one year project to do this advanced testing and prepare a handbook to tabulate different concretes with admixtures, and temperatures to maintain to get high early strengths. This could be used for many design conditions. The handbook might take longer than the one year, so the contract might be extended. This research will be funded by the Center for Advanced Infrastructure Technology (CAIT) at Rutgers of which Dr. Ali Maher is the director.

I asked Ansari about the material itself. He knows nothing about it as he is not a chemist. They just worked with the use of the product. He referred me to: Diane Hughes of Sika Marketing at phone 201-933-8800, or to Norman Blank, Director of Research at Sika at the same phone number.

Ansari is writing a paper on the application to the prestressing industry. He has just started to address this area, but Sika has worked with the prestressing industry before.

Ansari explained how they relate the temperature to the expected strength through a "maturity factor" From concrete cylinder tests, they developed a temperature/time curve. The area under that curve up to a particular time is the maturity. Then the maturity is plotted against the strength.

John Rotondo, President
Rotondo Precast (Oldcastle Group)
Fredericksburg, VA 22407
Phone Interview by RB Harris, 12/05/96

Mr. John Rotondo is with Rotondo Precast (Oldcastle Group) of Fredericksburg, Virginia. He was given on the nomination as a person familiar with the Sika product.

Mr. Rotondo says that they are using the Sika Rapid-1 Hardening Accelerator Concrete Admixture primarily for prestressed highway bridge beams and slabs. They have been getting good results with the admixture.

The casting bed for beams and slabs is outside and subject to the weather. The use of steam heating for curing has sometimes resulted in cracking due the sharp variance in temperature. The Rapid-1 admixture generates enough internal heat that the cracking is greatly reduced. It allows them to obtain up to 4000 psi strengths in about 12 hours. This allows them to cut the prestress tendons and remove the beam to finish curing. Then the bed can be reused for the next beam. Therefore, there is an increase in their production.

Rotondo says that they use other Sika products and that this one was suggested to them by the Sika representative. He feels its a good product, but that it depends upon the type of cement being used. In some of their other plants, they haven't had as much success. He uses Type III high early cement and his mix contains about 40% blast furnace slag.

His customers are the West Virginia DOT and the Virginia DOT. The admixture is not approved for general use. They have to get special permission on a per-project basis to use it.

Mark Noble, Executive Vice President - Concrete Products
Sika Corporation
Lyndhurst, NJ 07071
Phone Interview by RB Harris, 12/05/96

Mr. Noble doesn't know of the details of the Sika Rapid-1 Hardening Accelerator Concrete Admixture. He is the head of the division and he suggested that I talk to others in the group. He says that they are more familiar with the product itself. He referred me to Mr. Hussy.

Urs Hussy, Director - Product Management
Sika Corporation
Lyndhurst, NJ 07071
Phone Interview by RB Harris, 12/05/96

Mr. Urs Hussy was asked about the development of the product itself, apart from its uses. He said that the product was developed in Switzerland. The world headquarters of Sika is in Switzerland, and they do the R&D on new products there.

Hussy says that the ideas for new products come from either of two sources: one from the market, and the other from basic research developed from the R&D laboratory. He doesn't know how Rapid-1 began. He will call his colleagues in Switzerland and get back to me next week.

Hussy was involved with the testing of the product in the US beginning in 1994. They did most of the application testing in 1995 to fine tune the product to the US market. Most of this was field testing.

Urs Hussy, Director - Product Management
Sika Corporation
Lyndhurst, NJ 07071
Phone Interview by RB Harris, 1/6/97

Dr. Hussy has been in contact with Sika AG in Zurich, Switzerland. He says that the Rapid-1 admixture was developed by a special department within the company R&D division. Dr. Urs Maeder is the head of the Department of Admixtures for Concrete. Members of Dr. Maeder's group actually did the development, but Dr. Maeder was responsible for it. Dr. Maeder's phone is: 011-41-1-436-4040 and his FAX is 011-41-1-432-8609.

The product is patented in Europe and in the USA. Rapid-1 has been widely accepted in Europe and has spread worldwide.

The reason for the development was to replace calcium chloride in concrete. For a long period of time, calcium chloride was the only way to achieve high early concrete strengths. The use of calcium chloride adds chlorides to the concrete and may cause the reinforcing steel to corrode. Calcium chloride has a temperature range for its use from about 0° - 15° C. Rapid-1 can be used in a range from about 0° - 40° C, yet it is comparable to the use of calcium chloride in lower temperature ranges.

EXHIBITS

SIKA CORPORATION
products/systems/services...worldwide

November 27, 1996

Professor Robert B. Harris
Department of Civil Engineering
University of Michigan
2350 Hayward Avenue
Ann Arbor, Michigan 48109-2125

RE: NOVA Award Nomination
Sika Rapid-1

Dear Professor Harris,

Thank you for assistance with Sika's nomination for the 1997 NOVA Awards. We are honored to be a part of the program, and appreciate the efforts you and your peers put into the selection process.

As per your request, I am including additional information about our Sika Rapid-1 *hardening accelerator* concrete admixture. I found it difficult, however, determining what type of information would best meet your requirements, and am therefore providing twelve copies of assorted information:

Sika Rapid-1Technical Data Sheet: General information provided by Sika.

Sika Bulletin - New Jersey Highways: An overview of the hardening accelerators use and testing.

ENR excerpt: An independent review of Sika Rapid-1.

Civil Engineering News excerpt: An independent review of Sika Rapid-1.

NJIT/Rutgers University Preliminary Report: An initial report of the New Jersey DOT research project.

Transportation Builder excerpt: A Sika press release providing a product use overview.

Business Week excerpt: An independent review of innovation.

I have provided these copies individually so that you may preview the information and forward only what you feel is appropriate; I've also duplicated this letter if you feel it should be included.

If there is any other information you would like to review, please feel free to contact me or any of the other references listed on our nomination form. We are excited to be included in the final review, and look forward to your recommendations!

Sincerely,
SIKA CORPORATION

Todd C. Spindler
Marketing Manager - Concrete and Underground Construction

TS10/harris1.doc

Sika Rapid-1®

ISO 9000

Non-chloride, hardening accelerator.

DESCRIPTION

Sika Rapid-1 is a non-chloride hardening accelerator. Sika Rapid-1 contains no calcium chloride or any other intentionally added chlorides and will not initiate or promote the corrosion of reinforcing steel present in the concrete.

Sika Rapid-1 meets the requirements of ASTM C-494 Type C accelerating admixtures, and AASHTO M-194 Type C.

APPLICATIONS

HIGH EARLY STRENGTH CONCRETE:

Sika Rapid-1 delivers excellent results in normal and hot weather conditions where very high early strengths are required.

Conventional accelerators promote early stiffening of the concrete, making it unworkable within a short period of time. Sika Rapid-1 is designed for applications where early stiffening (slump loss) is not desirable but high early strengths must be obtained within a specified time.

Benefits

- ▲ Early stripping and re-use of forms.
- ▲ Faster finishing operations on flatwork surfaces.
- ▲ Earlier post-tensioning.
- ▲ Effective with Type I/II/III cements.

PRECAST CONCRETE:

Sika Rapid-1 delivers excellent results for precast concrete when high early strengths are required. Curing times are significantly reduced while concrete quality is improved.

Benefits

- ▲ Use as a replacement for steam curing to save energy costs.
- ▲ Increase early strengths and allow faster rotation of molds to increase production per day.
- ▲ Use as a replacement for Type III cement.

COLD WEATHER CONCRETING:

Sika Rapid-1 is an effective hardening accelerator where high early strength concrete is desired and the use of calcium chloride is prohibited.

Benefits

- ▲ Insulation and heating costs for curing time are reduced.
- ▲ Earlier stripping and reuse of forms increases labor productivity.
- ▲ Accelerated strength gain allows earlier structural use and speeds completion time.

Placing concrete in freezing conditions:

When used at Sika recommended dosage rates, Sika Rapid-1 may reduce the need for cold weather concreting practices as specified in ACI 306 - Standard Specification for Cold Weather Concreting.

Field evaluations should be carried out when concrete is to be placed in freezing conditions to determine the minimum ambient and concrete temperatures required, and the optimum dosage for the desired setting time and strength performance. Sika strongly recommends that appropriate sound curing practices be followed to protect fresh concrete from excessive heat loss in extreme weather conditions.

HOW TO USE

DOSAGE

To promote high early strength Sika Rapid-1 may be used at the rate of 4-48 fl. oz. per 100 lbs. (390-3120 ml/100 kg) cement.

When used to protect concrete from freezing, dosage will vary with different brands of cement and ambient temperatures and higher dosages may be necessary. Sika recommends that trial mixes be performed to determine the most efficient dosage. Contact your local Sika representative for information and assistance.

USE WITH OTHER ADMIXTURES

Sika Rapid-1 performs well in combination with other admixtures such as non-retarding water reducers, high range water reducers and air entraining agents.

Do not mix Sika Rapid-1 with expansion agents or shrinkage compensating agents.

MIXING

Add correct amount of Sika Rapid-1 at the concrete plant or into ready mix truck at the job site. The admixture may be added manually or by automated dispenser directly into the sand or into the water line at the batch plant.

When used in combination with other admixtures care must be taken to dispense each admixture separately into the mix. Do not mix with dry cement.

CONCRETE FINISHING AND CURING:

Finish and cure Sika Rapid-1 concrete in accordance with sound concreting practices as specified in ACI 302 and 308. For placement in sub-freezing temperatures, Sika Rapid-1 may be used to speed finishing and curing times per ACI 306 - Standard Specification for Cold Weather Concreting.

PACKAGING

55 gallon (208 liter) drums and bulk delivery.

STORAGE AND SHELF LIFE

Sika Rapid-1 will begin to freeze at 25°F (-5°C). If frozen, thaw slowly and agitate thoroughly to return to its normal state before use.

Shelf life when stored in dry warehouse conditions between 50°F and 80°F (10°C-27°C) is one year minimum.

TYPICAL DATA FOR SIKA RAPID-1	
COLOR/APPEARANCE:	Reddish-violet liquid
SPECIFIC GRAVITY:	1.17 ± 0.05
pH:	>7
CHLORIDES %	<0.1

Bulletin

Sika Rapid®-1 Keeps New Jersey Highways Open

The New Jersey Department of Transportation has successfully evaluated Sika Rapid-1 in a progressive study on the development of high early strength concrete for roadway repairs. As part of the research project, the State commissioned the New Jersey Institute of Technology and Rutgers University to design a concrete mix that would consistently reach 3,000 psi compressive strengths (300 psi flexural strengths) in 4 to 6 hours. The use of such a concrete will allow the Department of Transportation to remove, replace, and re-open full depth concrete roadway repair areas in under 12 hours (overnight). To date, each successful installation used Sika's patented Rapid-1 *hardening accelerator* in the concrete.

One of the State's guidelines for a new concrete mix was an easy to produce design using readily available materials. The NJDOT's new designs use standard cements and aggregates (Figure 1). In addition to the use of a HRWR, a hardening accelerator is incorporated to provide the high early strengths. Unlike a set accelerator, a hardening accelerator does not cause an early set of the concrete, but dramatically increases strength gain *after* the concrete's initial set (Figure 2). For the installation crew, this means placement of the concrete can continue as usual without concern for flash setting, early stiffening, or slump loss. Additionally, hardening accelerators do not reduce ultimate strength, making them an ideal choice for

Example Mix Design

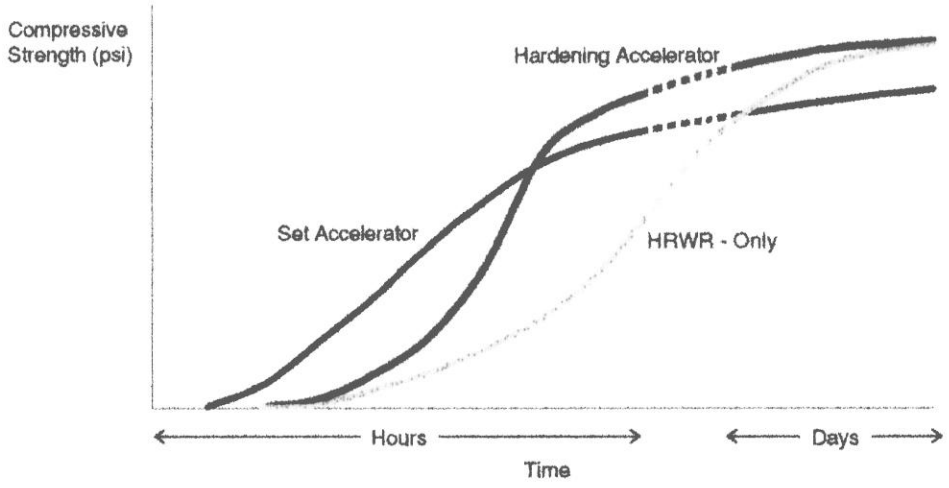
Cement Type I* (lbs.)	799
Water (lbs.)	312
Coarse Aggregate (lbs.)	1800
Fine Aggregate (lbs.)	1200
Air - Sika AER (fl.oz./cwt.)	0.8
HRWR - Sikament 86 (fl.oz./cwt.)	12
Sika Rapid-1 (fl.oz./cwt.)	30
W/C Ratio	.39

* Essroc Type I

One of the New Jersey Department of Transportation Field Trial Mixes for High Early Strength Concrete.

Figure 1

design engineers. The referenced NJDOT mix therefore uses conventional materials and placement procedures for unconventional strength gain!

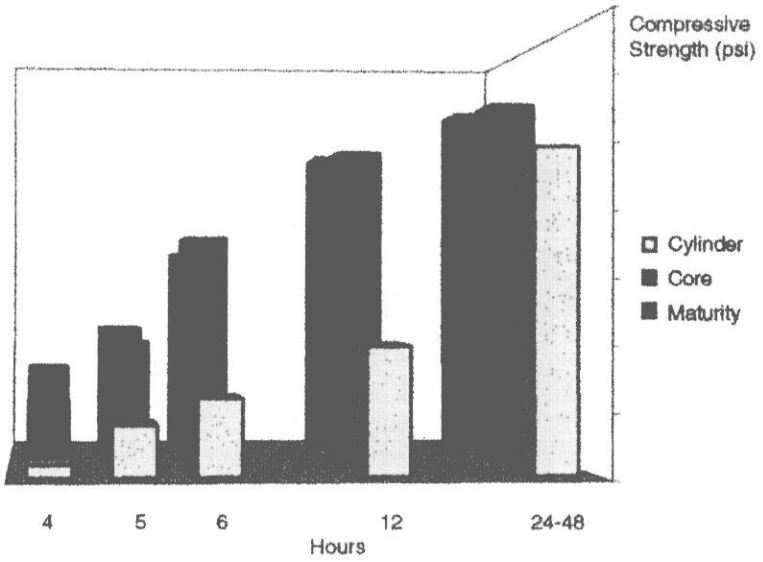


Compressive Strength Comparison:

Hardening Accelerators initiate rapid strength gain after the initial set period. The time and compressive strength values will be altered by mix designs and Hardening Accelerator dosages.

Figure 2

In order for the state to determine just how soon concrete with Sika Rapid-1 could be opened to traffic, researchers developed maturity curves for their specific mix designs. Maturity curves are graphs that relate strength gain to a combination of both time and temperature. These graphs are helpful because they allow a more accurate prediction of the in place concrete's strength gain. Compressive strength gain of test cylinders, however, can be much slower than actually achieved in a slab with a greater thermal mass; this is particularly noticeable when using a hardening accelerator (Figure 3). By using maturity curves, roadways can be confidently opened in under 6 hours, whereas test cylinders may require 8 to 12 hours (or more) to arrive at the specified minimum strength.



Comparison of Compressive Strength Indicators

Maturity curves are good indicators of the in place concrete's actual strength, as verified by cores. Test cylinders may suffer from a lack of the slab's thermal mass, and therefor indicate lower strengths for the first several hours.

Figure 3

With mix designs and maturity curves developed and tested, the NJDOT can now specify 12 hour lane closures for removal and replacement of deteriorated concrete roadways and joints, with freshly poured concrete ready for traffic or paving operations in 4 to 6 hours. In a recent demonstration for State authorities, Sika Rapid-1 was specified for full depth joint repairs on I-295 in Woodbury, New Jersey. All admixtures, including the hardening accelerator, were added at the plant prior to the 30-45 minute transport time. The concrete remained workable for nearly 90 minutes, and was ready for traffic within the 6 hour window (Figures 4 and 5).

Concrete Properties

Ambient temp. (°F)	60-70
Concrete temp (°F)	70-80
Slump - batched (in.)	8
Slump after 45 min. transport (in.)	4-6
Air Content (%)	5.5-8

Four Pours: May 16, 1996, I-295, Woodbury, New Jersey.

Figure 4



Concrete with Sika Rapid-1 remained workable after 45 minutes of transportation time.

Figure 5

Sika Rapid-1 is a revolutionary non-chloride concrete hardening accelerator offering very early high strength concrete for roadway repairs, fast track floors, or precast elements, without sacrificing workability and ultimate strength. For more information, contact your local Sika Representative or call (800) 933-SIKA.

ENR
Engineering News-Record

MAY 20, 1996 A PUBLICATION OF THE McGRAW-HILL COMPAI

ACCIDEN
to fatal

ARCHITE
agenda

ENVIRON
pulls plu
after tir

THE TO 40 CONTRAC

Will the good tin

► TOTAL F

► INTERNA

► GENERA

Paving

TRAFFIC BACK IN ALMOST NO TIME

RESEARCHERS AT THE NEW JERSEY INSTITUTE of Technology say they have developed a public-domain recipe for fast-curing concrete pavement that is generally simple to mix and ready for road traffic in six hours or less instead of the more common 24 to 48 hours.

Others make similar claims, says Ali Maher, civil engineering professor at Rutgers University, New Brunswick, N.J., and a codeveloper of the mixture. But Maher says there is nothing else that satisfies the requirements of the New Jersey Dept. of Transportation, which funded the research under a $25,000 contract with Rutgers and a $85,000 contract with the New Jersey Institute of Technology, Newark, through NJDOT's Bureau of Research, Trenton.

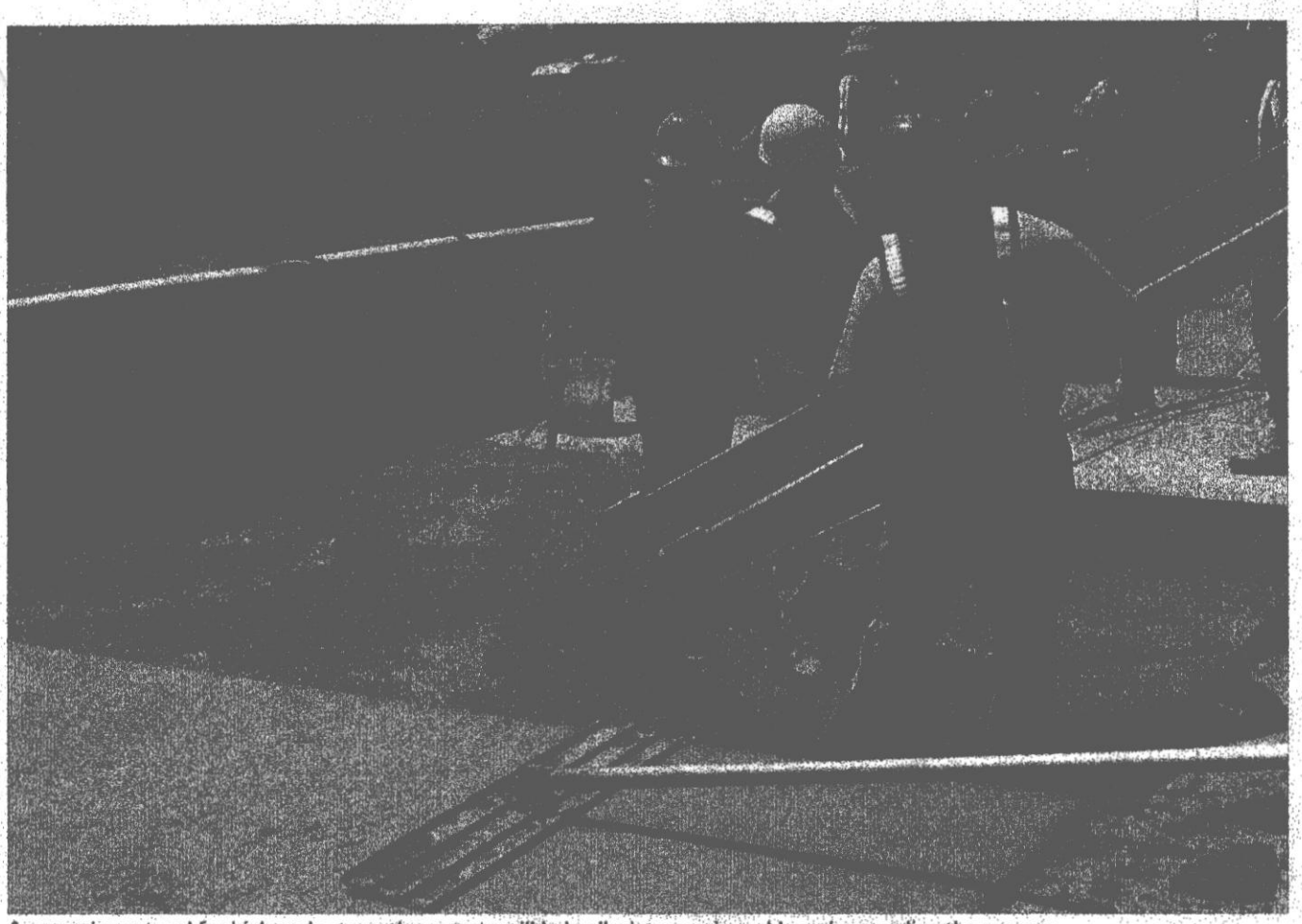
The mixture reaches a flexural strength of between 250 and 300 psi, and a compressive strength of between 2,500 and 3,000 psi in less than six hours on the way to its ultimate strength of 4,000 psi. The concrete is appropriate for full-depth repair of jointed concrete slabs with or without bituminous overlay.

"Actually, it's not just a mix design, but a procedure," says Farad Ansari, civil engineering professor at NJIT. Unlike proprietary quick-setting formulas, the new mixture starts with Type I cement and 1-in. nominal aggregate, which most suppliers have on hand. Then superplasticizers, an air-entraining admixture, and a nonchloride-based accelerator are added, and the mix is quickly covered with a blanket. "The key to early strength is to have enough temperature," adds Ansari. "Air temperature must be at least 23° Centigrade, or it must be made with hot water."

The researchers connect a laptop to heat-sensing thermocouples that are embedded in the slab. By plotting temperature changes relative to the elapsed time, the researchers can determine the maturity of the slab. No test cores are necessary.

The eight-month project runs until the end of August. After the team finished laboratory tests, they poured 10-ft-square slabs in a ready-mix yard. And on May 15, NJDOT poured a test slab on Interstate-295. "We're going to do the pour, leave it covered for six hours, pull the blankets and open it for traffic," said Ansari at press time, in anticipation of the event. ❑

By Matthew Phair



A new mix protocol for high early strength concrete will help alleviate repair problems by speeding the process.

Concrete mix expedites road repairs

NEWARK - When people leave work and the only thing that lies between them and home is a stretch of highway, the last thing they want to encounter is a road cluttered with orange cones, noisy machines, and construction workers. The delays caused by roadway repairs are the most common source of aggravation for motorists. We won't even get into the headaches experienced by municipalities who are forced to come up with funding for all the road rehab work.

But a new mix protocol for high early strength field concrete developed for the New Jersey Department of Transportation at the New Jersey Institute of Technology (NJIT) in conjunction with the Sika Corporation should help alleviate the frustrations engendered by highway construction projects. It allows repairs to be completed within hours rather than days and is said to be more cost-effective than conventional mixes.

A typical concrete mix necessitates at least 28 days to reach its full strength potential. But the new mix, which is designed for full-depth repair of jointed concrete slabs and restoration prior to bituminous overlay, can achieve flexural strengths of 300 psi and compressive strengths of 2,500 psi within four to six hours, according to researchers.

"That means they can close the roads around eight at night, when the traffic is relatively slow, pour the concrete, repair the highway and open it back up the next morning," said NJIT's Farhad Ansari, Ph.D.

Ansari explained that in developing the mix, he used all the constituents of normal concrete with one exception: the water-to-cement ratio was higher than usual.

"That ratio for high-strength concrete is typically low. But [in this mix] it was not abnormally low because we wanted to make the concrete very workable so that the crew could place it," he said.

One of the admixtures that Sika provided to fulfill the aim of workability was a strength accelerator, a non-chloride based mixture that will not corrode reinforcement bars.

According to Ansari, what differentiates this concrete from similar mixes is the time element.

"Every state tries to come up with some sort of fast-track concrete," he said.

"But no one has done anything less than 12 hours. And once they achieved just that, either the concrete was very hard to work with or they have not gotten the same level of strength we have."

The time-curtailing aspect of the mix translates into cost savings as well.

"The cost savings come from the rapid process of putting it on and opening traffic," stated Ansari.

Currently, the high early strength concrete is not available on the market, but Ansari expects that it will be in the near future.

"We are talking about writing specifications for it," he said. In addition, NJIT will present it to the Transportation Research Board in January of next year. ■

HIGH EARLY STRENGTH CONCRETE FOR FAST TRACK CONSTRUCTION AND REPAIR

A JOINT NJIT/RUTGERS REPORT

Submitted to the
New Jersey Department of Transportation
Bureau of Research

March 29, 1996

New Jersey Institute of Technology, Rutgers University, the New Jersey Department of Transportation along with the cement, and admixture industry, namely: Sika, Master Builders, Euclid and Essroc have been cooperating to develop a "Fast Track" concrete for full-depth repair of jointed concrete slabs, and restoration prior to bituminous overlay. The goal has been to develop a mix that would produce a flexural strength of 300 to 350 psi, corresponding to a compressive strength of approximately3000 psi, within 4 to 6 hours. As part of the quality control for this mix the maturity of the concrete, essentially the time-temperature product during the curing process has been studied. The maturity method will be employed by NJDOT for quality control during the first implementation stage at I-295 in Salem County. We are pleased to report successful achievement of the above-mentioned goals.

To date, NJIT has studied 14 batches, 4 using Master Builders, and 10 using Sika products. These batches have produced three candidates, design weights for these mixes are shown in the appendix. On the margin, Master Builders mix using type III cement reached the target flexural strength in 7 hours. This mix comes close to the strength target but also had a 3.5 inch slump and a 4.5% air content. Perhaps an adjustment in the air content would also bring the slump to acceptable values. A little more work needs to be done on this mix. The best candidate is a Sika mix used successfully in three batches using a type I cement. A modification of this mix serves as the basis for SK11 batch to be mixed at Rutgers (on 3/29/96). This mix has consistently yielded the target flexural strength within 6 hours in laboratory specimens. These mixes have consistently yielded slumps in the 6 to 8 inch range and air contents of 6%. One day strengths are in the 5200 psi range with 28 day strengths at 7000 psi. One day shrinkage was measured to be 0.04% and 28 day shrinkage at 0.09%. Chloride permeability tests are underway. Today's SK11 batch has the cement content reduced to 700 lb./cyd and additional Sika Rapid 1 hardening accelerator. The final candidate is a Sika mix that used a Allentown type I/II cement. This mix achieved a compressive strength of 2800 psi in just over 5 hours. As this was a field trial at the Mt. Holly batch plant, only the compressive strengths and maturities were recorded. More study of this mix is required.

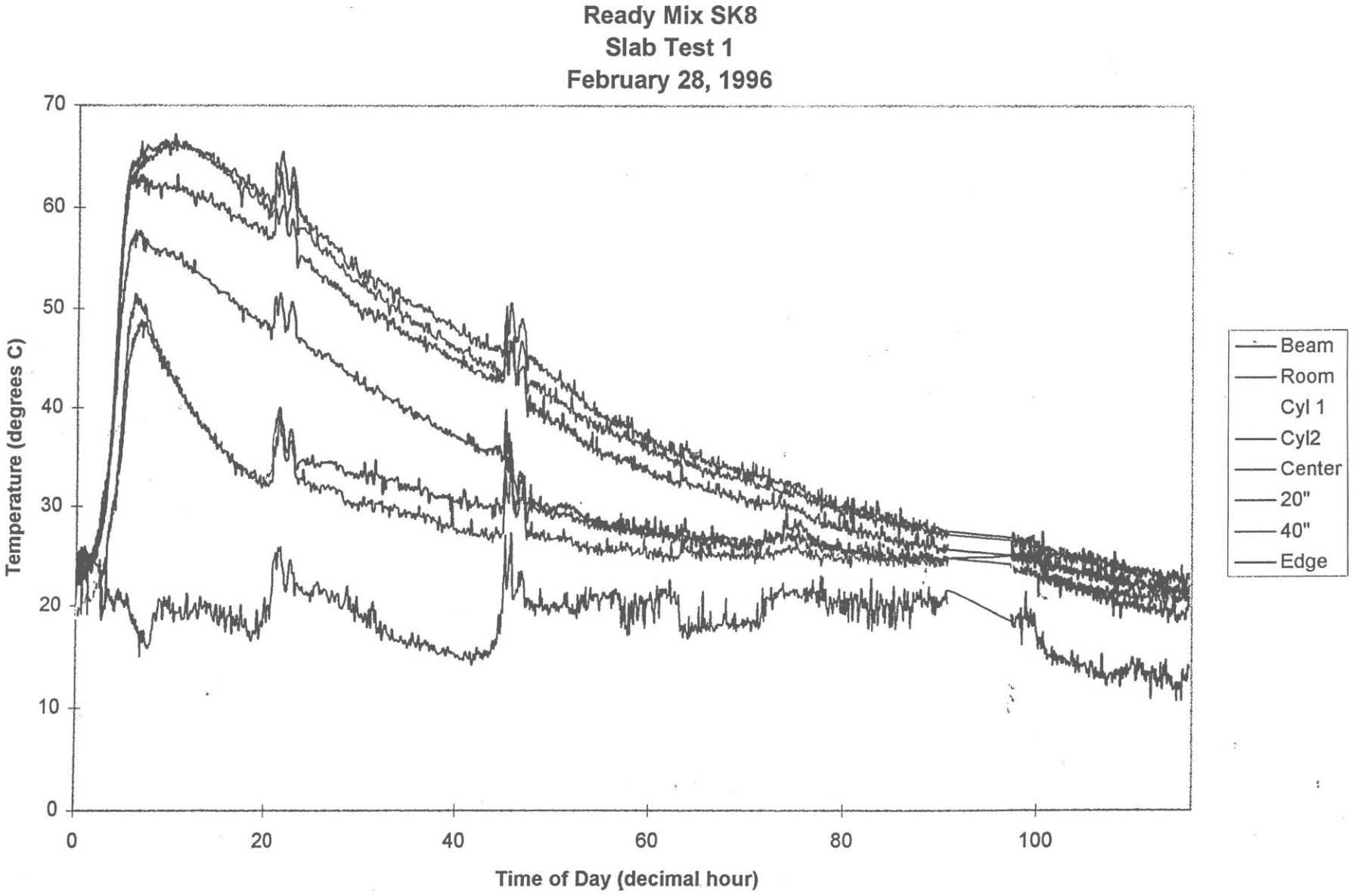
The principle of the Maturity Method is that for a given concrete mix at a particular maturity, the adjusted time temperature product, will have a corresponding strength. It does not matter how this product is reached, that is whether time or temperature is increased, For a given maturity a particular strength can be predicted. This method was developed by the pre-stressed concrete industry and has also found application in construction aiding in the earliest possible removal of formwork. It is hoped that this principle can be used to restore traffic to repaired highway segments as soon as practically possible. By measuring the maturity and then conducting a compressive strength test on a test cylinder for conformation, it is thought that normal loads can be placed on the highway slabs with confidence that they will carry the loads after relatively short periods of time. To this end, the temperature of test cylinders, beams and, when possible, test slabs were measured by inserting thermocouples into the specimens and monitoring using a multi-channel portable computer data acquisition system developed at NJIT. A plot of the SK8, NJIT slab 1, shows the results. The strength of samples from the same batch, kept under the same conditions, were tested at various times noting the maturities. In the SK8 experiment, at a maturity of 115 degree-hours a compressive strength of 2200 psi was predicted using the composite SK6, SK7 and SK8 maturity curve included in appendix . A cored sample yielded a compressive strength of 2300 psi. A normal test cylinder tested at 116 degree-hours had a compressive strength of 2860 psi for the same batch half an hour later.

An analysis of the relationship between compressive strength and flexural strength shows good agreement to the standard ACI expression. A plot of the regression analysis is included in this package.

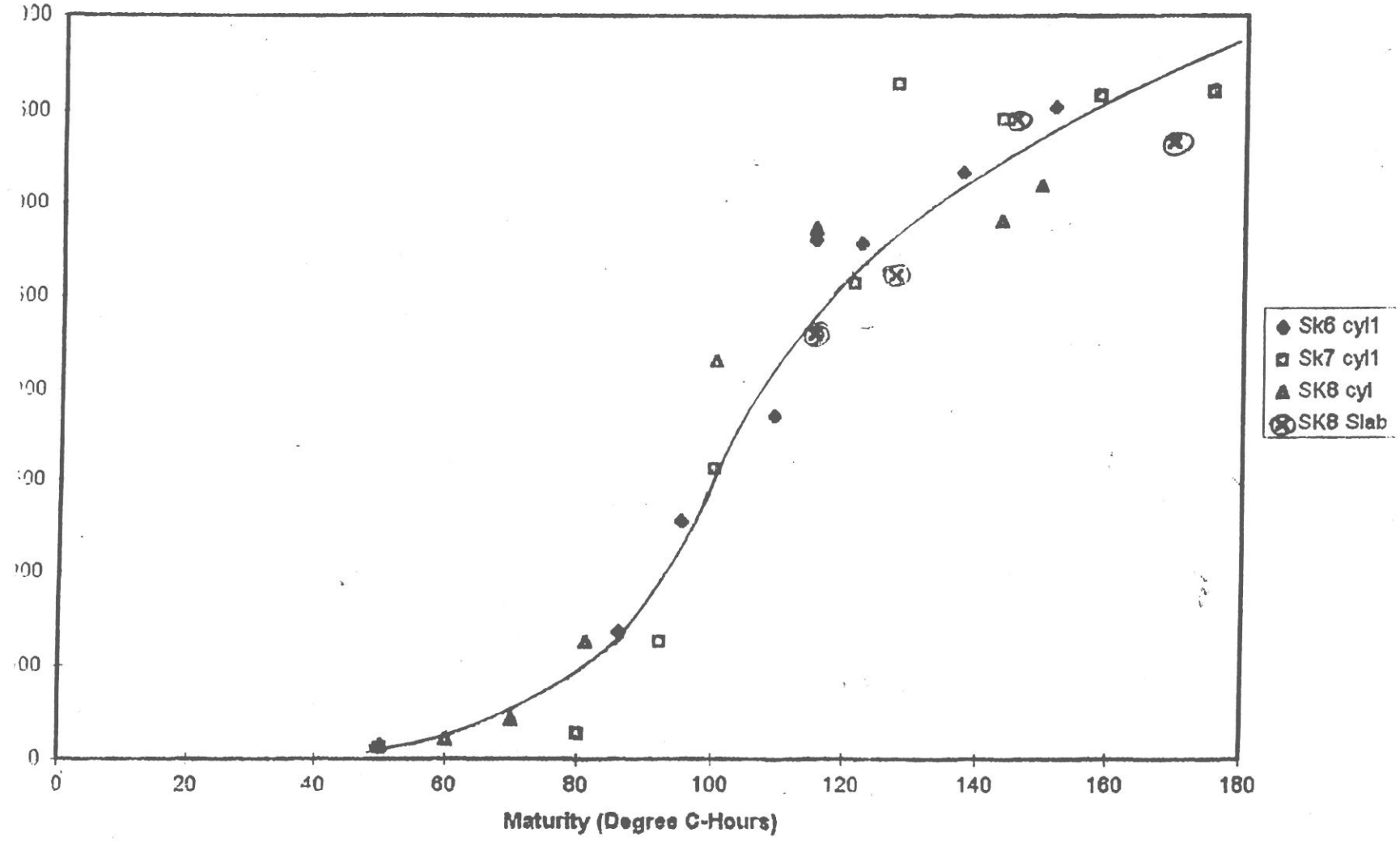
Today's tests (3/29/96) are intended with slight changes to the mix, namely a reduction to cement content (700 lbs/cyd) and an increase the amount of hardener. Reducing the cement is meant to make the mix more economical. The increase in the hardener is meant to speed even further the speed of the strength gain. The mix is modified as a consequence of these changes, and this will in turn results in a modified maturity curve. The maturity curve for SK6, 7 and 8 will be used as a basis for performing the test but it is hoped that a shift similar to that seen in the curves for SK 4, 5 and 7 will

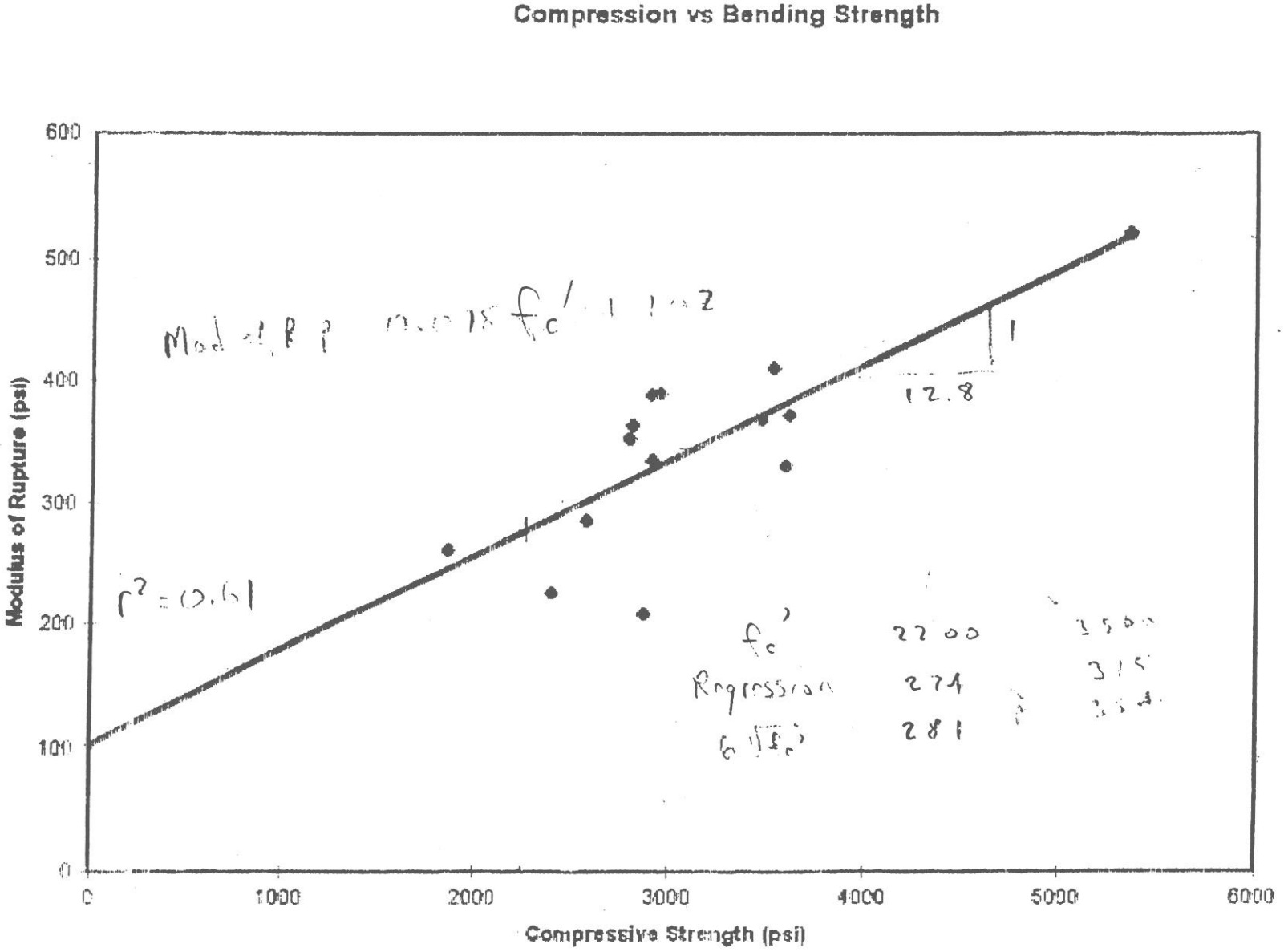
be seen. We are also hoping to be able to actually test the flexural strength of the slab by extracting beam samples from the slab. We also hope to learn a little more about the temperature gradient through and across the slab.

	Sika Type I Mix	Sika Type I/II Mix	Sika Rutgers Mix	Master Builders Typ Mix
Cement (lbs.)	799	799	700	799
Water (lbs.)	312 (0.39)	312 (0.39)	274 (0.39)	283 (0.35)
Coarse Aggreate (lbs.	1800	1800	1800	1750
Fine Aggregate (lbs.)	1200	1200	1200	1170
Sikament 86 (oz/cw)	12	12	12	
Sika Rapid 1 (oz/cw)	30	45	40	
Siak AER (oz/cw)	1.3	1.3	1.3	
Pozzutec 20 (oz/cw)				90
MBEA (oz/cw)				3

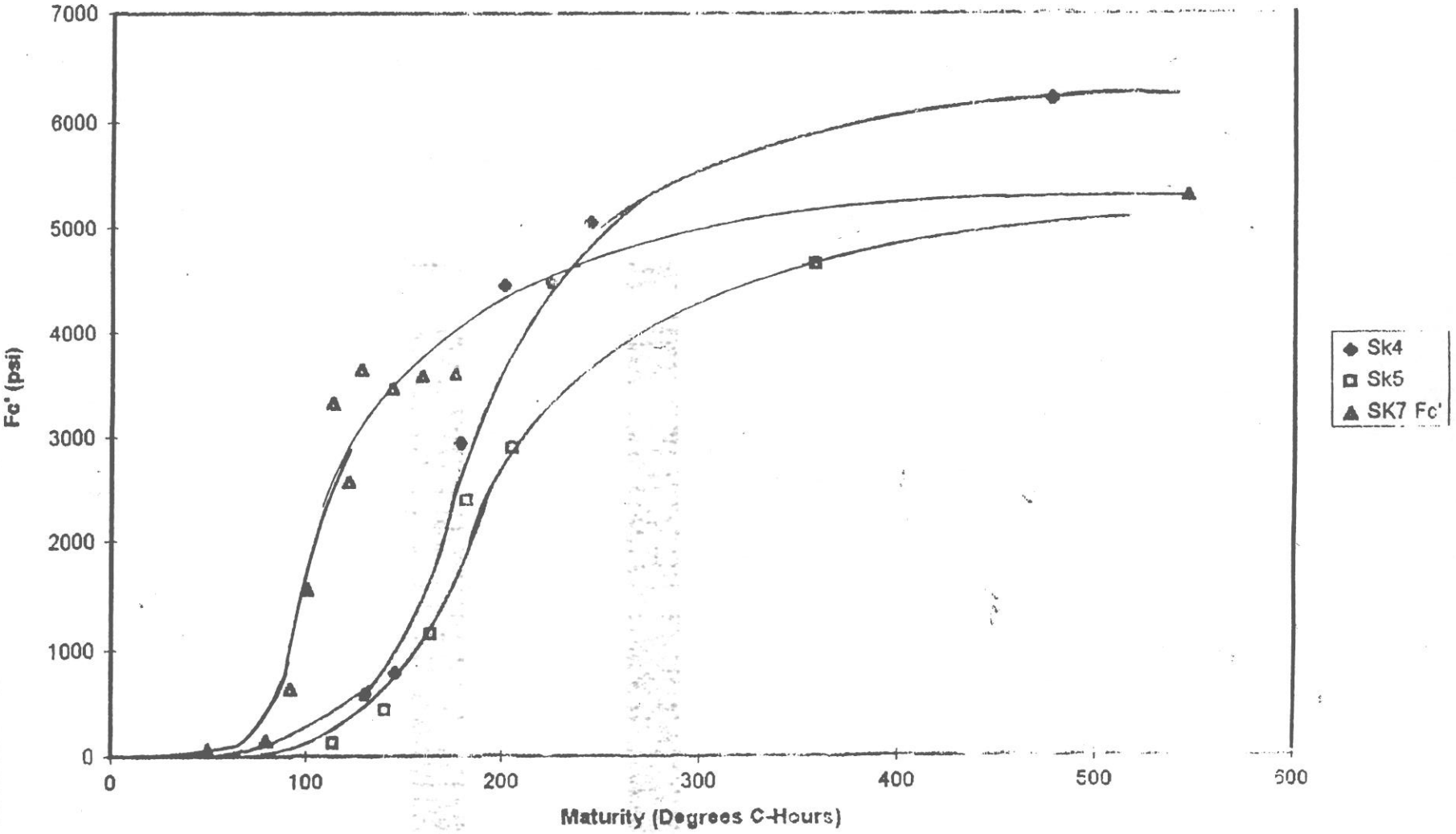

Ready Mix SK8
Slab Test 1
February 28, 1996
Temperature (degrees C)
70
60
50
40
30
20
10
0
0
20
40
60
80
100
Time of Day (decimal hour)
Beam
Room
Cyl 1
Cyl2
Center
20"
40"
Edge

Sk6, Sk7 and Sk8 Maturity Curves
February 1996




Compression vs Bending Strength
Modulus of Rupture (psi)
Compressive Strength (psi)
600
500
400
300
200
100
0
0
1000
2000
3000
4000
5000
6000
12.8
1
$r^2 = 0.61$

Fc' Maturity Curves Sk4, Sk5, Sk7
Feburary 1996



INSIDE: CADD/GIS Makes Impossible Deadlines Possible

Transportation BUILDER®

OCTOBER 1996

OFFICIAL PUBLICATION OF THE AMERICAN ROAD & TRANSPORTATION BUILDERS ASSOCIATION

1996 TRANSPORTATION CONSTRUCTION PRODUCTS SOURCEBOOK

Patented Fast Track Concrete Opens Roads Sooner

Concrete road and bridge repairs, often responsible for significant traffic delays and road closures, can now be completed overnight!

Sika Rapid-1, a patented concrete hardening accelerator from **Sika Corp.**, Lyndhurst, J.J., provides the strength gain necessary for high early strength concrete mixes to be ready for traffic in four to six hours.



Concrete typically requires several days to develop strengths safe enough for traffic.

Full depth replacement of concrete joints and restoration of roadway surfaces for traffic or paving operations therefore require extended lane closures.

Sika Rapid-1, however, is a new non-corrosive concrete admixture that allows mix designs to develop 3,000 psi compressive strengths and 350 psi flexural strengths in just four to six hours.

This unique hardening accelerator works with standard concrete components (including Type I cements), making the final mix affordable and easy to produce.

Initial handling of the concrete is unaffected, allowing placement and finishing without early stiffening.

Shortly after the concrete is set, however, Sika Rapid-1 initiates a rapid strength gain resulting in permanent, full depth concrete placements that can be poured in the evening and ready for early morning rush hour!

Bulletin

The May 20th, 1996 edition of Business Week includes this feature on Sika Rapid-1:

Developments to Watch

EDITED BY NEIL GROSS

IT'S A HARD, HARD ROAD

CONCRETE TAKES SO LONG TO HARDEN COMpletely—28 days, for a standard formula—that road-repair crews tend to fall back on less durable patching materials. New Jersey's Transportation Dept. wanted concrete that could be poured after the evening rush hour and be ready by the next morning. So it challenged suppliers.

The winner: Sika Corp., the Lyndhurst (N.J.)-based U.S. arm of Sika AG, in Zurich. Its mixture, Sika Rapid, hardens concrete made from standard cement so quickly that it can support normal traffic in six hours. That means it can withstand a compressive force of 2,500 to 3,000 pounds per square inch and a flexing strength of 300 to 350 PSI. And it keeps hardening after that.

The Swiss formula was tested with the New Jersey Institute of Technology, Rutgers University, cement supplier Essroc of Nazareth, Pa., and Redy-Mixt Konkcrete of Woodbury, N.J. It's being road-tested this spring.

Peter Coy

FOR FURTHER INFORMATION: Go to Business Week Online at America Online or E-mail dtwmay@businessweek.com