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# History of Interstate Paving In Iowa

## Manatt's Paradigm

Project Report #19

May, 1995

In the annals of Iowa history, 1993 may be known as the year in which new records were set for the coldest average annual temperature in recent times, the wettest 12 months since data was kept (which reduced crop yields statewide by over 25%), the most devastating summer of flooding across the entire Midwest in terms of property loss and, notwithstanding such adverse conditions, some of the finest highway reconstruction yet performed on Interstate 80 between Des Moines and Davenport.

Before describing these state-of-the-art Portland cement concrete inlay paving projects, we should review the circumstances under which such activity became necessary.

### IOWA'S INTERSTATE HIGHWAY NETWORK

There were 400,000 motor vehicles and 67 miles of paved roads in Iowa in 1920. The legal speed limit was 30 miles per hour. No buses or freight-hauling trucks operated over rural highways. However, by 1930 the number of vehicles had doubled, speeds were increasing and bus-truck traffic became substantial. From 1930 through 1940, the primary system grew to 5,208 miles of paved roads as a response to the public demand for all weather highways that followed from "Lincoln Highway" and "seedling mile" incentives.

From the post-World War II era up to 1960, huge wartime savings created an insatiable demand for consumer products, including automobiles and trucks. Iowa vehicle registrations grew by 36 and 55 percent respectively. As road wear and the ravages of age took their tolls, the structural condition of both state and national highway systems worsened.

In the Federal Aid Act of 1956, Congress established a National System of Interstate and Defense Highways totalling 42,500 miles that was expected to meet traffic service requirements anticipated in 1975. This program was financed through a national trust fund composed of fuel taxes and user fees. Construction costs of the allocated Interstate route segments were divided on a 90-10 percent federal-state matching ratio. Thus began the most extensive public works program ever accomplished in the United States.

In Iowa during this pre-1960 era, state legislation was enacted to meet transportation demands generated by an exploding economy. Greater maximum weights and width limits for trucks were permitted. Increases to 18,000 pounds per axle or 32,000 pounds on a tandem axle and gross weights up to 73,280 pounds became the standard. A Farm-to-Market road network was established, bridge widths were expanded and design criteria modifications were adopted. In 1955 the Mason City Gazette editorialized "that the task of estimating future road needs calls for an imagination that just doesn't seem to be present in the human animal. Accurate forecasts are difficult when economic and social conditions rapidly change, weather cannot be controlled and heavy traffic wears out the pavements." As early as 1920, Iowa's Chief Engineer Fred White expressed his frustration when saying, "By the time we get the roads paved, the first of them will be worn out and we will be ready to start again. So let's go forward into it with our eyes wide open that we are starting something that we shall never finish!" The problems confronting highway officials in subsequent years has supported the wisdom of those words.

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During the early 1950's, eastern states found that property taxes and vehicle license/user fees were insufficient to meet all construction demands. By establishing a network of toll roads initially financed through sale of revenue bonds and to be repaid from toll charges, four- lane superhighways between major metropolitan areas could be quickly developed. Iowa soon realized that a tremendous increase in traffic would result on our already overburdened roads so in 1954 the General Assembly authorized a feasibility study for an east-west, four-lane, limited access highway across the state. On completion of that study, its conclusion was "that construction and operation of a toll road across Iowa including a new Mississippi River bridge near Davenport was economically feasible by 1959, if located via Iowa City, Newton, Des Moines, Atlantic and Council Bluffs."

Under a separate Toll Road Authority created in 1955 for the purpose of constructing and operating the road, work on its location and design was commenced. When Federal funds for the Interstate Highway System became available in 1957, Iowa abolished their Authority and transferred all responsibility to the Iowa State Highway Commission which promptly awarded $13 million in construction contracts by using its predecessor's engineering.

With no fully modernized highway segments in existence that could be incorporated, the state started from ground zero to design, acquire right-of-way and build the authorized 710 mile Interstate system. Closing the 56.5 mile gap between Grinnell and Iowa City in 1964 was probably the most spectacular effort that Iowa had seen in a half-century of road building because it completed all 168 miles of I-80 between Des Moines and Davenport in six years. From Des Moines on I-35, 36 miles were finished to Osceola plus 25 miles to Ames. To the west 41 miles were opened between Dexter and Atlantic, and an added section on I-29 from Onawa to Sioux City was placed in service. Work continued on I-235 (the Des Moines Freeway) as well as peripheral segments bypassing Davenport and Council Bluffs. By the close of 1968, operationally independent major segments existed across Iowa on I-80, on I-29 from Council Bluffs to Sioux City and on I-35 from Des Moines to Blairsburg.

In 1969 supplemental mileage was allocated to Iowa for an Interstate route between Iowa City and Waterloo, and a new Missouri River bridge at Sioux City.

On November 7, 1976, some six months ahead of schedule, Iowa opened to traffic the last section of the original 710 miles, and on September 12, 1985 its entire 72 mile supplemental route, thereby completing all Interstate highways in Iowa.

**BUILDING THE SYSTEM**

Among the 1956 conditions for earning the 90 percent federal aid participation, states were required to tailor their Interstate structural designs for interchange geometrics, embankment slopes, drainage features and pavements to engineering standards adopted by the Bureau of Public Roads. In a sense, optional choices were catalogued by type from which the contracting authority could select its preference, providing it accommodated traffic loadings and volumes projected for 20 years in the future, and initial costs were estimated to be lowest. Although modified as conditions warranted and experience dictated, basic criteria also included bridge vertical clearance, shoulder widths and type and median width and depth.

In Iowa the preferred pavement type was Portland cement concrete (PCC) because of its predictable performance, load bearing ability and availability of durable aggregates. With the exception of only six sections totalling 73.4 miles that were built with full-depth asphalt, all other initial Interstate routes spanning 708.8 miles were PCC.

During the early years of this national construction effort, highway engineers, agencies and associations joined in a concerted effort to refine design parameters, evaluate materials qualities and advance equipment capabilities needed to serve the projected traffic of the future. Iowa responded by categorizing general criteria, as follows:

- From 1956 to 1965, PCC pavements were 24-feet wide, 10-inches thick, jointed at 76'-6" spacings, reinforced with mesh-dowels and built on a 4-inch granular subbase. Shoulders were 6-feet inside, 10-feet outside and built of 8-inch asphalt treated base material.

- From 1966 to 1975, PCC pavements consisted of 8-inch thick Continuously Reinforced Concrete

(CRC) constructed on 4 inches of Class A granular subbase, cement treated base or asphalt treated base material. The 48 longitudinal rebars comprised 0.6% of the cross-sectional area and were placed at the neutral axis. Buried lugs for longitudinal stability were located adjacent to bridge ends.

- On I-80 from MP 106 to MP 122, a bar mat reinforced section was originally built but has since been replaced with conventional PCC after its life as a serviceable pavement was used up.

- In Marshall County on Primary US 30, a demonstration project was built in 1963 of CRC with the reinforcement placed on chairs. Although serving a much lighter traffic function, its condition remains good and only minor pavement repairs have been needed to date.

- Steel placement on all Interstate CRC projects totalling 334.3 miles was positioned through various tube guides, depressors or other means that experience has shown did not provide the uniform depth needed to assure long-range performance.

- From 1975 to 1985 (completion of the Interstate program), PCC pavements consisted of 24-feet wide by 10-inch thick plain concrete slabs jointed at 20-foot intervals and using load transfer devices. PCC shoulders 6-feet wide inside and 10-feet wide outside were tied to the mainline concrete pavement and the entire section placed on 4-inches of Class A subbase, consisting of Econocrete, cement treated base or asphalt treated base.

- In recent years following completion of the initial Interstate construction, the need for updated safety features, increased truck size, weight and traffic volumes, and the ravages of time and wear dictated that enhancements be installed. These included longitudinal drains, partial and full-depth patches, median and embankment slope flattening, modernized interchange geometry and wider, stronger mainline pavements.

- Through 1993 on Interstate 80 between Des Moines and Davenport measuring 167.29 miles, 68.05 miles have been rebuilt. The three projects completed in 1993 involved work on 32.6 centerline miles. On all 782.15 miles of Iowa Interstate Highways, 167.53 miles have now been reconstructed.

- Since 1979 PCC inlays have been the preferred method used to replace old Interstate pavements. This design option accommodates the traffic stream without detours, allows for work on each roadway independent of the other, reduces staging demands and permits recycling old components into the new facility. PCC inlay specifications require crushing the original slab into a full-width granular subbase that slopes transversely to drain into the longitudinal perforated subdrain. New concrete using Class III coarse aggregate is currently poured 12.0-inches thick and 26-feet wide, with 14-feet in the driving lane for added strength and load distribution to resist heavy trucks. The pavement is non-reinforced but contains load transfer skewed dowel basket assemblies at 20-foot centers. The finished pavement has a painted edge line at 24-feet, and intermittent rumble strips are created within the outer 2-feet of slab to better guide traffic. The paved shoulders also have a continuous rumble texture which serves to alert inattentive motorists. As part of the reconstruction effort and to enhance safety, median foreslopes are regraded to 6:1.

NOTE: Add insert here - IDOT standard x-section sheet.)

- Another rehabilitation option used in Iowa to achieve additional strength and service life is the concept of a bonded PCC overlay placed on existing pavement. From 1979 to present, several sections totalling 48.39 miles were successfully constructed. After diverting traffic and preparing the old surface, a 4-inch or thicker PCC overlay is paved with ACC or PCC shoulder treatments added to match the new elevation. Advantages of this concept is that a substantial gain in pavement structure and strength can be obtained, profile and riding quality are restored, new safety delineation is presented and the work is completed in a shorter time frame.

**1993 PCC INLAY PROJECTS**

After evaluating reconstruction candidates remaining on the Interstate System, Iowa Department of Transportation authorities programmed the following three projects for 1993. Although originally well built of durable high quality materials, the burden of transporting far higher truck volumes carrying greater loads than predicted or designed for caused accelerated deterioration.

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**JASPER, IM-80-5(164)154**
MP 151.45 to MP 156.28
(From 2 miles E. of Mitchellville to 1 mile E. of IA 117 interchange)
Original Construction 1960 24'x10" PCC on 4" GSB Ferguson Limestone - Dur-3
AADT Traffic 8,140 Trucks 1,380
Est. 20 Yr. Des. 21,300 3,620 (17%)
Reconstruction 1993 26'x12" PCC on 9" tapered GSB/recycled PCC
AADT Traffic 24,100 Trucks 7,600
Est. 30 Yr. Des. 38,400 14,950 (39%)
Est.EASL's (2,024) = 101,291,130

Contractor: Manatt's, Inc., Brooklyn, Iowa

Bid Letting March 30, 1993

Contract Amount: $7,404,387.72;

S.Y. PCC/ML: 148,934.00 @ $20.89 = $3,111,231.26

Note: PCC item is 42.0% of total contract

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**JOHNSON, IM-80-7(59)247**
MP 240.22 to MP 257.86
(From just W. of IA 965 to 2 miles W. of X-40 interchange)
Original Construction 1961-62-63 24'x10" PCC on 4" GSB Cr. Limestone - Dur-3
AADT Traffic 9,270 Trucks 2,040
Est. 1983 21,100 4,640 (22%)
Reconstruction 1993 26'x12" PCC on 9" tapered GSB/recycled PCC
AADT Traffic 33,200 Trucks 9,340
Est. 30 Yr. Des. 50,350 16,356 (32%)
Est.EASL's (2024) = 113,903,213

Contractor: Fred Carlson Co., Inc., Decorah, Iowa

Bid Letting December 18, 1992

Contract Amount: $12,514,696.14

S.Y. PCC/ML: 315,819 @ $19.60 = $6,190,052.40

Note: PCC item is 49.5% of total contract.

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**SCOTT, IM-80-8(146)278**
MP 278.47 to MP 294.66
(From Cedar County line to just E. of I-280 mixmaster)
Original Construction 1960 24'x10" PCC on 4" GSB Cr. Dolomite - Dur-3
AADT Traffic 5,630 Trucks 1,290
Est. 1979 17,100 3,930 (23%)
Reconstruction 1993 26'x12" PCC on 9" tapered GSB/recycled PCC
AADT Traffic 24,100 Trucks 7,700
Est. 30 Yr. Des. 41,600 15,765 (38%)
Est.EASL's (2022) = 104,227,740

Contractor: McCarthy Improvement Co., Davenport, Iowa

Bid Letting February 23, 1993

Contract Amount: $5,731,567.3

S.Y. PCC/M: 110,182 @ $21.56 = $2,375,523.92.

Note: PCC item is 41.4% of total contract.

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**MANATT'S PARADIGM**

While all three projects were let for 1993 construction using identical PCC inlay design criteria and currently applicable specifications, there was an immediately noticeable difference in the Manatt's process versus the other two contractor's approach.

The conventional concept involves building median crossovers just beyond project limits, diverting directional traffic to the opposite roadway for head-to-head operation and removing old pavement from the roadway under construction for off-site crushing.

their cost for this 4.8 mile project and undoubtedly enabled the firm to submit the successful low bid totalling $7.4 million. Work generally proceeded as follows:

- Traffic was diverted to the eastbound lanes.

- In conjunction with Duit Construction Co., Inc. of Edmond, Oklahoma a unique recycling equipment train was assembled at project mid-point. This involved pavement demolition by a truck mounted "guillotine" breaker, concentrated on the passing lane. A track mounted backhoe with rhino horn picked mesh reinforcing and dowel bars from broken concrete, followed by another bucket-equipped backhoe that fed a primary impact crusher which towed a dual roll secondary crusher. Work was limited to one 12-foot lane, with production averaging about 2,000 lin. ft. per day.

- The primary crushing unit was a 130/150 Impactor mounted on 4-10'x1.5' tracks and provided travel power to the entire train. The secondary crushing unit was a standard double roll Cedar Rapids wheel mounted screening plant. At the discharge belt, electromagnets were positioned to catch steel reinforcing fragments. A water tanker accompanying the crushers maintained dust control by fog spraying.

- The crushing train operated on the unbroken passing lane. A GOMACO 9500 fine grade trimmer shaped the subgrade to slightly below design requirements and, at the contractor's option, up to 2-inches of fines were placed and compacted as an impervious moisture barrier. Excess fines remaining were wasted into the median for slope flattening or ditch filling. The crushed and screened recycled base material was dozed from its windrow on to the prepared grade where outlet was provided for free moisture through a longitudinal edge drain that had been previously installed by others.

- After reaching the end of the project, direction was reversed and the concrete recycling process repeated for the passing lane, with equipment travel confined to the recycled aggregate subbase-covered driving lane. A wetted condition was sufficiently stable to accommodate the tracked power unit of the equipment train without damage.

- Prior to these operations the interior existing paved shoulder was removed to subgrade elevation and that area served as a haul road. The outside 8-ft. shoulder was preserved as originally constructed for future use. Upon completion of the new PCC paving, both shoulders were brought to finished elevation with ACC hot mix.

- By concentrating recycling efforts on one-half of the project length, a full-width area was achieved to allow the start of full-width 12-in. X 26-ft. PCC paving. Manatt's selected a C-3WR mix using Kaser's Class III durable coarse aggregate from Sully, sand from Colfax and conventional admixtures.

- Concrete was wet batched through a drum mixer on their Con-E-Co LoPro plant and deposited on the grade by either their Curbmaster or GOMACO belt placer after previously having wetted, consolidated and trimmed the drainable base. Skewed dowel baskets were anchored in place to assure proper alignment and 20-ft. spacing. A GOMACO two-track GP-3000 paver with autofloat completed the process, while using a "rocket launcher" attachment to install centerline tiebars behind the augers and vibrators. Texture was obtained by astrograss drag. White pigmented curing compound was machine applied while transverse tining 1/8" deep by 3/4" spacing was impressed. The outer pavement edges were left untined and a blanking band preserved contraction joint paths to discourage raveling.

- Control cracks over the dowel assemblies were induced by a self-propelled SOFF-CUT G-2000 saw. Subsequent 3/8" dry diamond sawing cut the transverse intermediate 20-ft. contraction joints for 11/16" preformed neoprene joint seal installation. The longitudinal centerline joint was filled and sealed with backer rods and hot-pour material.

- Pavement quality in terms of meeting specification requirements for tested strength, true dimensions, texture and ride is superior.

The rate of paving ranged from 1,500 to 2,400 lin. ft. per day. Progress throughout the project was impeded by heavy intermittent and frequent rainfall, in addition to the volume of concrete required by the 12-in x 26-ft. slab. Profilograph traces showed readings of 1.2 to 5.0 inches per mile, well below the maximum 12.0-inch non-grind threshold, although minor grinding was necessary at some bridge approach headers.

- Except for localized traffic restrictions required to complete guard rail installations, all pavement was opened to traffic by October 27. Significant incentive bonus was earned by the contractor for his expedited progress and quality of work.

## CONCLUSION

The story of highway construction in Iowa has not ended. Evolution of the Interstate System covers only a relatively short interval in the passage of time, a pause that reflects the indispensability of effective transportation upon economic and social progress. However, technological advancements are but one phase in the development of Iowa's roads. Progress continues through a shared interest between our association of concrete contractors and the State Department of Transportation engineers who collectively seek to further the knowledge and expertise required to build pavements that will economically and safely transport motor vehicles of the future.

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