CHAPTER THREE

CONSTRUCTION RESEARCH AND DEVELOPMENT IN THE PRIVATE SECTOR

Three major types of private sector firms are involved with infrastructure construction: construction firms, manufacturers of construction equipment, and producers of construction material. In addition, certain firms manufacture equipment used in construction, such as laser-based construction alignment equipment and data processing equipment for use at construction sites. However this equipment probably adds comparatively little to the overall cost of construction. This chapter describes infrastructure construction-related R&D programs of representative firms from each of the three major categories and summarizes other efforts made by these firms to encourage technological innovation and transfer of information about innovative ideas within the firm. The information is based primarily on interviews with knowledgeable individuals in the firms.

The results of OTA's examination are very rough because only a handful of firms involved in infrastructure construction could be contacted in the limited time available and because it was difficult to attribute research and development (R&D) efforts specifically to infrastructure construction rather than to other types of construction or design. However, the results are adequate for showing that a very small fraction of revenues for all types of construction go into privately sponsored R&D at major types of companies connected with construction (probably less than $1,088 million, or 0.33 percent of the total value of new construction in the United States for 1985) and that construction firms, in particular, do little in the way of R&D.

CONSTRUCTION FIRMS

Types of Technological Innovation

Eight large construction firms and two engineering firms that build large infrastructure projects were contacted for information about their efforts toward technological innovation. The construction firms included Bechtel Group, Inc.,[10] [11] Brown and Root, Inc.,[12] Fluor Corp.,[13] the M.W. Kellogg Co.,[14] Kiewit Construction Group, Inc.,[15] Morrison-Knudsen Corp.,[16] the Parsons Corp.,[17] and Rust International Corp.[18] The engineering firms were Greiner Engineering Sciences, Inc., and Figg and Muller Engineers, Inc. R&D is important at the design level since the design process often forecloses applications of construction R&D.[19] Figg and Muller indicated that their firm undertakes project specific research, although the

---

10 Tim Killen Manager of Engineering and Construction Technologies, *Bechtel National Inc;* personal communication, Mar. 27, 1987.

11 Dennis Vanderpool, Manager of Construction Technologies, Bechtel National, Inc., personal communication, Mar. 31, 1987.

12 T. L. Austin, Jr., President and Chief Executive Officer, Brown and Root, Inc., personal communication, Mar. 18, 1987.

13 Ed Dopheid, Director Of Sales, Fluor Construction, Fluor Corp., personal communication. Apr. 22, 1987.

14 Robert Levy, vice president of Technology Development, The .M.W. Kellogg Co., personal communication, Apr. 23, 1987.

15 Martin Kelley, Vice president, Kiewit Construction Group, Inc., Personal communication, Mar. 24, 1987.

16 Mike Kulchak, Morrison-Knudsen Corp., personal communication, APr. 8, 1987.

17 Otha Roddey, president, parsons Corporation, personal communication, Apr. 22, 1987"

18 David Rozendale, president, Rust International Corp., personal communication, APr " 23, 1987.

19 Henry L. Michel, president and CEO, Parsons, Brinkerhoff Inc., Personal communication, May 18, 1987.

amount expended is confidential. OTA did not find evidence of sizeable expenditures on R&D among these engineering firms. Some of these construction firms have nominal R&D departments or budgets, while others do not.

Moreover, for both design and public works projects comprise only a small portion of each firm's business; those that have R&D programs address them to technologies applicable to other areas where the bulk of their business originates. For example, Bechtel has a 300-person R&D department, which monitors technologies developed outside the firm, conducts research and develops new technologies, and explores potential areas for new business. Bechtel does support some projects within the company to develop new technologies with potentially broad applications. Support of these projects is an effort to advance fundamentally the state of the art of construction technology and thus seems to qualify as incremental or advanced construction R&D in the sense described in chapter one. Brown and Root, Kiewit, and Kellogg have programs to monitor new technologies and to communicate information about innovative ideas within the company.

However, these programs do not actually develop new technology. Parsons, Fluor: and Rust International have software development programs for scheduling and cost control, which could possibly be classified as construction R&D, but which do not fundamentally advance the state of the art of construction technology. The source at Fluor indicated that in the past. when Fluor's clients in the petroleum and hydrocarbon industries were in better financial shape, Fluor had more cash flow to pursue technology developments, such as better rigging and heavy lifting approaches.

Some companies support R&D efforts outside the company; for example, Bechtel supports research to develop new technologies at several universities. Also, all except one of the eight firms contacted (Parsons) were listed in 1986 as members of the Construction Industry Institute (CH), a research institute dedicated to improving the cost effectiveness of the U.S. construction industry. Established in 1986, CII provides support for construction R&D at universities. The annual level of support for CII is $6 million, and much of the research is directed at data systems and management support activities, although one does support development of new construction technology. Total industry .wide expenditures for R&D efforts outside individual companies (such as for university research) do not appear to be substantial.

In general, there seem to be four categories of technological innovation by the construction firms: (1) developing new technologies in special, internally funded projects within the company, (2) applying or modifying technologies recently developed outside the firm, (3) combining already existing technologies in novel ways, and (4) providing incremental advances to existing construction techniques. Innovations from categories two, three, and four typically occur in the context of specific construction projects. Examples of innovation from each of these categories are discussed below.

Bechtel funds technology development projects within the company, including the development of an expert system to handle onsite welding engineering problems and the development of a three-dimensional design-modeling system. The design-modeling system was developed after Bechtel discovered that the systems of several outside vendors did not meet its needs. The system has infrastructure construction applications, because it can help construction engineers visualize the structure to be constructed, and Bechtel reports that it may attempt to market the system.

An example of using technology recently developed outside the firm is Kiewit's use of computer-aided drafting at certain job sites. Kiewit had no part in the development of computer-aided drafting but adopted the technology when it became commercially available. In other examples, Bechtel used robotics technology developed at Carnegie-Mellon University in

[20] Construction Industry Institute, Annual Report, 1986 (Austin, Texas)" Also, Richard L. Tucker, "Perfection of the Buggy Whip," The Construction Advancement Address, First Annual Peurifoy Construction Research Award, American Society of Civil Engineers (Boston, MA: Oct. 29, 1986).

cleaning up the Three-Mile Island nuclear power plant and also provided some support to the University of Texas to develop an automatic pipe fabrication system. (Neither of the Bechtel examples are known to have infrastructure construction applications, however.)

Kiewit combined technologies in a novel way in the construction of tunnel walls for an underground powerhouse, Here, Kiewit combined steel fiber-reinforced concrete with microsilica shotcrete technology to produce a high-strength, fast-setting concrete tunnel wall. The concrete was applied pneumatically from a hose using existing shotcrete technology. In addition, Bechtel hopes to combine computer-aided design technology for manufacturing plants with automatic pipe fabrication to simplify the design/construction interface.

An example of an incremental advance on existing construction techniques is Brown and Root's development of ways to pack water valves in structures more efficiently. This advance does not involve any new technology or fundamentally new construction procedures; instead, it appears to involve closer attention to one aspect of construction in order to do it more efficiently. The advance occurred in construction projects for the power industry and may have applications for sewer systems.

Many construction firms have programs to monitor technological developments related to construction, to encourage innovation, or to communicate innovative ideas within the company. Bechtel's R&D department does this, and Brown and Root recently formed a competitiveness committee to examine construction techniques and equipment available for construction. Brown and Root also spent several million dollars educating employees at Crosby and Associates' quality school to encourage them to find better ways of doing things and to help facilitate sharing innovative ideas in the company. So far, no major successes have resulted for Brown and Root from these programs.

Kiewit relays information about innovations in construction projects to other parts of the company at an annual meeting attended by 400-500 executives and key employees. Two days of the meeting are spent reviewing construction methods at individual projects. The microsilica/fiber -reinforced concrete wall described above was discussed at this year's annual meeting.

In summary, three of the construction firms surveyed do little internal research and development to advance fundamentally the state of the art of infrastructure construction. There is little activity to develop new technologies with potentially broad applications for construction. The firms most often innovate by applying or adapting technology developed outside the firm, by combining existing technologies in new ways, and by incrementally modifying existing construction procedures. Much of the innovation in these categories occurs at the level of individual projects. Based on informal discussions with experts in the construction field, this state of affairs is probably typical throughout the industry .[21]

Industry - wide R&D Exnenditures

The total expenditures on R&D by the eight U.S. construction firms are shown in table 3-1. These expenditure estimates are based entirely on discussions with the firms listed above and apply to construction as a whole; not just infrastructure construction. OTA analyzed information supplied by the firms and eliminated expenditures for efforts to find out about, evaluate, or use existing technologies and attempted to eliminate expenditures on research not directly related to construction itself, such as the exploration of new potential areas of business. Ambiguities arose, particularly in the area of software development for scheduling and cost control, The ambiguous expenditures were included in the total R&D expenditures. Thus, the R&D estimates probably overstate actual spending by the construction firms to develop new construction technologies.

Total 1985 contracts are also shown for each of the firms in table 3-1. "Total 1985 contracts" refers to the total value of all prime construction contracts, shares of joint ventures,

21 For example, Frederick Krimgold, Virginia Tech, Alexandria, VA, personal communication, Mar. 17, 1987.

Table 3-1.–RllD Expenditures of Eight Major U.S. Construction Firms

Company	Total 1985 Contracts (in millions)	Total 1985* R&D Expenditures (in millions)	Total 1985 R&D Expenditures (percentage of total contracts)
The Parsons Corp.	8,620.0	0.5	0.006%
Bechtel Group, Inc.	7,364.0	<10	~o.14z
The M.W. Kellogg Co.	6,757.0	0	0
Morrison-Knudsen Corp.	5,887.7	0	0
Brown & Root, Inc.	5,578.7	0	0
Fluor Corp.	5,127.4	1.5+	0.03%+
Rust International Corp.	5,097.9	4.0	0.08%
Peter Kiewet Sons', Inc.**	1,322.5	0	0

3. OTA estimates based on criteria described on preceding page.

** This company is now known as Kiewet Construction Group, Inc.

SOURCES: Total 1985 contracts from Engineering News Record, "The Top 400 Contractors," Apr. 17, 1986, pp. 58-99. R&D expenditures from OTA, based on discussions with the construction firms.

design/construct contracts, and construction management contracts where the firm is exposed to financial liability similar to that for a general contractor.[22]

Many construction firms, including Parsons, Morrison-Knudsen, and Fluor, had over one-half their total 1985 contracts in construction management. Discussions with firms indicate that the quoted total contract amounts are very inexact measures of the amount of construction work done by the firms. However, according to this reckoning, the 1985 contracts for the eight firms totalled $45,752.2 million, and the R&D expenditures totalled less than $16.0 million. Thus, the firms devoted less than 0.04 percent of total contract volume to R&D. Since the firms contacted included the seven largest construction firms in the United States in terms of 1985 contracts, 0.04 percent is a reasonable upper-bound estimate for the fraction of total contract volume devoted to R&D for all construction firms.

The total contract volume for the top 400 construction firms in 1985 was !$136.. billion. Assuming that firms outside the top 400 do not spend significant amounts on R&D and that the 0.04 percent is an upper bound to the fraction of total contract volume devoted to R&D, the total expenditures on R&D performed within all construction firms was probably no greater than about $48 million in 1985. This approximate upper limit is consistent with the National Research Council's estimate of $54 million for the total R&D funding level for construction contractors.[23]

---

22 The figures for total contracts are from Engineering News Record, "The Top 400 Contractors," Apr. 17, 1986, pp. 58-99.

23 National Research Council, Construction Productivity: Proposed Actions by the Federal Government to Promote Increased Efficiency in Construction, (Washington, DC: National Academy Press, 1986).

PRODUCERS OF CONSTRUCTION MATERIALS

Total R&D expenditures by major building materials producers for 1985 was $202.9 million. It is not known how much of this amount was expended On evaluative research as oPposed to incremental or advanced R&D to improve construction materials. The figure is used here as an estimated upper bound to the amount spent by manufacturers of construction materials on incremental or advanced R&D for construction.

MANUFACTURERS OF CONSTRUCTION EQUIPMENT

Manufacturers of construction equipment typically spend a few percent of sales on R&D activities. Three such manufacturers were contacted about their R&D efforts. One, CMI Corporation,[25] is a relatively small firm ($ 135.2 million in sales during 1985) M that specializes ‘n grading and paving equipment, asphalt recycling equipment, and a few other related types of equipment. *7 The others, Caterpillar Inc.[28] and Deere and Company*[g] are much larger firms ($6,725 million and $4,060.6 million in sales during 1985, respectively)30 that manufacture a wider variety of equipment types. Deere, for example, manufactures farm equipment as well as

---

24 Business Week, **Op. cit.** Note that this category includes *afl* types of building materials, not just the construction materials relevant to the kinds of public works discussed in this Staff Paper. Therefore, this estimate is an order of magnitude greater than that in table 9-1 and the accompanying text.

25 Tom Steele, vice president for Engineering Research and Development, CM I Corporation, personal communication, Mar. 24, 1987.

26 Business week, “R&D score board,” Jun. 23, 1986, PP. 139-156.

27 Standard and poor’s Register of Corporations, Directors and Executives, Volume 1 (New York: Standard and Poor’s Corp., 1987).

28 chuck Grawey, Director of Research, c~terpill~r, Inc., personal communication, ~~ar. ~4T 1987,

29 R Ussel Sutherland, v ice president for Engineering and Technology, Deere and Corn Pan}’> personal communication, Mar. 20, 1987.

30 Business week, oP. cit.

construction equipment. A summary of the total R&D budgets of the three firms appears in table 3-2.

Based on discussions with the firms, it appears that all three spend most of their R&D dollars on developing incremental changes to existing products and improving manufacturing ef - ficiency. Examples of incremental changes are improvements in engine efficiency to produce more power and improvements in the reliability of equipment. These changes reduce the time and expense required to do construction but do not change the way construction is done by in- troducing new technologies or processes.

CMI and Deere reported working in several specific areas of R&D to develop new tech- nologies or processes for construction. CMI is doing R&D to improve processes and equipment for asphalt recycling (about $1 million per year) and to improve processes and equipment for concrete paving (about $600,000 per year). Deere is developing high-pressure water jets for renovation of bridges (about $100,000 per year) and is doing R&D on applications of electron- ics, such as electronic control of gearshift mechanisms in scrapers and remote control of con- struction equipment. The source at Deere estimated that Deere spends about $5-!$6 million per year to develop new construction technology.[31] The source at Caterpillar reported that Caterpil- lar is also doing R&D on applications of electronics to construction, but declined to comment further on its efforts to develop new technologies. He estimated that Caterpillar spends less than five percent of its R&D funds on advanced R&D.

Table 3-2 summarizes the estimated expenditures of the three firms to develop new technologies or processes for construction. These expenditures are for R&D activities that could in some cases correspond to advanced R&D related to some type of construction (not necessarily infrastructure construction). Because none of the firms could supply exact figures for these types of expenditure, and because the distinction between a new technology and an improve-

---

31 Sutherland, oP. cit.

Table 3-2.-RAD Budgets For Selected Manufacturers of tinstruction Equipment, 1985
(in mill iOnS of dollars)

		Tot~l R&D Budget		Approximate R&D Budget for New Technologies or Processes	
MdnufaCtuCer	Sdles in Mi l l ions of Dol ldrs	Mi l l ions of Dol ldrs	Percentage of Sales	MILLIONS OF DOLLARS	PERCENTAGE OF SALES
CMI	135	5.6	4.1	1.6	1.20
I)eefe*	4,061	223	5.5	6	0.14
Cdtcrpi l ldr	6,725	326**	4.8**	<16	<0.24

x Mdnutdcturers fdrm equipment db well as construction equipment.

IID Excludes R&D expenditures for mdnufdcturing processes.

Sources: 1985 sales figures for all firms and total R&D budgets for 041 and Deere from Business Week, 'RAD Scoreboard," June 23, 1986, pp. 134-156. [otal IUD Budget for Caterpi l lar from Chuck Grawey.

gests an upper bound only to the order of magnitude for private expenditures on infrastructure construction R&D. Indeed, some reviewers of this paper contend the amount is overstated.

The level of spending by major Federal agencies and agencies that use Federal funds on incremental or advanced R&D for infrastructure construction in 1985 was estimated in chapter two to be $14 million. This corresponds to an upper bound to total (Federal plus private) spending on infrastructure construction R&D of !5129 million, or 0.4 percent of the total value of new infrastructure construction put in place in the United States during 1985. The level of spending by major Federal agencies and agencies that use Federal funds for activities classified by the agencies as infrastructure construction-related R&D for 1985 (which includes management, design, and evaluation research) was found in chapter two to be $103 million. This corresponds to an upper bound to total (Federal plus private) R&D expenditures of !5218 million, or 0.63 percent of the total value of new infrastructure construction put in place during 1985. This upper bound is a very optimistic estimate, and the actual percentage of the total value of new construction spent on R&D is probably much less.

CASE STUDY

The Complex Process of Implementing an Infrastructure Innovation

BRIDGE RECONSTRUCTION USING PRECAST, PRESTRESSED CONCRETE PANELS

Precast, prestressed concrete panels have been used to replace aging highway bridge decks in the United States since the 1970s.[33] (The technology had been known and used in Europe for 30 years previously.) The main benefit of using the panels, compared to the conventional method of pouring concrete directly on the bridge's superstructure, is that the panels do

33 Mrinmay Biswas, "Precast Bridge Deck Design Systems," reprinted from the Journal of the Prestressed Concrete Institute 31, vol. 2, March-April 1986.

not require a long curing time. This permits installation of the panels at times of day when traffic levels are low and use of the entire bridge deck when levels are high. It also shortens the total time required to do the deck reconstruction, Thus, precast, prestressed concrete panels are most useful in crowded urban areas where loss of a few lanes on an important bridge during rush hours can cause serious traffic congestion problems.

Precast, prestressed concrete panels are made by stretching high-strength steel wires with hydraulic jacks to high tension. Then, high-strength concrete is cast in a form around the wires and allowed to harden. The result is that the tensile load of the panel is carried by the steel wires, so the panel combines the tensile strength of steel with the compressive strength and rigidity of concrete. The process of forming the panels in this way is called "pretensioning." The panels can be joined together with steel wires passed through the panels and stretched to high tension. This process is called "post-t ensioning."[34]

The Frenchman Eugene Freysinnet is generally credited with developing modern concrete prestressing methods. He began work on these methods in the 1920s.[35] In the late 19QOs, bridge construction using precast prestressed elements proved to be an efficient and economical way to replace the bridges destroyed in Europe during World War 11.[36] Prestressed concrete was not used in the United States until the 1950s and 1960s, when it was utilized for bridge construction, primarily for bridges with spans of about 100 feet or less. Use of precast, prestressed concrete members for construction of longer-span bridges (with a method called segmental con-

3A The Encyclopedia Americana, International Edition, vO]. 4, Birmingham to Burlington (Danbury, CT: Grolier, Inc., 1986), p. 529.

35 Walter Podolnov, Jr and Jean M. LMUher, Construction and Design of prestressed Concrete Segmental Bridges "(New York: .John Wiley and Sons, 1982), p. 4,

36 BiSwaS, OP. cit.

ment to an existing product can be fuzzy, the quoted amounts should be understood as only suggesting the order of magnitude of expenditures by the firms to develop new technologies and processes for construction. The figures do show that while the fraction of total sales revenues spent to develop new technologies or processes for construction is small, the actual amount of money spent is not trivial.

The total R&D expenditure for major farm and construction equipment manufacturers in 1985 was approximately $837.3 million.[32] Since this figure includes R&D to develop farm machinery as well as construction machinery, it is an upper limit to expenditures on incremental or advanced construction R&D by equipment manufacturers.

TOTAL PRIVATE EXPENDITURES FOR CONSTRUCTION R&D

Table 3-3 shows the estimated upper limits to construction R&D by construction firms, construction equipment manufacturers, and construction materials producers. The upper limit to the total private spending on construction R&D for 1985 is $1,088 million. This amount represents 0.33 percent of the total value of new construction in the United States for 1985.

Table 3-4 shows estimates of the total value of new infrastructure construction for the United States in 1985. It is impossible to determine from the available information the total expenditure by private firms on infrastructure construction R&D. Indeed, since many technologies apply to different types of construction, it may not make sense to attempt to separate infrastructure construction R&D from other types of construction R&D. Nevertheless, if the level of private infrastructure construction R&D is assumed to be in the same proportion to the level of total private R&D for construction as the total value of infrastructure construction in the United States is to total construction in the United States, then the level of private infrastructure construction R&D for 1985 has an upper bound of $115 million. Clearly, this figure sug-

S2 This was obtained from data in Business Week, oP. cit., with the Caterpillar R&D budget corrected according to information from Chuck Grawey, op. cit.

Table 3-3.-Upper Limit to R&D Expenditures by Private Firms For All Types of Construction

	MilLions of Dollars
Construction Firms	48
Construction Equipment Manufacturers	837
Building Materials Manufacturers	203
TOTAL	$1,088

Source: Office of Technology Assessment.

Table 3-4.–Approximate Infrastructure Construction Expenditures
Based on Data *From* the **Census Bureau** for 1985

Type of Public Construction	Expenditure (in *millions* of ciOllars)*
Highways and Streets	$19,998
Sewer Systems	7,196
Water Supply Facilities	2,664
Miscellaneous	4,512
Total	$34,370

'r' 1986 dollars.

Source: Adapted from U.S. Department of Commerce, Bureau of the Census, Value of New Construction Put in Place, C30-86-12, February 1987, (Washington, DC: U.S. Government Printing Office, December 1986).

struction) did not begin until later--the first such bridge was completed in the United States in 1973.[37]

The use of precast, prestressed panels for bridge deck reconstruction began as a response to a need in bridge reconstruction, not as a result of any particular technological development. During the 1950s and 1960s, a great deal of highway and bridge construction took place, including work on the interstate highway system. Structures were often built quickly, and the builders did not always anticipate the level of use they would eventually enjoy. Moreover, structures were not always maintained in top condition. Since the 1970s, these bridges have begun toshow significant signs of aging, and many have needed rehabilitation. Furthermore, in many areas no good alternate traffic routes exist for bridges, which are used to capacity during rush hours. Thus, precast prestressed concrete panels have been attractive in many cases because they cause less traffic disruption than conventional redecking approaches.[38]

Three basic factors must be weighed when deciding whether to use precast prestressed panels for bridge redecking. The first factor is cost, which depends partly on the size of the job and the uniformity of the bridge panels required for redecking. If only a few panels are needed or if the bridge has variable width or curvature, then panels may be very costly relative to poured concrete because the forms needed to manufacture the panels would be used only a few times. On the other hand, if the bridge is very long and has uniform width and curvature, the forms can be used repeatedly for many panels. The availability of local facilities for manufacturing panels is an additional cost consideration. Finally, the cost of maintaining traffic levels during rush hours by opening and closing lanes on the bridge can also be high.

The second factor is traffic disruption. Precast prestressed panels generally offer a big advantage here since traffic can pass over them shortly after they are laid, permitting construc -

37 podolnoy and ,~~uller, opt cit., p. vii.

38 James Lutz, project Director, Greiner Engineering sciences, Inc., 13althnore, ~D, Personal communication, May 6, 1987.

tion during the night and traffic flow during the day. Also, bridges can generally be redecked in a shorter total time using panels than by using poured concrete.

The third factor is performance of the completed bridge deck. Poured concrete has an advantage in that it bends somewhat in response to the bridge superstructure below it, thereby reducing stresses on the structure. This phenomenon is known as “participation.” The riding surface of poured concrete is potentially better than that of panels because it can be adjusted very accurately to form a nearly perfect flat surface. Imperfections in a panelled surface can be compensated for to some extent by overlaying asphalt on top of the panels, but long-term problems can result because of water and salt seepage through the asphalt layer. Precast prestressed concrete is generally of higher quality than poured concrete because it is prepared under more controlled conditions.[39]

Precast, prestressed concrete panels were used during 1982 and 1983 on the Woodrow Wilson Memorial Bridge across the Potomac River near Washington, DC. Traffic across the bridge is extremely heavy, so safe maintenance of all six lanes of traffic during peak hours, four or five lanes during off-peak hours, and one lane in each direction at night were mandatory during the reconstruction period. The entire concrete deck of the 5,900-foot bridge needed to be redecked and widened.[40] Since maintenance of traffic was an overriding concern and the bridge was long, of uniform width, and without curvature, use of prefabricated deck segments was the clear choice of reconstruction method.

A bonus clause in the contract for redecking the Wilson Bridge rewarded the contractor, Cianbro Corporation, for each day the contract was completed ahead of schedule, up to 120 days. The contract required completion of the work within 575 calendar days. The reward was

39 Ibid.

40 James G. Lutz and Dino J. Scalia, “Deck Widening and Replacement of Woodrow Wilson Memorial Bridge,” reprinted from the Journal of the Prestressed Concrete Institute, vol. 29, No. 3, May-June, 1984.

based on a Federal Highway Administration estimate of the cost of traffic disruption due to construction, reportedly about $10,000 per day, even though six lanes were generally open during rush hours. About 15 percent of the way through the project, Cianbro offered to complete the deck work within 350 calendar days, or 225 days earlier than required by the contract, if paid for the additional costs of hiring more work crews and supervisors and the costs of making more forms for manufacturing panels at the fabrication plant. This additional cost was reportedly about $3,000 per day for the 105 days saved above the 120 days rewarded in the contract. The offer was accepted. Cianbro completed the bridge redecking within 350 calendar days, as promised.[41] According to a confidential source, if conventional construction methods were used, the project would have taken three years and only three lanes would have been open to traffic throughout the day.

[41] James Lutz, Projects Director, Greiner Engineering Sciences, Inc., Baltimore, Maryland, personal communication, May 6, 1987; and Lutz and Scalia, op. cit.