BIG OR SMALL, DOES WARRANTY CONTRACTING PROVIDE EQUAL OPPORTUNITIES TO ALL?

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ABSTRACT

The need for continuously improving the performance of existing highway infrastructure has become one of the major concerns of state Departments of Transportation (DOTs). Warranty contracting makes contractors accountable for the repair and replacement of deficiencies during highway operation and therefore helps state DOTs address this key concern. However, the successful development of warranty contracts would require partnering of many sections of the industry and the state DOTs. Moreover the agencies and contracting industry question whether warranty contracts provide equal opportunities to small and big contractors. This paper presents the determinants of industrial acceptance of warranty contracting. The results are based on a survey conducted at the University of Alabama encompassing various types of contractors. Most importantly, this paper discusses whether there exists an equal opportunity amongst various contractors while using warranty contracts. Recommendations are made to the state DOTs to promote wide acceptance of warranty contracts.

KEY WORDS

Warranties, Project Delivery, Contracting, Equal Opportunity, Industry Acceptance

INTRODUCTION

During the early 1990s warranty provisions were introduced in highway construction to protect public agencies' initial investment by making the contractors accountable for maintenance. Since then there has been a gradual increase in the use of warranties for transportation projects. By the end of 2003, more than 30 state Departments of Transportation (DOTs) had incorporated warranty provisions into their transportation construction programs (Bayraktar et al 2004). It was observed that warranty contracting could benefit the state DOTs by improving project quality, reducing overall life-cycle cost, and accelerating project delivery, as well as encouraging contractor initiated innovations. But there were some issues like higher initial costs, a reduction or even elimination of small contractors from the bidding process, and an increase in contract disputes and litigation, in addition to skepticism from contractors and sureties (Anderson

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and Russell 2001, Hastak et al 2003, FHWA 2005). These issues posed a serious concern for the acceptance of warranty contracts by the construction industry.

Hancher (1994) first defined highway warranty contracting as a project delivery method with performance guarantee that holds the contractor accountable for the repair and replacement of deficiencies during highway operation. Based on the initial experience in Wisconsin, Russell et al. (1999) developed a warranty implementation guide for state highway agencies. Bayraktar et al. (2004) in their work summarized the benefits and shortcomings from the perspectives of DOTs, contractors, and surety companies. Although there was no reported financial gain from using long-term warranties in Colorado (Goldbaum 2006), the cost-efficiency of warranty contracting was observed in the states of Wisconsin and Indiana. A comparison about the cost performance of warranty projects was done by Kerbs et al. (2001) with the historical data in Wisconsin and yielded a conclusion that warranty projects cost 13% less than the standard projects in terms of life cycle project costs. Singh et al. (2007) estimated that warranty contracts represent more than 70% cost reduction over the entire service life in Indiana. Cui et al. (2004) showed that cost-efficiency could be improved through a delayed warranty purchase decision, especially when significant uncertainties exist in the estimates of roadway performance and repair costs.

The previous studies provide a justification of the use of warranties from the public agencies' perspective. But there is a need for an integrated analysis of warranty contracting that includes contractors' and surety companies' standpoint, because the use of warranties may affect state DOTs, contractors, and surety companies differently. It is understandable that an advantage to one project participant may be a disadvantage to others. Furthermore, the successful implementation of warranty provisions will need involvement of many sectors from the industry along with the state agency. Ignorance of industry perspectives may even result in unsuccessful implementation of warranty contracting. Additionally, public concerns with regard to equal opportunities for all companies may pose serious challenges for the public agencies to implement warranty contracting and other alternative project delivery methods. It is widely accepted in the contracting industry that an innovative program should provide equal opportunities to all organizations, big and small, rather than favoring only a few firms.

SURVEY DESIGN

A survey was designed to collect industry opinions on warranty contracting. The questionnaire was kept short to minimize the amount of time required to complete the survey, thus increasing the likelihood to receive a response. The survey questions were prepared by a cooperative effort between the research team at the University of Alabama and the project advisory committee, including representatives from the Alabama Department of Transportation (ALDOT), Alabama Road Builders Association, and surety companies. The final questionnaire included twelve questions covering information about the responding company, acceptance of and concerns about warranty contracting, and the expected impact of warranty provisions. Four questions were finalized to collect details like company background information, including annual dollar revenue, years in the highway construction business, percentage of revenue in each type of highway project, and warranty project experience in other states. These questions were used to categorize responding companies into groups based on their size, highway construction experience, warranty project experience, etc.

Four questions were designed to collect contractors' opinions on using warranty contracting. In these questions the respondents were asked to give details about what type of warranted projects they would consider bidding on, how long a warranty period they would accept, what they would request in return for warranties, and what were their concerns about warranty work. In this same group additional questions addressed the views about the availability of and length of the warranty bond that they could obtain. The last group of questions covered collection of information about the expected impact of warranty contracting. Questions are : what type of roadway projects would achieve a life cycle cost benefit from warranties, what measures of roadway performance they would accept, what would be the impact of warranties on construction quality and owner-contractor relationships. For additional details on the questionnaire, the readers are referred to Cui et al (2007).

SAMPLING

ALDOT qualifies a contractor based on several criteria like the company's financial statement, equipment fleet, and construction experience. During the time of surveying, 360 companies were prequalified to work as contractors for ALDOT. These contractors were divided into groups using company size, state residency, or experience in warranty jobs as a criterion. For the survey, we defined several dichotomous variables with the value of 0 and 1 to describe the characteristics of prequalified contractor. For example, taking the case of residency, the residency variable x is defined as the state residency of a responding company then if a responding company takes residency in Alabama x equals to 1, otherwise x equals to 0 for non-Alabama resident companies. The characteristics of the survey population were represented by the group distributions of prequalified companies. However, these distributions are generally unknown.

When sampling is done from a finite population, the survey requires sufficient responses, or a typical sample with statistically indifferent group distributions. Here as per the condition we consider a finite population of size N from which a simple random sample of size n is drawn, without replacement. Hence, let $\bar{x}$ be the sample mean and let $\bar{X}$ and $\bar{S}$ be the population mean and variance. For a dichotomous group variable with a value of 0 or 1, $\bar{x}$ and $\bar{X}$ are denoted by p and P, respectively, and the variance can be found as, $S^2 = \frac{NPQ}{N-1}$, where, $Q = 1 - P$. It is known that $Var(\bar{x}) = (\frac{N-n}{Nn})S^2$. By imposing the restraint $Var(\bar{x}) \le V^*$ for a pre-chosen margin of error V^*, the required sample size to satisfy this inequity is determined (Desu and Raghavarao 1990), as

$$n^* = \frac{NS^2}{S^2 + NV^*} + 1 \qquad (1)$$

or,

$$n^* = \frac{N}{1 + \frac{(N-1)V^*}{P(1-P)}} + 1 \qquad (2)$$

Since P is usually unknown and somewhat difficult to guess, a conservative approach is to take P=0.5 which yields the highest value for n^*. Thus, with N=360 prequalified contractors, the required sample size for $V^*= (0.1)^2$ is

$$n^* = [360/\{1+(359*0.01)/(0.5*0.5)\}]+1 = 24 \qquad (4)$$

Based on the calculation above, if 100 questionnaires are sent out, the required sample size needs at least 24 responses, or a 24% response rate. Considering the fact that the average response rate from construction companies on earlier similar research was within 10-20% (Hastak et al 2003), the research team decided to send the prepared questionnaire to all 360 prequalified contractors with a target minimum response rate of 7% to achieve the required minimal response rate for a sound statistical analysis.

SURVEY IMPLEMENTATION

ALDOT provided a cover letter to the questionnaire which explained the purpose of the research and a list of prequalified contractors. The questionnaire was sent out to all the 360 contractors by mail and twenty-eight contractors responded within the required return period for the questionnaire. After a reminder fifteen more questionnaire responses were received. Out of the total 43 responses, three were discarded because the companies were specialty contractors for roofing, ITS, etc, with no experience in the research area and one more response was discarded as a company responded twice with conflicting answers. When contacted, the respondent confirmed that the latest response reflected their current opinion on warranty contracting. Thus the research team finalized 39 responses as usable responses which represents a 10.8% response rate and satisfies the minimum sample size requirement for the survey design.

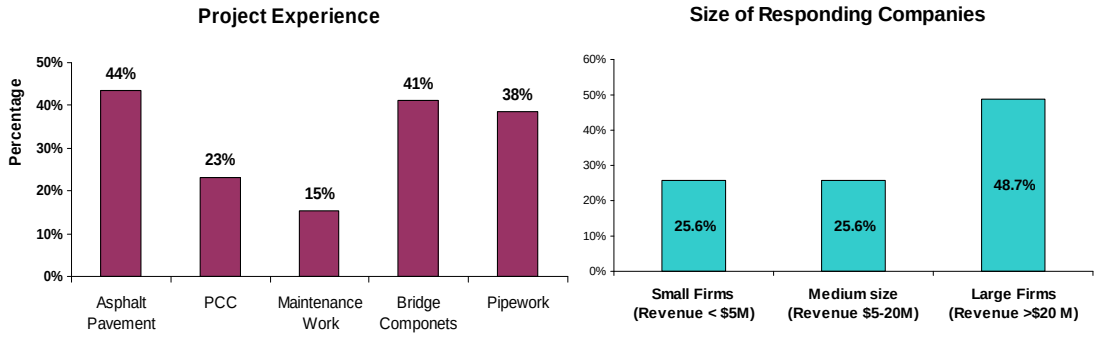

Figure 1 Profile the of Responding Companies

Out of the 39 responding contractors, 18 were local companies in Alabama, while 12 were from the southeastern states which included Mississippi, Tennessee, Georgia, and Florida. Remaining 7 contractors had their head offices in Texas, Minnesota, Indiana, Kentucky, Pennsylvania, Virginia, and Connecticut. Based on a discussion with ALDOT engineers and Alabama Asphalt Pavement Association (AAPA), the research team categorized contractors with over $20 million annual revenues as large, contractors with annual revenues from $5 to $20 million as medium-size, and contractors with annual revenues less than $5 million as small contractors. As per this criterion, 48.7% of the respondents were categorized as large contractors, while 51.3% were in the small and medium size groups. Broken down by work focus, 44% of the responding contractors had done asphalt pavement projects, 23% had done Portland Cement Concrete (PCC) pavement jobs, 41% had done bridge work, and 38% had done pipework (Figure 1).

ACCEPTANCE OF WARRANTY CONTRACTING

The successful implementation of warranty contracting largely depends on wide acceptance by the contracting industry. Without the acceptance from contractors, none of the state DOTs would be able to shift maintenance responsibilities. In several states, where highway departments intended to let projects with warranties, few contractors would bid on these jobs. An investigation of industry acceptance of alternative contracting could help state DOTs to understand the potential reasons for non-acceptance by the industry and help to develop creative solutions. One result from the research showed that a majority of highway contractors in Alabama accept short-term warranties on highway projects, but a little more than one-fourth of the responding contractors were not ready to bid on warranty projects in Alabama no matter what the type, term, and performance indicators of warranties are. The survey results also support the argument that there is a significant difference between the acceptance of new construction and of resurfacing jobs. It was found that half of the contractors who accepted warranty contracts were more willing to offer warranties on new construction projects than on resurfacing. This result is similar to the findings by Bayraktar et al. (2004) that contractors wish to reduce risks on warranty jobs and prefer to warrant design-build contracts.

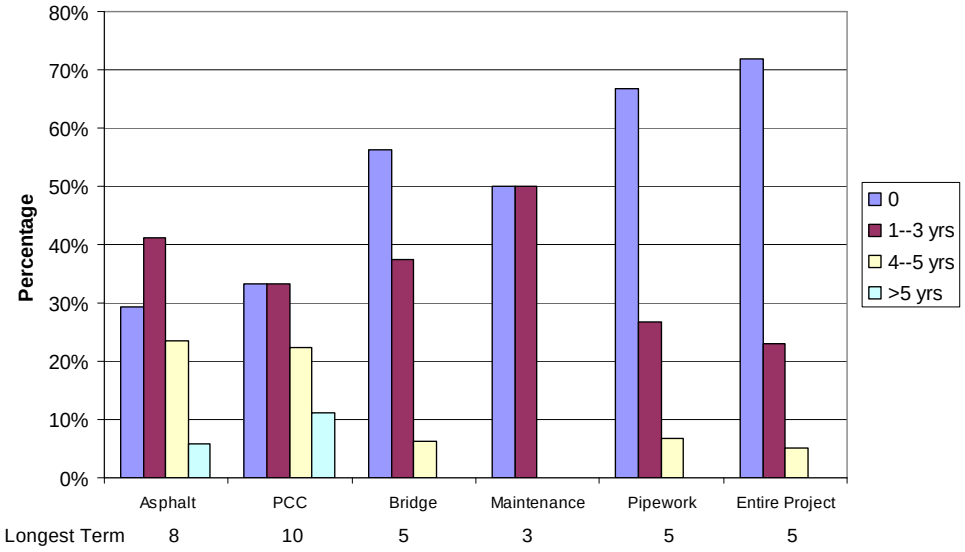

Figure 2 Industry acceptance of Warranty Contracting

It was also found that most contractors considered bidding on warranty jobs but their decisions depended on the term of the warranty period and the type of the project. Most contractors were found to offer warranties on asphalt pavement and PCC pavement. It was found that forty one percent of asphalt paving contractors would bid on asphalt pavement projects with less than 3-year warranties. On the other hand, when the warranty period was between 4 to 5 years, less than one quarter of contractors were ready to take warranty risks and only 6% of asphalt paving contractors were found to offer a warranty of 5 years or more. No contractor in Alabama was ready to bid on a warranty of over 8 years on asphalt pavement projects while for PCC projects, the longest acceptable warranty period was found to be 10 years. It was found that thirty three percent of PCC contractors would offer warranty for less than 3 years, while only 22% would consider

bidding on a 4-5 year warranty job. Only about 11% of contractors would offer a warranty of more than 5 years on PCC projects. Similar results were observed for other types of highway projects. And the majority of contractors suggested a warranty period of 3 years or less. As a return for accepting a warranty contract, the contractors requested an increased cost on top of the total installed cost, as well as leniency in the construction specifications. Figure 2 provides a consolidated view of industry acceptance of warranties in Alabama.

WARRANTY CONTRACTING: EQUAL OPPORTUNITY TO ALL?

Industry acceptance of warranty contracting needs to be further evaluated in terms of the opportunity offered to all construction companies. As public agencies, the state DOTs are expected to provide equal opportunities to all construction companies. However, it is widely believed that the inclusion of warranties in highway projects makes it difficult for small contractors to bid on due to involved risks and bonding availability. In another words, warranty contracting has been generally recognized to be favorable to large contractors rather than small ones. This paper presents an opposite argument on the equal opportunities offered by warranty contracting. The argument is based on the analysis of variance (ANOVA) with company size as the independent variable.

ANOVA is a commonly used technique to test the differences among two or more independent groups. Since company size is the only independent variable, the one-way ANOVA test has been conducted. Given there is no difference across the groups, the mean square for treatments (MSTR) and the mean square for error (MSE) were calculated and the ratio MSTR/MSE has an F-distribution. If the F-value is significant at a given level of confidence, e.g. 5%, there is sufficient evidence to reject the hypothesis that the groups are all the same. We can also calculate the P-value given that the null hypothesis is true. If the P-value comes out to be less than the significance level then we reject the null hypothesis. Or we do not reject the null hypothesis and judge that there is not much evidence to reject the hypothesis that the groups are all the same. The ANOVA test is shown in Table 1.

It is obvious in Table 1 that all P values are too big and hence the null hypothesis can not be rejected. Therefore, it is statistically reasonable to conclude that there is not much difference across the groups in terms of every dependent variable. As to the wararnty contracting in highway construction, this means that small, medium-size, and large contractors have similar warranty experience, share similar concerns associated with warranty contracting, and make similar bidding decision on warranty projects. It should be noted however that contractors usually have extremely opposite opinions about warranty contracting as shown by the large variances in each group. For example, the accepatable warranty term indicates the maximal warranty duration that contractors would bid on. The mean value in the small contractors group is 1.1 year, with a standard deviation of 2.1. This indicates most small contractors will accept less than one year warranty, while several would consider longer warranty contracts. Similarly, large contractors on an average accept 2.37 years warranty contracts. The large variances of 7.02 indicates a big difference about the acceptable warranty term. One contractor was found to warrant his work for 8 years while several others wanted to warrant for much lesser years. These extremely opposite responses cause large variations. Furthermore, there is no significant evidence to state that more number of large contractors prefer Design-Build-Warranty (DBW) projects than small contractors. And contractors, no matter large or small, statistically hold same opinions on the impact of warranty

contracting on construction quality and owner-contractor relationship. Additionally, the results for warranty concerns generally have higher P-values. Therefore, there is less evidence to reject the hypothesis that no significant difference exists across the groups regarding the concerns associated with warranty contracting. There is an increaseing trend in the means from small contractor group to large contractor group, which may indicate increasing concerns in large contractor group regarding the risks associated warranty contracting. However, this trend is not statistically significant.

Table 1: Analysis of Variance with Company Size as Between Group Factor

	Size of Contractor							
	Small		Medium Size		Large		Test	
	μ	σ	μ	σ	μ	σ	F-value	P-value
Warranty Project Experience	0.40	0.27	0.30	0.23	0.37	0.25	0.11	0.90
Acceptable Warranty Term	1.10	2.10	1.80	2.18	2.37	7.02	1.16	0.32
Acceptance of Warranty Projects	0.90	0.10	0.80	0.18	0.68	0.23	0.72	0.49
Acceptance of DBW Projects	0.20	0.18	0.30	0.23	0.42	0.26	0.72	0.49
Impact on Construction Quality	0.33	0.50	0.50	0.72	0.41	0.26	0.15	0.86
Impact on Owner-Contractor Relationship	0.22	0.69	-0.20	0.84	-0.06	0.76	0.57	0.57
Concerns								
Involved Risks and Liabilities	2.50	5.61	3.70	4.68	3.32	3.78	0.86	0.43
Warranty Duration	2.00	4.89	2.20	4.62	2.26	3.65	0.05	0.95
Legal Issues	1.30	3.79	1.90	5.21	2.47	3.82	1.11	0.34
Availability of Warranty Bond	1.70	5.57	1.90	4.54	2.32	3.78	0.32	0.73
Warranty Cost Estimating	1.10	2.77	2.20	5.96	2.11	4.10	0.95	0.39

Note:
1. Small contractors with annual revenue below $5 million, medium size contractors with revenue between $5 - $20 million; and large contractors with annual revenue above $20 million.
2. Sample size is 39, with 10 small contractors, 10 medium size, and 19 large contractors.
3. F-test criteria using P<5% is 3.26

WARRANTY CONTRACTING: WHAT MAKE A DIFFERENCE?

If the size of companies does not make difference regarding the acceptance of warranty contracting, then what factors determine the industry opinion? Understanding of the determinants of industry acceptance would help state DOTs better design or fine-tune their existing systems and practices to successfully implement warranties in highway construction. In this research, a nonparametric correlation analysis was then performed to assess the significance level of influence caused by other factors such as company age, warranty experience inother states, legal issues, risks asscociated with warranties, bonding availability. Considering the characteristics of the data collected in the survey, the Spearman's rank correlation procedure was used to make inferences about the association between industry acceptance and the factors mentioned above. Spearman's correlation coefficient is widely used for ordinal variables. It is a special case of the Pearson product-moment coefficient. The readers are referred to Weiss (2005) for a detailed explanation of the Spearman correlation analysis. The analysis was conducted using SPSS 13.0 for Windows. As shown in Table 2, the levels of influence of three factors on the acceptance of warranties by the industry were identified as significant, namely past warranty experience in other states, legal issues, and leniency in specifications.

Table 2 Spearman Correlation Analysis

Description	Spearman's Correlation	P-value
Warranty Experience in Other States	.410(**)	0.010
Legal issues	-.333(*)	0.038
Leniency in Specifications	.322(*)	0.046
Company Size	-	0.230
Risk and Liabilities	-	0.267
Availability of Bonds	-	0.492
Warranty Duration	-	0.554
Industry Experience	-	0.554
Warranty Cost Estimating	-	0.604
Addition of funds	-	0.650

Note: 1. Sample Size = 39
2. * significant at the 0.05 level (2-tailed).
3. ** significant at the 0.01 level (2-tailed).

The most important determinant of warranty acceptance lies in a company's past warranty experience in other states. It is shown that the richness of warranty experience significantly increases the acceptance probability of warranty contracting. The Spearman correlation analysis indicated that it is significant even at the 99% confidence level. The positive coefficient indicates a positive influence on warranty acceptance, i.e., the more warranty experience, the higher is the acceptance of warranty contracting. This is partly due to the change in warranty concerns and opinions generated by warranty experience. The survey showed that as a contractor becomes more experienced in warranty projects, he/she will better understand the risks associated with warranties and that in turn alleviates the concerns about risks and liabilities, but raises the concerns about bonding availability, which is beyond his/her control. Furthermore, an experienced contractor would be more likely to request flexibility in design and construction to reduce the warranty costs and risks. The bottom line is that contractors learn from warranty projects and then show increasing tendency to accept warranty contracting. Another significant difference between with warranty experience and without warranty experience groups lies in the concerns about bonding availability. It seems that most experience in warranty contracting indicates bonding as one of the biggest bariers to retaining the use of warranty contracting. And this issue has not been sufficiently realized by those who have no warranty experience before (Table 3).

State DOTs can encourage contractors' learning by implementing pilot projects. In a pilot project, an experienced contractor will serve as an example to the local industry. His success in the warranty project will increase the confidence and knowledge of other contractors to accept warranty contracting. Simultaneously, they will learn the best practices and lessons, and become aware of the possible pitfalls in warranty contracting. It is interesting to identify that company size and the state residency do not contribute to the warranty learning process. So the perception that warranty contracting favors large firms is likely not true. The survey also shows no statistical correlation between company size and acceptance of warranty contracting. Combined with the finding that the company size doesn't affect the availability of bonds, it is safe to draw the conclusion that warranty contracting does not impede competition in the highway construction market.

Table 3: Analysis of Variance with Warranty Experience as Between Group Factor

	Warranty Experience in other States						
	w/o warranty experience		w/ warranty experience		Test		
	μ	σ	μ	σ	F-value	P-value	
Acceptance of Warranty Projects	0.64	0.24	1.00	0.00	7.47	0.01	*
Acceptance of DBW Projects	0.24	0.19	0.50	0.27	2.78	0.10	*
Impact on Construction Quality	0.38	0.51	0.50	0.27	0.29	0.59	
Impact on Owner-Contractor Relationship	0.00	0.70	-0.08	0.91	0.06	0.80	
Concerns							
Involved Risks and Liabilities	3.68	3.06	2.36	6.09	3.81	0.06	*
Warranty Duration	1.96	3.62	2.57	4.73	0.84	0.37	
Legal Issues	2.28	3.96	1.57	4.57	1.08	0.31	
Availability of Warranty Bond	0.32	0.23	0.93	0.07	19.31	0.00	*
Warranty Cost Estimating	2.08	3.99	1.50	4.73	0.71	0.40	

Note:
1. Sample size is 39, 25 of them without warranty experience, 14 with warranty experience.
2. Significant at the 0.10 level

CONCLUSIONS

The analysis shows that wide-spread industry acceptance exists for less than three years warranties in Alabama. There is a sufficient degree of acceptance for 4-5 year warranties in pavement projects. However, the local industry is not prepared to accept warranties for over 5 years. It has been also observed that there is very less difference between the small, medium and the large contractors in terms of availability of opportunity offered by warranty contracting. Although company size does not matter, warranty project experience does make a difference for a contractor whether to accept warranty contracting or not. In another words, contractors will learn from warranty projects and reevaluate the risks and liabilities associated with warranty contracts. This observation suggests a better strategy for state DOTs to implement warranty contracts. Implementation of pilot warranty projects helps achieve a significance level of market acceptance. The pilot projects must be carefully selected to ensure success. They will serve as both a test bed for evaluating the effectiveness of warranty contracts and an educational platform for the local contracting industry. Additionally, the development of the pilot projects will strengthen cooperation and partnership among the state DOT, the contracting industry, sureties, and beyond.

Local construction companies may need to adjust their strategies and opinions on warranty contracting. This research highlighted the fact that warranty contracting may not be as risky as it appears. Many contractors learn from past experience and are able to control the risks well. When the concept of “Get in, Stay in, Get Out, and Stay Out” becomes a new objective of the FHWA, the construction industry will see warranties becoming integral components in more and more transportation projects, especially in design-build projects. To maintain a competitive position, contractors need to consider providing operation and maintenance services. Participation in the policy discussion and cooperation with the state DOTs in pilot projects would help improve their competitive advantage in today’s changing construction market.

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