

A STUDY ON THE INTRODUCTION OF PERFORMANCE WARRANTY SYSTEM FOR PAVEMENTS INTO KOREA

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ABSTRACT: This study is designed to examine the current status of the performance warranty systems for asphalt pavements implemented in Europe, USA, and Japan, and to review the feasibility and possibility of introducing this system into the Korean environment. For such objectives, the concept and necessity of performance warranty and the status of Korean contracting systems and overseas performance warranty systems were evaluated. In particular, the bidding systems, performance guarantee systems, and maintenance work inclusion status in the projects and warranty specifications of Europe, USA and Japan were comparatively evaluated. And methods of introducing the performance warranty system by utilizing defects liability system and design-build contracts of Korea were suggested.

Keywords: warranty, performance warranty, warranty contracting, warranty system, performance specification

1. INTRODUCTION

Performance warranty system for asphalt pavement projects has been implemented by various European countries for such a long time, and its effect was verified. As a study on the expected effect of introduction and application possibility of this system in the USA is progressing, the number of projects applying performance warranty is rapidly increasing. It can be noted that in Japan, the performance warranty system suitable for Japanese constructional features is being implemented for its settlement.

Roads extension in Korea has been on the rise since 1970. And with the increase in the traffic volume and the number of medium/heavy vehicle traffic, damages of road pavement have increased accordingly. In line with this, the road maintenance cost has been rapidly rising since 1990. And the importance of design and construction considering Life Cycle Cost (LCC), including maintenance cost, is clearly emerging. And the necessity of performance warranty contracting system which is being implemented in Europe, USA and Japan and which provides LCC reduction effects, is brought about.

This study has been carried out in order to review the feasibility/possibility of introducing the performance warranty contracting system for the asphalt pavement works being implemented in Europe, USA and Japan into Korea. In this study, the concept and necessity of performance warranty contracting system and the performance warranty contracting system status of Europe, USA and Japan where this system is being

applied were surveyed and evaluated. In particular, the bidding systems, performance guarantee methods, maintenance work inclusion status in the projects and performance warranty specifications were comparatively evaluated. And methods of introducing the performance warranty system by utilizing defects liability system and design-build contracts of Korea were suggested.

2. CONCEPT AND NECESSITY OF PERFORMANCE WARRANTY CONTRACTING

2.1 Concept of Performance Warranty Contracting

A warranty is an assurance for the integrity of the product such that the product will serve its useful life and that if there is any deficiency the contractor will undertake remedial action. (Singh 2004) In the existing conventional contracting system, the client is providing the detail design, while during process of the construction, the contractor is performing quality control and inspection according to the design. However, in the performance warranty contracting, the contractor is allowed to select the materials or construction method by his own discretion within the range of complying with the requirements of the specification.

In general, the warranties include material and workmanship warranties and performance warranties. For the material and workmanship warranties, the method specifications are employed, and the contractors shall replace and repair any defect and damage that occurred due to inferior materials and poor workmanship after the

works completion. The warranty periods of material and workmanship warranties are generally a short period (around 5 months – 7 years) after the works completion. This contracting system is using the method specifications and is similar to the conventional Korean contracting system operating defects liability system. The difference from the Korean conventional contracting system is that the contractors have an option of material selection and partial discretion right and liability for the workmanship and guarantee the construction quality by implementing the maintenance works.

On the other hand, in case of performance warranty contracting system, the end result specifications are used and the contractors are allowed to be involved in mixed design as well as the pavement materials and construction methods. The contractors are then liable for any damage or defect due to the materials, construction and design during the warranty period. It is a general practice for performance warranty contracting system to apply a long term (5-20 years) warranty period. This contracting system can induce more technical innovation from the contractor, but the contractors may face a potential risk of having to secure competitiveness in terms of design, construction and maintenance.

2.2 Necessity of Performance Warranty Contracting

Roads extension in Korea has been increasing since 1970. With the rise of traffic volume and medium/heavy vehicle traffic, the road pavement damages have been frequently occurring. As a result, the road maintenance cost likewise rapidly increased since 1990. Fig. 1 shows the annual road extension and repair cost status of the Korea expressway. (Ministry of Construction &Transportation, Roads Repair Status) (Ministry of Construction &Transportation, Roads Status Survey) (Seo, 2007). With the increase of roads repair cost, the importance of design and construction considering LCC including maintenance cost for the road pavement is brought about. Furthermore, the necessity of introducing performance warranty contracting system being implemented in Europe, USA and Japan with LCC reduction effects into Korea, is on the rise.

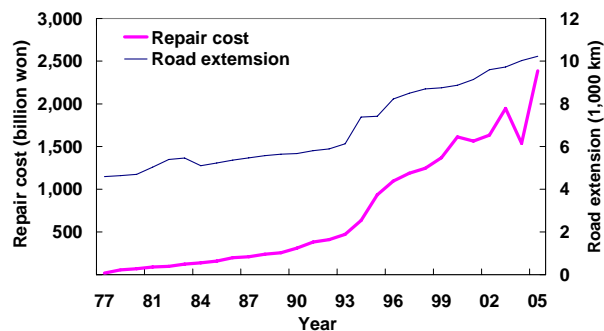


Fig. 1. Annual road extension and repair cost

Fig. 2 (Kwon, 2008) shows the frequency of service years in case of damage occurrence (condition requires repair exceeding the level of overlaying) of the local main road asphalt pavement. It can be observed that the early

damages occur most frequently during the elapse of 5-6 years after the work completion.

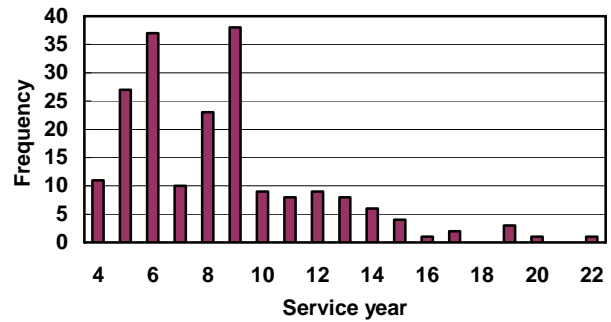


Fig. 2. Relation between service years of local main road asphalt pavement and damage frequency in Korea

One of the main reasons behind the occurrence of asphalt pavement damages during the early stages before arrival at the design life is known to be in the technical failure of the mixed design for the asphalt concrete. Technical failure of mixed design could be significantly improved through the implementation of the performance warranty contracting system. On top of this, the asphalt pavement life could be further extended, with limited cost, through the preventive maintenance works under the implementation of the performance warranty contracting system.

3. CONTRACTING SYSTEM STATUS OF KOREA

3.1 Bidding System of Korea

The bidding systems are one of the important factors to be considered for the success of the performance warranty contracting. There exist the prequalification system, qualification assessment system, lowest price awarding system, and integrated assessment awarding system in Korea. The prequalification system of Korea is supposed to be applied for the project over a certain magnitude. However, the discrimination power of assessment criteria was not sufficient, and the assessment process is considered to be distorted by the actually obligatory joint-venture contracting system.

The Korean qualification assessment system is a system that assists the qualified and competent bidder in securing his construction cost nearing to the actual construction cost. This system is usually applied for a design-bid-build contract. Under this system, the lowest bidder among the bidders who received an acceptable point for the bid price and non-priced factors is selected as a successful bidder. However, this system has actually resulted in the establishment of the lowest bidding rate deadline for possible contracting, thus causing it to be criticized for eliminating price competition. Furthermore, due to lack of discrimination power for the non-priced factors and operation of duplicated preliminary pricing system, the contractor who can pinpoint the lowest bidding rate deadline could be the most probable winner.

It is for this reason that this system is called “System of fortune” critically. (Lee, 2006)

The lowest bidding system has disadvantages of having the large possibility of inferior works due to excessive competition and unreasonably low price.

Bidding price and design point were arranged to be assessed compositely to select a successful bidder in design-bid-build system, and the alternative contracting system through the revision of the Act On Contracts To Which The State Is A Party, October 2007. For this reason, it can be seen that this system has a great potential to be developed into an advanced contracting system.

3.2 Defects Liability System of Korea

Defects liability system similar with performance warranty contracting system of the foreign countries is implemented in Korea as a warranty system. Defects liability period is stipulated by the relevant law. Defects liability period of asphalt pavement road is 2 years. The maintenance bond amount for the road pavement works is defined as 3/100 of the contract price.

The method of guaranteeing defects liability includes the provision of joint surety. In most cases, the client is requesting maintenance bond and joint surety at the same time. In the project contract, bonding rate in Korea is much lower than that of the USA, and the default rate is lower than that of the USA (Lee, 1996) as well because it is judged that the joint surety system in Korea is playing a role of strong guarantee means. However, the defects liability system in Korea is open to disputes as the determination criteria of ‘defects’ are not clearly defined.

4. COMPARISON OF OVERSEAS PERFORMANCE WARRANTY SYSTEM

4.1 Status of European performance warranty system

(1) Warranty period of European performance warranty system

Demand for road construction in Europe is increasing, and road maintenance is faced with many problems. Warranty contracting has become a fundamental system for asphalt pavement in Europe. The kinds and periods of performance warranty contracting are different depending on each country. Table 1 shows the warranty period of each European country. The warranty periods differ depending on required performance indicator.

Table 1. Performance warranty system and warranty period of European countries

	(Short-term) performance warranty	Pavement performance contract(PPC)	Pavement performance contract(PPC)	DBFO
Warranty period	5 years	11-16 years	20 years	25-30 years
Applied country	Denmark, Sweden, UK	Denmark, Sweden	Germany	Spain, UK

(D’ Angelo, 2003)

In the PPC, liability of design, construction and maintenance for specified level of pavement performance lie in the contractor. It is worth-noting that for warranting performance during the design life, the maintenance is

included. DBFO system includes maintenance exceeding total life period of the project, and the warranty period may be extended to a new period by giving the pavement road a new function to be re-used several times.

(2) European bidding system

European countries allow past performance and other non-priced factors to be reflected in the bidding process. These countries consider this contracting system as a decisive factor in the success of the warranty contracting. The two main methods reflecting non-priced factors into contracting system includes project-based prequalification and best value procurement. (D’ Angelo, 2003)

(3) European warranty bonds and retainage system

Performance warranty bond is required for securing financial solvency when any defect occurs during the warranty period. Warranty bond rate per country is diversified within the range of 0-10%. UK does not require warranty bond as they rely on their prequalification system. (D’ Angelo, 2003) As some European countries identify warranty bond with retainage system, they usually pay the construction cost by retaining the bond during the warranty period.

4.2 Status of US performance warranty system

(1) Introductory background of the performance warranty system and application status

Warranty system is one of the innovative systems being reflected recently in US highway project industry. According to a data issued in 2003, some states had implemented short term performance warranty projects with warranty period of 5-7 years. (See table 2)

Table 2. Performance warranty system of US states

State	Warranty period	Warranty type	Contracting type
Wisconsin	5 years	Short-term performance	
Florida, Minnesota	5 years	Short-term performance	Design-build
Michigan	7 years	Short-term performance	

(D’ Angelo, 2003)

(2) Warranty Bonds

US road industry was concerned over the bonding system at the initial stages of warranty system introduction. Except for Florida, every state implementing bonding system requires a performance bond. Estimation method of performance bond amount is different from each other. (See table 3)

Florida had minimal use of the bonds. This state started to implement the guarantee system similar with the UK system. (D’ Angelo, 2003)

(3) Bidding system

In the case of USA, the lowest bidding system is adopted. It was just recently that they started to implement the best-value procurement as a test case.

(4) Project contracting system that includes maintenance works

In the case of USA, federal funds were not allowed to be used on highway maintenance, and therefore the

Table 3. Performance bond amount of US states

State	Bond amount
Wisconsin	Estimated cost for a 1-1/2" overlay on the mainline pavement
Florida	Estimated cost to mill and replace 2" to the nearest \$25,000.
Michigan	New bituminous pavements – 10 percent of the total warranted bid amount. Bituminous overlays – 100 percent of the total warranted bid amount.
Illinois	New bituminous pavements – 20 percent of mainline cost. Bituminous overlays – 50 percent of mainline surface and binder.
Minnesota	New bituminous pavements – 30 percent of the total warranted bid amount. Bituminous overlays – 20 percent of the total warranted bid amount.

(D'Angelo, 2003)

warranty system that includes maintenance works could not be applied. However, in 1991, a relevant law was passed, and the application of the performance warranty system was allowed.

4.3 Status of Japanese performance warranty system

(1) Introductory background of the performance specified contracting system and application status

Japan had established an operation schedule for public works bidding contract procedure improvement in 1994 and had introduced VE system, design-build system, performance specified contracting system, comprehensive assessment contracting system and others. (Seo, 2007) Application status of Japanese performance specified contracting system is shown in Table 4.

Table 4. Application status of Japanese performance specified contracting system

	1998	1999	2000	2001	2002	2003
Number of contracting	2	14	28	53	179	131

(Seo, 2006)

(2) Characteristics of Japanese performance specified contracting system

In Japanese performance specified contracting system, the criteria for completed pavement performance is added to the material and working method specification. The contractors are allowed to suggest materials or working method. Japanese performance specified contracting system is specifying the performance only upon work completion. Therefore, the performance warranty period after the work completion does not exist, and maintenance works are not included in this system.

(3) Performance guarantee method

In Japan, it was surveyed that any case of breach of performance specified contracting system could not be found, as contractual breach is reflected in the work result assessing points as a way of guaranteeing performance upon work completion. This practice is similar with the prequalification system of UK. Due to this reason, the performance specified contracting project was ordered in a similar pattern with the general (not warranted) contracting project. It is understood that any separate system for performance guarantee is not being operated.

(4) Bidding system

As bidding systems, there are the lowest bidding system, technical proposal system, integrated assessment bidding system, and other systems. Integrated assessment contracting system is a system of selecting a successful bidder by assessing compositely the non-priced factors including performance, skill, and technology suggested by the technical proposal and the price as in the case of European best-value procurement. This system is applied for a large-scaled project. In this system there are also the design/construction proposal type and construction proposal type, and this system could be applied also for a design-build contracting system.

5. COMPARISON OF APPLICATION ENVIRONMENT FOR PERFORMANCE WARRANTY SYSTEMS IN KOREA AND ABROAD

5.1 Comparison of bidding systems

Various European countries consider prequalification process and best value system as important factors for the success of the performance warranty contracting system. Europe, USA and Japan have started the implementation of prequalification process and best-value procurement in order to implement the performance warranty system as shown on Table 5. As a result of this, they have garnered performance warranty effect. In Korea, it is considered as a requisite in the enhancement of the practicality of prequalification system. It is also important in the establishment of a contracting system that can assess price and technique compositely currently under introduction so as to implement the performance warranty system.

Table 5. Comparison table of bidding systems in Korea and abroad

	Europe	USA	Japan	Korea
Contracting system	·PQ ·best-value procurement	·PQ ·Operating the lowest bidding system ·best-value procurement under introduction	·PQ ·Integrated assessment bidding system	·PQ ·The lowest bidding system, ·Qualification assessment system ·Integrated assessment bidding system under introduction
Performance warranty effect	·effective	·Not effective	·Effective	·Not effective

5.2 Comparison of performance guarantee methods

In the performance warranty system, the bonding system (retainage system) is a means of making the contractor guarantee any committed performance. As shown on Table 6, in the case of Europe, they are implementing the bonding system but the bond amount is much smaller than that of USA. However, they are garnering the performance warranty effects by applying PQ process and best-value procurement and establishing reliability and cooperative relation with the contractors.

Table 6. Comparison of performance guarantee methods in Korea and abroad

	Europe	USA	Japan	Korea
Performance guarantee methods	·Bonding amount(retention) about 0-10% ·PQ, best-value procurement	·Warranty bonding amount(new asphalt pavement)1 0-30% of bidding price	·Project performance bond (No performance warranty bond after work completion) ·Project assessment point system	·No performance warranty system
Characteristics	·Bonding amount is small but performance warranty effect is realized by PQ & best-value procurement	·As warranty bond amount is big, medium/small contractors are excluded from bidding process.	·Through project assessment point system significant performance guarantee effects are realized	·Performance guarantee method is not sufficient due to unpreparedness of performance warranty bonding system and etc.

In the case of USA, the considerably big performance warranty bond amount is causing a problem as well. This problem is the fact that the medium/small contractors are unable to arrange long term performance warranty bond policy and are being excluded from the bidding process. Therefore, in order to implement performance warranty system in Korea, the arrangement of performance warranty bonding system and bidding system improvement shall be provided.

5.3 Comparison of maintenance work inclusion status in the projects

For the performance warranty projects, performance maintenance and life extension of the products are allowed through preventive maintenance implementation by the contractor. However for general contract projects where the contractor does not implement maintenance works, the performance of products are deteriorated, and life extension becomes impossible as time goes by since the preventive maintenance is not implemented until any defect occurs at the completed works. As shown on Table 7, Europe and USA include maintenance works in the performance warranty system. But for Korea and Japan, the maintenance works are not included in the contracted project. In order to introduce performance warranty system, the inclusion of maintenance works is required.

Table 7. Maintenance work inclusion status in the projects

	Europe/USA	Japan/Korea
Maintenance works inclusion status	·Maintenance works are included in the projects	·Maintenance works are not included in the works. ·Maintenance bonding system
Characteristics	·Maintenance works implemented by the contractor	·Maintenance duties are implemented by the clients ·Maintenance works is implemented by separate contracts

5.4 Comparison of performance warranty specifications

In order to introduce performance warranty system, the performance specifications that include performance indicator, performance threshold values and performance measuring methods are required. Clear and fair performance indicators are the main and decisive factor in the success of the performance warranty system. In the case of Europe, USA and Japan, the performance specifications are presented. However, in Korea, only criteria corresponding to the quality and dimensional criteria that are used generally in the method specifications are presented, and the performance specification has not been developed. It is therefore required to develop the performance specifications in order to introduce the performance warranty system.

6. INTRODUCTION METHODS OF PERFORMANCE WARRANTY SYSTEM INTO KOREA

6.1 Introduction method of performance warranty system by the utilization of the defects liability system

Comparison of defects liability system of Korea and performance warranty system of foreign countries is shown on Table 8.

Table 8. Comparison of defects liability system of Korea and performance warranty systems of foreign countries

Classification	Defects liability system of Korea	Performance warranty system of foreign countries
Warranty periods	·2 years	·5 years~20 years
Bond amount	·3% of contract price	·Europe: about 0-10% of bidding price ·USA: 10-30% of bidding price (new pavements) ·Japan: Nil:
Assessment level of surety company	·Not strict	·In the case of USA, strict
Guarantee methods	·Joint surety system ·Bond amount are reverted to national treasury.	·Europe: PQ, best-value procurement utilization ·USA: mostly bonding system ·Japan: Project assessment point system utilization
Assessment and repair criteria	No criteria for defects determination and repairs exist.	·Performance assessment and repair criteria at work completion and during service period exist.
Maintenance works	·Maintenance when the defects occur	·Routine and preventive maintenance

As shown on the table above, the defects liability system is similar with performance warranty system of the foreign countries in that for a certain warranty period after the work completion, the client requests the contractor to repair the products when any defects occurred or the performance is not sufficient, as revealed by inspecting the products at regular intervals. Furthermore, the bonds are utilized as a guarantee means. However, defects liability system differs from the performance warranty systems in terms of the warranty periods, bond amounts, assessment level of surety

companies, criteria of assessment and repairs. Therefore, in order to apply performance warranty system through the utilization of the Korean defects liability system, the warranty periods should be extended and the bond amounts should be increased if any other guarantee means is not available. In addition, as the burdens of the surety companies for the performance warranties are getting bigger, the assessment function of the surety companies that assesses the contractor's ability to fulfill his contractual obligation should be enhanced.

On top of that, the joint surety system being implemented under defects liability system should be abolished. This is due to the fact that the application of the joint surety system in the performance warranty systems may be difficult as the burden of the joint surety is excessively heavy. Furthermore, in order to apply performance warranty system under defects liability system, in case of contract default, the reversion system of bond amounts to the national treasury may not be feasibly maintained because that reversion amounts in a form of penalty could go well-beyond the reasonable level. In the application of performance warranty system, the performance assessment criteria and repairing activity criteria are required to be arranged at a certain time at the work completion and during service period after the work completion as well.

6.2 Introduction method of performance warranties by utilizing design-build contracts

Comparison of design-build contracts of Korea and performance warranties of the foreign countries is as shown on Table 9.

Table 9. Comparison of design-build contracts of Korea and performance warranties of the foreign countries

	Design-build contracts of Korea	Performance warranties of foreign countries
Used specifications	·Method specifications ·Quality level suggestion allowed	·Performance specifications ·Performance level suggestion allowed
Assessment functions	·Quality assessment of proposals and products	Performance assessment of proposals and products
Involvement scopes of the contractors	·Design + Construction	·Construction (Japan) ·Construction+ Maintenance ·Design+ Construction+ Maintenance
Bonding contents	·Performance bond + Maintenance bond	·Performance bond + Performance warranty bond

As shown on the table above, the design-build contracts of Korea is similar to the performance warranties in the aspect that the contractors are allowed to suggest criteria regarding the qualities of design and construction. However, the design-build contracts of Korea are different from performance warranties in terms of used specifications, assessment functions, involvement scopes of the contractors, and bonding contents.

In order to apply performance warranties by utilizing design-build contracts, the use of performance specifications is required, and the suggestion of

performance level of products by the contractor is likewise required. In order to achieve these objectives, the development of performance specifications that can be utilized for performance warranties is required. In addition, the contractors are required to raise his technical level so that he could suggest the performance level of the products. On the other hand, the client is required to raise his technical level so that performance level suggested by the contractors could be properly assessed. In addition, under the design-build contracts, the defects liability system is being utilized as a guarantee means. Therefore, in the introduction of the performance warranties by utilizing design-build contracts, the systematic environments to introduce performance warranty system by the utilization of the defects liability system are required to be arranged.

7. CONCLUSIONS

This study has been carried out in order to review the feasibility/possibility of introducing the performance warranty contracting system for the asphalt pavement works being implemented in Europe, USA and Japan into Korea. In this study, the concept and necessity of performance warranty contracting system and the performance warranty contracting system status of Europe, USA and Japan where this system is being applied were surveyed and evaluated. In particular, the bidding systems, performance guarantee methods, maintenance work inclusion status in the projects and performance warranty specifications were comparatively evaluated. And methods of introducing the performance warranty contracting system by utilizing defects liability system and design-build contracts of Korea were suggested. The main conclusion of this study is as follows.

1. In order to introduce performance warranty system, it is required to arrange the performance guarantee methods by supplementing the currently implemented bidding systems. As a means of performance guarantee, it is required to introduce or utilize the performance bonding system (or retention system), effective PQ process and best-value procurement (integrated assessment bidding system) comprehensively. Furthermore, the introduction and implementation of project contracting system including maintenance works into Korea are required, and the development and utilization of performance specifications are required.

2. In order to introduce performance warranty system, the defects liability system and design-build contracts can be utilized.

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