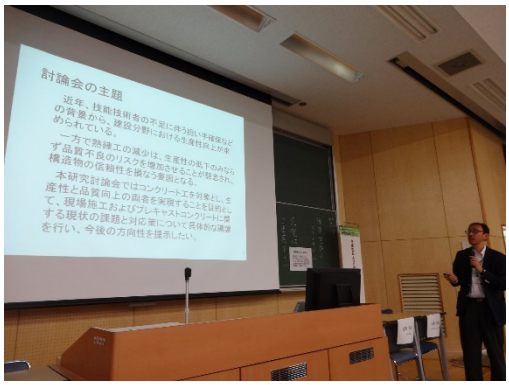
Panel Discussion at JSCE 2016 Annual Meeting

Concrete engineering – toward improved productivity and quality

Chair: Hikaru Nkamura (Nagoya University)
Panelists:
Tadatomo Ishibashi (JR East Consultants Conpany)
Fukuhisa Iwasaki (Ministry of Land, Infrastructure, Transport and Tourism)
Takashi Kawata (Shimizu Corporation)
Kyoji Niitani (Oriental Shiraishi Corporation)
Takashiro Tamura (National Institute of Technology, Tokuyama College)
Kazunori Sato (Tohoku Regional Bureau Ministry of Land, Infrastructure, Transport and Tourism)

Overview



Introduction by Prof. Nakamura

A panel discussion was held by the Concrete Committee as part of the Japan Society of Civil Engineers 2016 Annual Meeting at the Kawauchi-kita campus of Tohoku University on September 7th, 2016. With proceedings led by Prof. Hikaru Nakamura, six speakers gave presentations focusing on improving the productivity and quality of concrete structures: Dr. Tadatomo Ishibashi (work of the subcommittee for concrete structure design and construction for improved productivity and quality), Mr. Fukuhisa Iwasaki (introduction to i-construction), Mr. Takashi Kawata (work of the Japan Federation of Construction Contractors for improved productivity and quality of concrete structures), Mr. Kyoji Niitani (examples of effective precast concrete application and current issues), Prof. Takahiro Tamura (work of subcommittee studying management to ensure quality and durability of concrete structures) and Mr. Kazunori Sato (example of concrete structure quality and durability assurance at Tohoku regional

bureau of the Ministry of Land, Infrastructure, Transport and Tourism). These presentations were followed by a question and answer panel session.

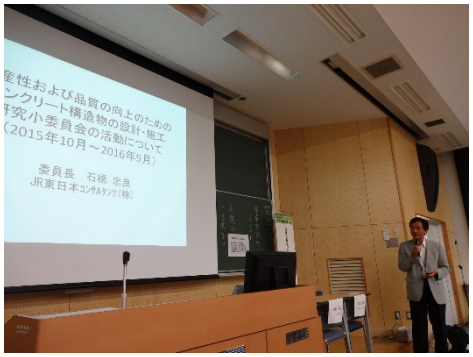
Presentation by Dr. Ishibashi

In the civil engineering field, there has been little improvement in the productivity of work on concrete structures. With the pool of skilled laborers decreasing in Japan as the birth rate falls and the population ages, the risk of falling productivity and quality is real.

A subcommittee (JSCE-267) discussed the design and construction of concrete structures for improved productivity and quality during the period Oct. 2015 to Sep. 2016. The focus was not only on clarifying the technical issues that inhibit productivity and quality improvement, but also on issues related to specification and ordering as well as on proposing suitable countermeasures. In addition, the effective application of precast concrete to the civil infrastructure was also discussed.

In his presentation, Dr. Ishibashi outlined some of this activity. For example, a specified reinforcement arrangement can sometimes be impossible to fabricate when there is a dense reinforcement layout. To avoid such trouble, three-dimensional modeling methods such as 3D CAD should be used in design to confirm that there is no interference among the reinforcement. It is important to add a detailed verification of the design by 3D modeling to the order specification when the reinforcement is dense. It is also necessary to add suitable regulations to the JSCE Standard Specifications for Concrete Structures to cover this.

Examples of improved productivity through the application of relatively massive precast concrete were introduced, classified by structure type: culvert, bridge, river revetment and others. For each example, a summary of the work, the reasoning involved, the construction method and the results were presented.

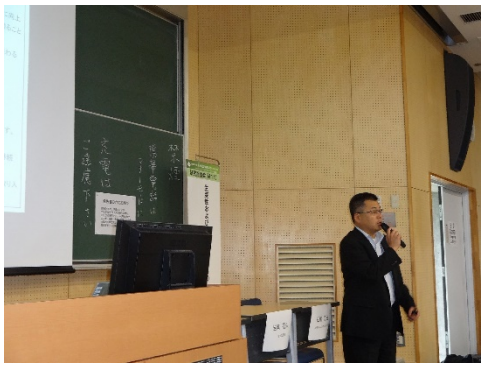


Dr. Ishibashi

Presentation by Mr. Iwasaki

In the past, a rising population in Japan meant that manpower was easily available and productivity was not a major focus. However, with population decreasing in recent years, a manpower shortage has arisen in the construction industry. In this regard, the Ministry of Land, Infrastructure, Transport and Tourism has been promoting 2016 as the year of productivity improvement through “i-construction”, which means the use of information and communication technology (ICT) in construction. The aim is to ensure that productivity improvements outstrip the falling population so as to ensure economic growth. The application of i-construction can also improve worksite safety.

The ministry proposes efforts in three policy areas: use of ICT (and especially 3D digital data) in all construction processes including surveying, design, construction, inspection and maintenance; spreading of construction periods so as to avoid a concentration of completions at the end of the business year and allow more appropriate construction periods; and total optimization through the use of precast concrete as well as in-situ concrete. The presentation included an explanation of the ministry’s approaches to productivity improvement, such as consultative meetings with experts and the setting of guidelines.



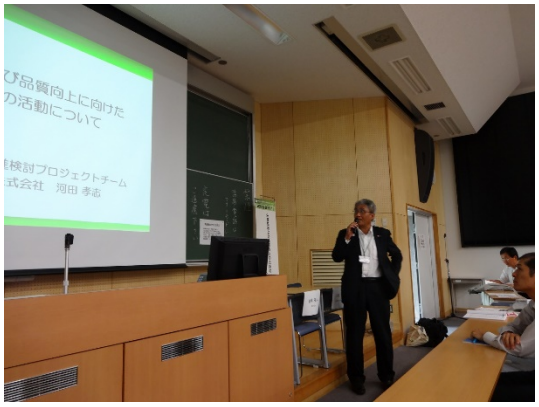
Presentation by Mr. Iwasaki

Presentation by Mr. Kawata

The number of skilled laborers will decrease by about 1.28 million over the next ten years. Even if new young workers can be found, it is estimated that there will be a shortage of about 3.5 million laborers as compared with the present population. This shortfall should be covered by productivity improvements.

The Japan Federation of Construction Contractors has established guidelines for promoting productivity improvements as a central pillar of the government’s i-construction recommendation. The federation set up a project team to promote precast concrete thoroughly in Sep. 2015. The team’s activities include a survey of precast

concrete applications, analysis of the effect of using precast concrete, selection of appropriate fabrication methods for precast concrete and specific strategies for the application of precast concrete to infrastructure. Seven types of construction were surveyed and the focus was on construction period, labor and construction cost. In the presentation, the case of box culverts was picked out for explanation.



Presentation by Mr. Kawata

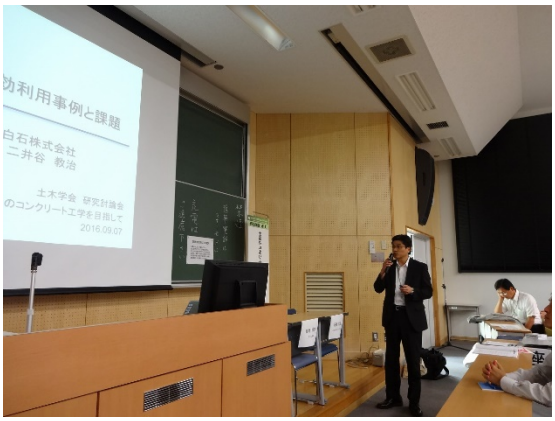
Presentation by Mr. Niitani

Girders fabricated using precast prestressed concrete were taken up as an example. Standards for precast prestressed concrete composite girders are provided in the specifications for highway bridges and two types of cross section are allowed: I-shape and U-shape. Precast girder segments are joined on site by applying a prestressing force. This method leads to labor-saving, rationalization and cost-saving.

Precast concrete is also applied to bridge piers. Cross-sectional slices of precast concrete are joined in the vertical direction by applying a prestressing force, thereby reducing the construction period and saving labor. Precast components are also used in the construction of massive box culverts in order to minimize traffic disruption and provide uninterrupted service to the public.

The merits of precast concrete include reduced construction period, labor-saving, assured quality, reduced traffic disruption, and improved safety, but another important factor is that special concretes such as high-strength concrete and concretes containing mineral admixtures for environmental protection can be used. There are also issues, such as initial cost, insufficient standardization and connection or joint problems. Overcoming these issues requires a comprehensive evaluation, such as by calculating a total cost that includes initial cost, social benefit of reduced traffic disruption, shorter construction period, reduced labor requirement, reduced construction noise, reduced CO_2 emissions and lower life cycle cost. Technical developments such as improved

mechanical connections are also important.



Presentation by Mr. Niitani

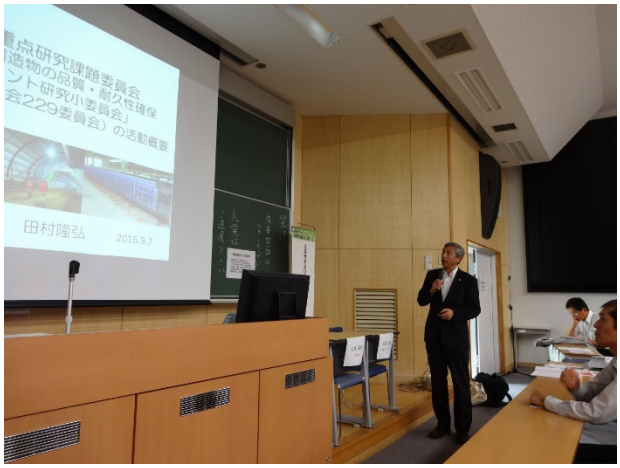
Presentation by Prof. Tamura

The subcommittee on “Study of management to ensure quality and durability of concrete structures” (JSCE-229) came into being in April 2016 following the work of the subcommittee dealing with quality assurance of concrete structures (JSCE-350). It focuses on in-situ concrete and aims to encourage concrete engineers “to construct quality concrete structures”. The activities of JSCE-350 revealed that the cracking inhibition system developed by Yamaguchi prefectural government leads to concrete structures of improved quality and has been deployed in the case of earthquake recovery roads and others in the Tohoku region of northern Japan. For sustained development of the system, standardization of technical guidelines and construction management are necessary. Hence, JSCE-229 focuses on management systems, information technology for data systems and the training of engineers.

The committee notes that technology for quality assurance in each process (design, construction and maintenance) should be developed and then a management process for reliably implementing each technology on site needs to be established. In addition, the plan-do-check-act (PDCA) cycle is being studied as a way to bring together design, construction and maintenance and organize various knowledge. An appropriate system of contracting and ordering as well as suitable guidelines are also being discussed.

A check sheet was created by Yamaguchi prefectural government in order to understand construction records and therefore construct quality concrete structures. Both of contractee and contractor check 29 items at the construction site. When the work is completed, a visual inspection is carried out. The results of the inspection are then reflected in the work plan for the next lift or construction stage. The committee will work to deploy such a PDCA system.

The work of the committee takes into account the use of mineral admixtures to avoid the alkali-silica reaction (ASR). Technical guidelines are necessary for this, taking into account regional environmental conditions.

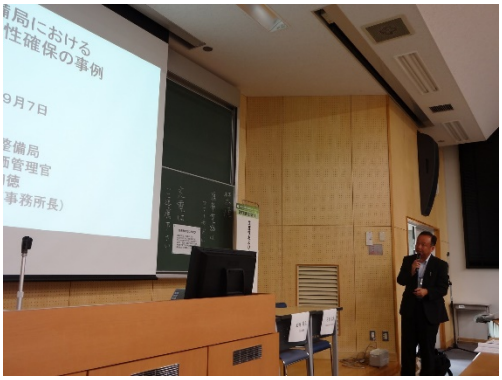


Presentation by Prof. Tamura

Presentation by Mr. Sato

The assurance of concrete structure quality and durability in the case of earthquake recovery roads constructed after the Tohoku earthquake was described. The severe cold experienced by the Tohoku region means that large quantities of de-icing agents are used, especially in coastal and mountainous areas. This leads to significant salt attack and frost damage in concrete structures. Under such a severe environment, low quality structures readily suffer damage and deterioration. Hence, the Tohoku regional bureau of the Ministry of Land, Infrastructure, Transport and Tourism has adopted Yamaguchi prefectural government's PDCA cycle system to ensure quality and durability. Construction work is examined using a check sheet. Curing under the cover of a vinyl wrapping after form removal was practiced. The effect of using this method was confirmed by visual inspection as well as by air permeability and water absorption tests after construction. Quality was shown to have improved.

Scaling and crushing of concrete slabs under Tohoku's severe winter environment was shown to be inhibited when slag cement was used. The initial cost of using fly ash cement for slabs as a measure to avoid ASR is relatively high as compared to ordinary Portland cement, but replacement of a deteriorated slab is much more expensive. Assuring durability is important from a viewpoint of total cost.



Presentation by Mr. Sato

Panel discussion

Panelists

Question from the audience:
With reduced construction periods, will workers have more days off?

Mr. Iwasaki:
Actually, even now, it is difficult to ensure that workers have two days off per week. Of course, in the prime contractor, employees can have two days off per week. However, construction workers do not want to take two days a week since they work on a day-rate system. As a contractee, it is necessary to prepare a system of time off. On the other hand, employment arrangements, meaning the payment system for workers, should be improved at the same time. Anyway, in general, if construction periods are reduced, it is easier for workers to take time off.

Mr. Kawata:
I'll add to Mr. Iwasaki's words that it is important to increase construction worker pay so that they are able to live properly even if they take two days off per week. In order to overcome the shortage of construction workers, we have to improve the construction industry to make it more attractive.

Chairperson:
What is the main barrier to achieving improvements in productivity and quality?

Dr. Ishibashi:
In efforts to improve productivity, quality control is most important. Therefore, construction methods that ensure quality are necessary. Inspection methods to certify

quality are also necessary. I would encourage researchers to develop such methods. On the other hand, the time taken in consultations before adopting a new technique is currently too long. I would ask contractees to shorten the time required.

Mr. Iwasaki:
It is important to make rules for the use of new and better technologies. Standards and guidelines must be formulated. Productivity improvements may lead to cost reduction. Shortening construction periods and reducing labor requirements are also important points. I hope to see further technological developments.

Mr. Kawata:
I think precast concrete is a good way to improve productivity and quality. Of course, precast concrete is currently expensive as compared to cast-in-place concrete. However, if we consider the total cost over the whole life cycle of a structure, precast concrete is not so expensive. So in cost calculations, it is preferable to take into account not only initial cost but also life cycle cost. Moreover, fabrication fees will fall when the amount of precast concrete ordered becomes larger. I will be working to spread the application of precast concrete.

Dr. Niitani:
I agree with Mr. Kawata's opinion. Productivity improvements will come about through the use of precast concrete. However, initial costs will be higher as Mr. Kawata mentioned. I hope that the merits of precast concrete will be evaluated adequately. At the same time, as a researcher, I will do my best to develop the technology further.

Dr. Tamura:
Good quality construction depends on accumulating, sharing and inheriting expertise. And also, autonomous thinking is important. This is especially true for site supervisors; a guidebook outlining how to think is more important than a manual.
In construction, I hope to see everyone making the best concrete from the very first by paying attention to detail.

Mr. Sato:
I'm always encouraging site engineers to make good concrete structures. I use quality structures as examples, showing them to engineers. I want to see a virtuous cycle through which concrete structures become better and better.

The initial cost of a high-durability structure is high. But in the case of concrete structures, differences in performance are often neglected. This is unlike some goods that we buy, such as cars, where we usually compare costs after taking into account differences in performance. Just as with selecting a car, it is preferable to adequately evaluate the performance of a concrete structure. To do this, we must adequately evaluate the required performance. We really need to show society what high-performance precast concrete is like.

Chairperson:
Do you have any thoughts about initial cost and performance?

Dr. Ishibashi:
Proper evaluation of performance depends on a good inspection method. That means a method which differentiates good technology from bad is necessary. In general, a bad concrete structure suffers from weak points in design and construction. Of course, proper attention is needed to achieve a quality concrete structure, while inattention leads to bad structures. For this reason, construction methods likely to result in imperfection should be avoided. Easy construction methods are preferable. On the other hand, proper inspection methods are also necessary.

Mr. Iwasaki:
Concerning initial cost, the argument for considering total cost is not necessarily a new one. In fact, this approach is already included in construction specifications. Despite this, the idea of total cost remains poorly understood. It is necessary to embrace this idea at every construction site.

Question from the audience:
I think current construction cost estimations are based on the use of cast-in-place concrete. How do we estimate total cost when precast concrete is used?

Mr. Iwasaki:
The situation is different in the case of preliminary design and specific design. However, as you point out, a method of cost estimation for precast concrete remains to be developed.

Chairperson:

Do you have some thoughts about inspection methods?

Dr. Tamura:
The purpose of inspection is quality control. The surface inspection evaluates not only surface quality itself but also concrete quality. Coefficient of water permeability and coefficient of air permeability are two evaluation indexes for the durability of concrete structures.

Chairperson:
What about the contractee's delivery inspection?

Mr. Sato:
The delivery inspection typically involves only strength and dimensions. Surface quality is rarely inspected. I feel that completion inspections are of lesser importance for concrete structures. The process of casting and curing is most important, so checks at each process during construction are more important.

Comment from the audience:
Cast-in-place concrete and precast concrete are quite different. I think the advantage of the productivity improvements is reduced time and effort rather than lower construction costs. The construction costs usually become high when the new technology is first adopted. However, when its technology is adopted widely, the costs will become small.
Precast concrete enables both productivity and quality improvements to be achieved. However, we have to consider how much we need improved quality.

Chairperson:
What are your thoughts on specifications for precast concrete?

Mr. Kawata:
I think standardization is necessary. Of course, not all structures can be constructed using precast concrete. Therefore, to expand the application of precast concrete, it is necessary to make use of it whenever a structure is suitable for its application. On construction sites for architectural buildings, little cast-in-place concrete is used, and many precast concrete components are used. We have to consider what the difference between architectural buildings and civil structures is.

Chairperson:
How do we think the quality of precast concrete?

Dr. Niitani:
Of course, quality of concrete should be the same for both of cast-in-place concrete and precast concrete. However, cast-in-place concrete is affected by ambient condition. As a result, durability of concrete become different between cast-in-place concrete and precast concrete. I think that difference of the durability is one of the advantage of precast concrete. And the evaluation method of its difference is desired.

Chairperson:
How do you think the relationships between construction and design? What is the consideration in design?

Dr. Ishibashi:
For the precast concrete, when the amount increases, construction costs are reduced. The contractee and designer must understand this. For cast-in-place concrete, certain problems may arise during construction in relation to the rebar arrangement. Adequate effort and time must be expended to overcome such rebar arrangement problems.

Mr. Iwasaki:
I agree with Dr. Ishibashi. Problems arise on site due to divergences from the drawings. This leads to many reworkings in the construction process. In the construction of a concrete structure, there are always some details that cannot be fixed when the initial order is placed. To deal with these, technical collaboration with the contractor is desired. I think a cooperative system should be developed; it may also be necessary to change the contract methodology. Incidentally, I plan to develop guidelines for the avoidance of rebar interference in the design process.

Chairperson:
How do you think the design process can improve quality?

Dr. Tamura:
I think that durability is rarely considered in the design process. Concrete quality is in the hands of the contractor. Contractors make a great effort in the construction process.

Mr. Sato:
I have heard that the design is sometimes changed on site because of technological limitations of construction methods.

Question from the audience:
The specifications for highway bridges are now under revision. However, information relating to i-construction and precast concrete is missing. What is the thinking at the Ministry of Land, Infrastructure, Transport and Tourism?

Mr. Iwasaki:
I think elemental technology is currently being discussed within each investigative committee. It will be made public soon.

Chairperson:
What expectations do you have for the Standard Specifications for Concrete Structures?

Dr. Tamura:
The technical level of the specifications is very high. However, descriptions are too long to read easily. It is important that site engineers are able to understand the specifications.