ADVANCED CONCRETE APPLIED AT VIETNAM

Tran Ba VIET [1]

INTRODUCTION

In the recent years, the advanced types of concrete applied in Vietnam include: High Performance Concrete (HPC), Self - Compacting Concrete (SCC), Steel Fiber Concrete, Roller Compacted Concrete (RCC) and Concrete for Marine structures. In addition in Vietnam, Rice Husk Ash (RHA) has also been studied to be used for production of these types of concrete. In this paper, the author presents the main results of the research and application of the above mentioned types of concrete and RHA in construction industry.

HPC – HIGH PERFORMANCE CONCRETE

This type of concrete is recognized as a high performance concrete type in addition to high physical- mechanical properties. HPC has been developed since the availability of high rank - water reduced admixture in the construction market. We have studied producing high - slump concrete with grade of 100MPa using either PC 40 or PCB 40. In fact, we have successfully produced precast elements of 80MPa: the tube piles, and in-place structural elements of 60MPa were also cast. Concrete with strength up to 60MPa has been used for precast elements, columns and beams of the lower stories of high-rise buildings, for water supply piping system, bridge girders and abutments/piers, as well as for elements that are the load-bearing ones in addition to waterproofing. For the time being, concrete with the strength of 60MPa can be easily produced at the commercial ready – mixed concrete stations (plants) in the routine production conditions. Crushed lime stone can be used as coarse aggregates for production of 60MPa strength concrete. With higher concrete strengths, granite, basalt should be used. Floated coal ash, lime stone powder, or activated pulverized coal ash can be used to replace a portion of cement and to increase the fine amount. Granular coal ash, the waste discharged from the metallurgical industry, can be imported from Japan to be used for replacing a portion of cement in concrete. Concretes with high slump, from 14-26cm, were produced. To produce concretes with the strength equal to and more than 60MPa, SF and RHA should be used. Studying on HPC is helpful for production of Steel Fiber Concrete, anti-corrosion concrete for Marine structures and for Self- Compacting Concrete.

[1] *Dr. Eng., Deputy Director, Vietnam Institute for Building Science and technology (IBST), email: vietbach57@yahoo.com*

SELF – COMPACTING CONCRETE

SCC has been studied since the availability of new-generation super-plasticizer of polycaboxylate Natri in the Vietnam construction market together with the presence of MBT and SIKA firms. Commercial names of the two admixture families are Glenium and Viscosity. The two mentioned firms have commenced providing their clients with the aids to the research and application of these admixtures. At present, the cacboxylate-based admixtures supplied by other firms such as Grace, Stondhard, and suppliers from China (Nikkang) are available in Vietnam construction market.

However, to legalize the use of SCC in Vietnam, the Vietnam Institute for Building Science and Technology (IBST) has studied the production of SCC, using the two mentioned super plasticizers for the concrete of different grades of strength: 30, 40, 50, 60, 70, 80 MPa. Both cement types PC and PCB with either Pha Lai thermo-power plant floated coal ash, crushed sand, or lime stone powder as a filler can be used.

From results obtained, the procedure for proportioning and construction of SCC has been developed by IBST and it was issued by the Vietnam Ministry of Construction (MOC).

At present, the wide application of this concrete is limited due to the high price of the admixture that makes the price unit of SCC higher than that of normal concrete. The price of the admixture at present in Vietnam is VND 60,000/litre and it makes the price unit of concrete increase about VND 200,000/m^3 than normal concrete. For the time being, SCC has been applied to casting bridge girders, structural elements with dense reinforcement, facing concrete such as that used for bridge desk waterproofing.

Based on research results on SCC, SCC with scattered fiber reinforcement for the facing and for the elements that are load-bearing ones in addition to waterproofing, such as the lining of Hai Van tunnel and other structures, has also been studied.

The disadvantage of the new generation super plasticizers is the high slump loss, therefore, the use of concrete in the hot weather condition or the use of ready-mixed concrete is not reasonable. This is the question that should be continuously studied. The use of SF (Silica fume) or RHA (Rice husk ash) for replacing a portion of cement in concrete has also been studied and a good result was obtained. SF and RHA have resulted in a strength ratio that meets the required standard.

SCATTERED FIBER REINFORCED CONCRETE (SFRC)

At present, two types of this concrete, PPFC (polypropylene fiber concrete) and SFC (scattered steel fiber reinforced concrete), are being applied. Research and application results of these two concrete types to different fields such as the facing of waterproofing structure, precast sewers, concrete elements that are the load-bearing ones in addition to waterproofing (such as tunnel lining, architectural concrete, decorating concrete,..) are available.

Some research results have been developed to be a Ph.D. thesis. The prosperity of application of scattered fiber reinforced concrete (SFRC) to the Vietnam construction field is very high. PPFC with grade of 30 has been applied to the facing of the steps of My Dinh National Stadium. Another applied research on PPFC for decorating concrete has also been developed in a testing scale.

SFC using RADMIX steel fiber has been applied to the elements that are load-bearing ones in addition to waterproofing, such as the lining of Hai Van tunnel and other defense structures.
At present, IBST can produce SFC with grade up to 100 and flexural strength of 250daN/cm^2 whose slump is 15cm.
Some types of steel fiber such as cold rolled fibers, hot–rolled/laminated ones with different lengths and diameters have been considered to be used in different construction conditions under the action of the Northern and Southern climate conditions of Vietnam.
The properties such as: ultimate curing strength, draying shrinkage, plastic shrinkage, impact-resistant ability, anti-cracking ability, corrosion resistance, train-stress in the Northern and Southern climate conditions of Vietnam have also been initially studied. The studies will be presented in a Ph.D. thesis and another three MEng. theses.

ROLLER COMPACTED CONCRETE (RCC)

RCC has been studying for the last 3 years. Though the research result obtained is limited, particularly the production technology, quality control, testing and construction equipment, it is recognized that RCC will be widely applied to the construction of water works in the coming years in Vietnam.
In fact, the 67 m high PlayKrong hydro-power plant's dam and the 56m high dam of Dinh Binh water irrigation work were constructed with RCC. A 2,000m^3 test block of RCC at PlayKrong and another 3,000m^3 test block of RCC were cast at Son La hydro-power plant to check the proportions (grading parameters) of RCC as well as the construction technology. Testing data on the strength of the cast block, waterproofing grade of concrete in the direction perpendicular with the casting surface are met. However, the permeable parameter along the casting surface, the bonding regarded as the tensioning resistance (anti-sliding resistance) between the slip formed layers have not been tested yet. The grading of aggregates should be adjusted, particularly the maximum size of aggregates. So do the technological parameters, particularly the rolling rate, which depends much on the grading. The thermal problem and problem of thermal stress have not also been controlled.
In the near future, the following dams are expected to be constructed with RCC: Ban Ve, A Vuong, Se San 4Dong Nai 3, Dong Nai 4, Song Tranh 2, Ban Chat, Huoi Quang and, the largest one is the dam of Son La hydro-power plant, which is 135m high with some 3,3 million of m^3 of concrete.
Based on the research results, we are now developing the construction and acceptance standards for RCC and these standards will be soon submitted to the Ministry of Construction for approval.
A research fellow has developed his research result and turned it out to be a Ph.D. thesis. The strong development of RCC in Vietnam is due to two main causes: a lower cost and a shorter duration of construction.
With regard to RCC studies, the following main questions are left undone: the bond between the lifts, the calculation of anti-sliding factor for the lifts, the permeable parameter along the casting surface, the quality control at the construction site, particularly the difference of the bond of different areas of the top lift; the control and construction of the bedding concrete layer (in this concrete, the amount of paste is more than the normal one); the reduction of permeable pressure through the bottom lift and the contraction joints of the top lift; the

analysis and control of thermal stress of RCC dams; the calculation and inspection of the monolithic nature of RCC dams in terms of bearing and waterproofing capacity, particularly the dam of Son La hydro-power plant, which is 135 m high with some 3,3 million of m^3 of concrete and built in an activated earthquake zone; the calculation and selection of mixing system of equipment, transportation and construction equipment; the construction measures in the flooding seasons. These are the urgent (burning) issues that must be studied prior to the construction of the Son La hydro-power plant dam, which is located on the upstream of the Red river, directly affecting the Hoa Binh hydro-power plant as well as the Red river delta, in addition to Hanoi, the capital of Vietnam. Vietnam cannot solve these questions itself and it needs to be consulted by the experienced foreign consultants such as the Japanese and Chinese ones.

Photo 1 RCC at Dam PlayKrong
(Kontum Province, Vietnam)

Photo 2 RCC at Dam Dinh Binh
(Binh Dinh Province, Vietnam)

WITH REGARD TO CONCRETE FOR MARINE STRUCTURES

In Vietnam, there is more than 3,000 km of coastal length. Thus, to study on concrete for marine structure is an urgent need. It has been studying for more than 20 years and now, many results on this filed are available. The Vietnam Institute for Building Science and Technology (IBST) has also conducted a great programme for more than 5 years from which, many specifications/guidelines on design, construction and acceptance for marine concrete structures have been developed by IBST and approved by Vietnam MOC to be issued as a legal basis for construction and acceptance of marine reinforced concrete structures.

One of the important matter that should be paid much attention with regard to the actual investigation and research result is the zoning of marine climates and zoning of sea water action on the corrosion of reinforced concrete structures. The research results showed that: there was no sulphate-corroded trace in marine concrete structure; Thus, it means that steel corrosion will makes concrete deteriorated before sulphate-corroded phenomenon can be identified. Based on this result, the main orientation of anti-corrosion is to prevent steel corrosion caused by ion Cl^-. This solution can be performed by increasing the concrete cover,

increasing the density of concrete, the waterproofing ability, adding corrosion inhibitors such as calcium nitrite to concrete during the construction process; or by covering reinforcement steel with an anti-corrosion coating and a coating for concrete. The research result obtained in Vietnam is similar to that gained by the Japanese colleagues at the PARIS. However this concept is different from our traditional one. In the above anti-corrosion solutions, the solution of increasing concrete quality by using HPC with RHA, in addition to the use of calcium nitrite as a corrosion inhibitor is often preferred when constructing new marine structures.

Research results have been being applied in building new structures, repairing the old ones, such as the adjustment of the thickness of concrete cover for the Bai Chay bridge and many other marine concrete structures in Vietnam.

WITH REGARD TO RESEARCH AND PRODUCTION OF RHA (RICE HUSK ASH)

To produce HPC, SFC, anti-corrosion concrete for marine concrete structures, silica fume (SF) is required to be used as a super-fine mineral admixture. In Vietnam, this is the exported admixtures with a very high cost due to the transportation expenses.

We have studied the production, and equipment required to activate rice husk as rice husk ash (RHA) according to Metha – Pitt technology. The strength activation of RHA produced according to this technology is similar to that condensed SF, but with a very cheap price due to the advantage of using rice hush much available in an agricultural country as Vietnam. At the same time, we have studied to develop the standard on strongly-activated mineral admixtures of RHA and SF used for concrete and mortar. The said standard was issued by Vietnam MOC, creating favorable conditions for wide application of RHA to the production of the above mentioned concrete. RHA produced by us can be exported to other countries, including Japan, for production of HPC.

CONCLUSION

Herein above is some brief information about the research, production and application of various types of advanced concrete in Vietnam in the recent years. The development of construction field, particularly the development of the infrastructure with a rate of over 16%/year has made the demand of using advanced concrete urgent. Mastering of the production technology, applied design and technological equipment is the task of technology transfer. There are many other questions relating to advanced concretes that should be understood and clarified. Therefore, the cooperation, the aid in training, research and application of advanced concretes are needed.

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