Review of development of GRC in japan

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Abstract

Nippon Electric Glass started production of AR-glass fibre in 1976. This form of glass has been in production for nearly 40 years. This paper reviews the company's experience over the past 40 years' with NEG ARG Fibre.

INTRODUCTION

Nippon Electric Glass started production of AR-glass fibre, which is called as "NEG ARG Fibre" in 1976. We have been producing it in Japan for nearly 40 years. Nowadays, our "NEG ARG Fibre" has become the only time-tested AR-glass fibre which is still produced in the same factory and used globally.

ALKALI RESISTANT GLASS FIBRE FOR GLASSFIBRE REINFORCED CONCRETE

As you know, alkali resistant glass fibre was introduced as the reinforcing material of GRC. Alkali resistivity of glass fibre is determined by zirconia content in the glass composition. 16% of zirconia content is specified as the minimum content giving sufficient alkali resistivity to glass fibre in the US, Europe and Japan. "NEG ARG Fibre" has kept satisfying these specifications. There are some alkali resistant glass fibres containing less than 16% zirconia in the market. But it is dangerous to use such a low zirconia AR-glass fibre in GRC made with OPC.

INTRODUCTION OF GRC INTO JAPAN

Alkali resistant glass fibre was introduced in Japan in 1973 and some manufacturers such as Asahi Glass and Nippon Sheet Glass started development work for designing, manufacturing, construction guidelines and use-applications of GRC. GRC was welcomed in the Japan market as an ideal new building material because of its non-combustibility, lightweight and design flexibility. However, it was required to set up a way to measure basic properties of GRC and a design guide in order to be able to launch it as the new building material. So, an industry-government-academia research council of GRC was formed to set the standards for GRC. Another industry group was organized to expand use of GRC.

INFLUENCE OF NATURAL ENVIRONMENT IN JAPAN

The GRC industry started to grow in Japan around 1977. However, there were some problems with GRC cracking and unfortunately the market lost confidence. Some of the problems were due to poor quality GRC, but some were due to the specific nature of GRC. At that time, the

GRC mix design was cement rich. Its strength was high but the drying shrinkage was also high. The natural environment in Japan is a cycle of high temperatures and humid summers followed by cold and dry winters. Under such a tough natural environment, the high internal stress of GRC caused cracking.

ADJUSTMENT OF GRC MIX DESIGN AND FASTENING SYSTEM

In order to solve the issues, the two organizations that had been working individually joined to set up the Japan GRC association in 1988. It established testing methods to measure mechanical properties of GRC for quality control and modified the GRC mix design and fastening systems to improve the quality of GRC applications. The Japan GRC association enlightens GRC manufacturers by publishing guidelines for designing and manufacturing exterior wall panel with conventional system, too.

In the mid-1980s, the Steel Stud Frame System was introduced from the US and it helped us to manufacture and install large size GRC exterior panels and improve reliability of GRC.

NEW CEMENT FOR GRC

In Japan, a new cement improving durability and dimensional stability of GRC was also developed. In 1985, Chichibu Cement (now Taiheiyo Cement) introduced “GRC Cement”. GRC using this cement can achieve one fifth of the shrinkage of GRC made from OPC and dramatically improve durability of GRC. With use of this cement, GRC can be applied for projects which require a high dimensional accuracy and it has gained reputation for excellent reliability.

This cement has enabled us to produce large sized GRC panels with ceramic tiles and natural stone surface finishes without the warping or distorting issues.

REGAINING MARKET CONFIDENCE IN GRC

With the above mentioned activities, GRC has regained market confidence in Japan. Many other fibre reinforced concretes for architectural use have been introduced in Japan such as those reinforced with carbon, aramid and polypropylene fibres. However, the only fibre reinforced concrete which has secured firm position as a building material is GRC.
In 2012, the Architectural Institute of Japan listed GRC as typical fibre reinforced concrete in the architectural standard specification for curtain walls. The use of GRC expands rapidly.

As you know, GRC is not only used for architectural wall panels or ornamental features but also for civil engineering, interior and various accessories. Nowadays major architects and design firms such as Norman Foster, Zaha Hadid, SOM and Kengo Kuma use GRC for important projects.

GRC has great features and is used in various applications. Furthermore, it has over 40 years’ experience as building material used for projects which normal concrete cannot achieve.

CONCLUSION

As mentioned above, the development of the GRC industry in Japan was a battle with our tough natural environment and it took a long time to establish market confidence in GRC. Overseas, where the natural environment and building standards are different from Japan, our experience is not applicable. GRC mix designs and installation systems must be employed according to local conditions and regulations.

Production of GRC mainly relies on labour intensive systems and its quality is dependent on skilled labour. This means defective products can be made if there is poor quality control. Automated mass production systems or the use of textile forms of alkali resistant glass fibre are possible ways to solve this issue.

However, lightweight concrete with high design flexibility are the major features of GRC and labour intensive systems are necessary for manufacturing such products. We believe production of safe and reliable GRC under high quality control is essential for further growth of GRC industry.