POLYMER-IMPREGNATED CONCRETE BEHAVIOUR UNDER SEA-WATER

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INTRODUCTION

The use of reinforced concrete in sea-work constructions depends on the ability to manufacture concretes durable enough in the marine environment. Concrete should resist the sulphate aggression as well as provide protection to reinforcement by chloride corrosion attack.

In general, such a durable reinforced concrete can be produced by using both superplasticizing admixtures to reduce the water/cement ratio, and mineral addition such as silica fume to improve the watertightness [1].

However, there are exceptional cases where a more reliable concrete is required for long-term durability of concrete reinforced structures. For instance, repair on concrete structures permanently under sea-water during their life service, would become too complicated. Moreover, structures in contact with very concentrated marine salt solutions, such as in sea-water distillation plants, should require a more chemically resistant concrete. In both these cases, a more durable material such as polymer-impregnated concrete (PIC) can be taken into account.

To manufacture a PIC, hardened concrete is dried and then impregnated by a low viscosity monomeric liquid such as styrene (S) or

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methyl methacrylate (MMA). The subsequent thermal polymerization reduces the open porosity and therefore the penetration of sulphate or chloride ions is definitely blocked. An increase in strength is also obtained depending on the amount of polymer impregnation.

In spite of these advantages, practical difficulties inherent to polymer-impregnation generally reduce the applicability of this technique to small or particular structures, whose increase in strength and durability induced by polymer-impregnation constitutes a priority choice with respect to practical difficulties or economic aspects.

With this in mind, it seems appropriate to verify the reliability of PIC in the marine environment, since an anomalous behaviour of non cross-linked polymethylmethacrylate (PMMA) PIC was experimentally noticed under sea-water [2]. After about one hundred days of total blockage of ion diffusion through the PIC, an abrupt chloride penetration was observed together with a slight, nevertheless significant decrease in strength.

EXPERIMENTS

Concrete (0.5 water/cement ratio) cubic specimens, after 14 days air curing, were impregnated with methyl methacrylate or styrene (S) and immersed in sea-water. Cross-linked methyl metacrylate specimens were also produced by trimethylolpropanetrimethacrylate (TMPTMA) addition. Moreover, plain non-impregnated concrete specimens were tested for comparative purposes.

Specimens were periodically submitted to compressive strength test and chloride penetration through a colorimetric test, by spraying fluorescein and silver nitrate on the splitted surfaces.

RESULTS

Within the experimental observation limits (300 days), a slight chloride penetration (about 5 mm) was observed in the polymethyl-methacrylate (PMMA) impregnated concrete, independently of the presence of cross-linking agent, whereas no penetration was recorded for the polystyrene (PS) impregnated concrete (Fig.1). This different behaviour could be ascribed to the methyl methacrylate higher volatility, which causes a partial monomer evaporation on the specimen surface during the thermal treatment before attaining a full polymerization. In other words, a competition seems to occur between the monomer MMA evaporation and its polymerization during the thermal treatment. Non-impregnated plain concrete was remarkably penetrated after a few days.

No significant change in compressive strength was observed by immersion in sea-water of impregnated concrete, independently of the type of polymer used. On the contrary, non-impregnated plain concrete increased in compressive strength, due to a higher degree of cement hydration (Fig.2).

CONCLUSIONS

Although polystyrene impregnated concrete showed an excellent behaviour, precautionary considerations, in relation to the high styrene toxicity and danger in its employment, do not suggest a wide use of polystyrene concretes.

On the other hand, longer experimental observation is necessary to assess whether the slight chloride penetration in PMMA impregnated concrete could be actually ascribed to the monomer higher volatility.

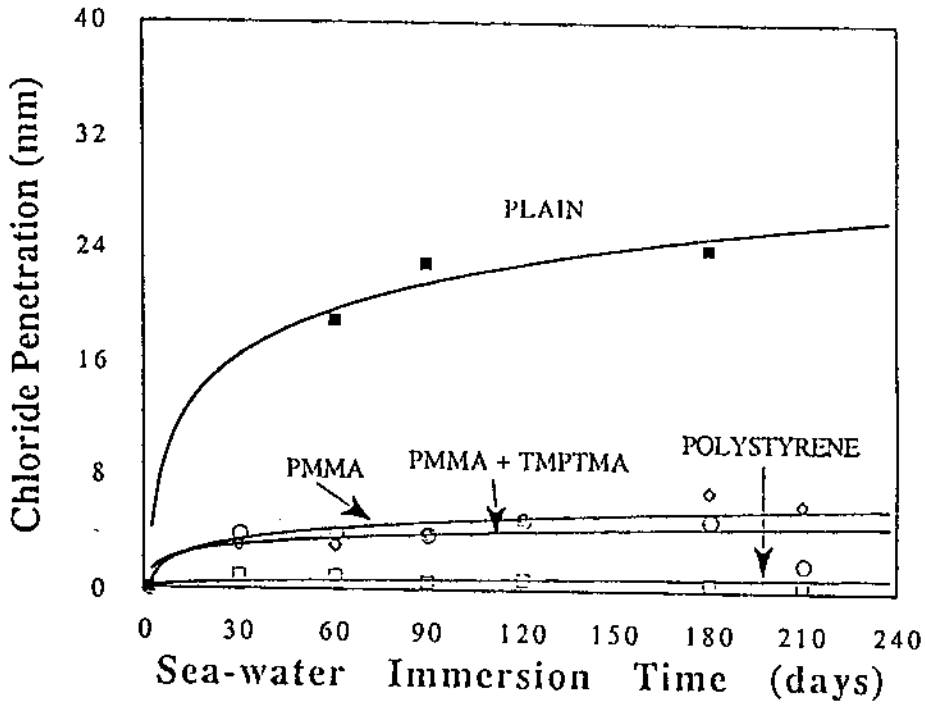

Fig.1 - Chloride penetration as a function of sea-water immersion time.

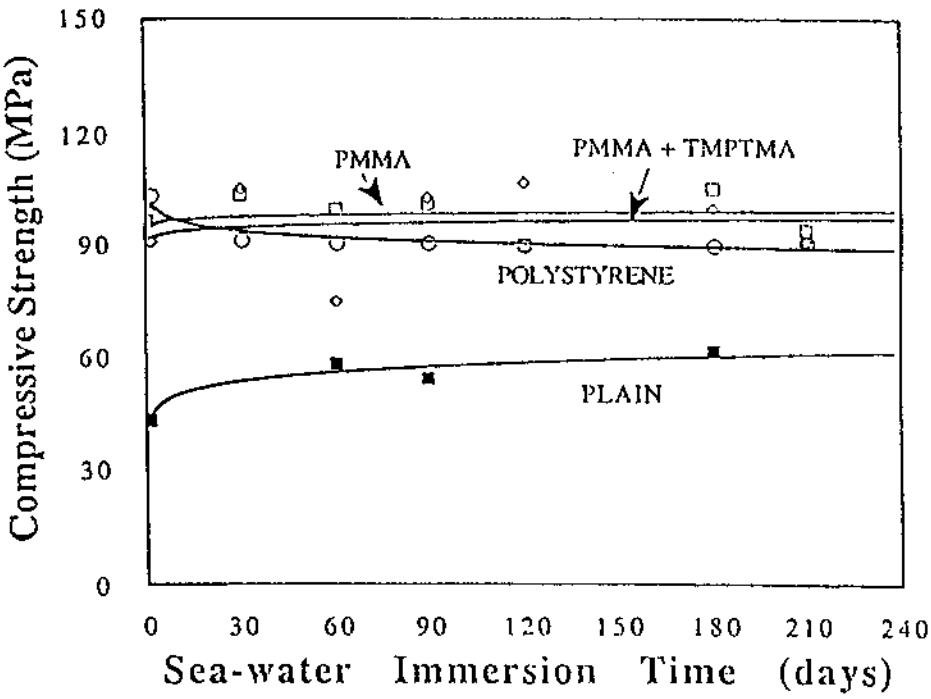

Fig.2 - Compressive strength as a function of sea-water immersion time.

REFERENCES

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