Abstract

Styrene is most commonly used in Vinylester resins (VERs) and is the co-monomer best described regarding VERs. However, there is little knowledge about the influence of other co-monomers on properties of resins and castings. Because of some unfavorable properties styrene provides in resins, e. g. the relatively low flash point, public interest in the usage of styrene-free resins in chemically bonded anchors has increased in the last couple of years.

To develop styrene-free VERs and to examine their qualifications when used in chemically bonded anchors was one of the main purposes of this thesis. Properties of several castings were examined and described and correlations between these properties and those of co-monomers were investigated to find a pattern that would allow facilitation for further examinations. One styrenated and seven styrene-free resins were synthezised and compared to each other in several investigations.

Using these different co-monomers a great variety of fracture-mechanical and mechanical properties of the castings can be achieved. Compared to the styrene-containing resin it is possible to get either higher, lower or equal strength, stiffness and elongation. Castings containing HPMA and PEG200DMA proved to be of special interest. VER/HPMA achieved highest results regarding modulus and strength. Elongation was equal to that of the resin containing styrene. VER/PEG200DMA showed the best results regarding elongation and had the lowest tensile modulus. Tensile and flexural elongations were as high as those of the styrene reference sytem.

Styrene-free systems showed a lower thermal resistance compared to the styrenated resin and absorbed more water. There were significant differences in alkali resistance as well. Only THFMA and PEG200DMA could deliver values similar to the styrene system. The different amount of ester groups in the networks could not explain these results but a correlation was found between residual strength and the sum of hydroxy- and ester group concentrations.

A method was deduced from these test results to allow assumptions on hydrophilicity properties of castings by considering the molecular structure and the amount of co-monomer used.

Chemical bonding anchors containing the synthesised styrene-free resins were produced. These showed high pull-out loads and little displacements under permanent loading. Adhesive properties of the resins showed no direct correlation to the bond strength of anchors. A tendency was found that resins with high stiffness provide anchors with higher bond strength. Alkali resistance of the bonding material was examined in slice tests. Even bonding materials containing resins that were almost completely destroyed during a boiling test with NaOH showed good residual strength here.

DSC-analysis of anchor grout samples collected from pulled out anchors showed low glass transition temperature and locally inconsistent cure degrees. The possibility of thermal postcure of anchor grouts after setting was examined to be able to better compare the different systems when almost completely cured. Two methods were considered: heating of the anchor rod using hot air and electromagnetic induction. Based on a thermodynamical calculation model the heat loss proved to be high when using hot air. Results of the induction method were promising, however. The degree of cure and the glass transition temperature could be improved almost over the complete embedment depth. A more homogenous network was achieved with a reduced content of residuals and better chemical resistance.