THE DEVELOPMENT OF FIBRES REINFORCED FLOWABLE HIGH STRENGTH MORTAR AND CONCRETE AS REPAIR MATERIALS

by

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PENGHASILAN MORTAR DAN KONKRIT MUDAH ALIR YANG BERKEKUATAN TINGGI DAN BERTETULANG SERAT SEBAGAI BAHAN PEMBAIKAN

ABSTRAK

Kajian tentang konkrit kekuatan tinggi mudah alir dan mortar sebagai bahan pembaikan telah dijalankan untuk memahami tabiat bahan-bahan ini di kawasan-kawasan pembinaan. Ujian-ujian percubaan telah dilaksanakan ke atas mortar mudah alir berkekuatan tinggi *(HSFM)* dan campuran konkrit berkekuatan tinggi yang mengalir *(HSFC)* diperkukuh dengan peratusan berbeza gentian keluli dan rencam gentian yang terdiri dari gentian keluli, gentian palma dan gentian Barchip. Bahan-bahan ini dicadangkan sebagai bahan-bahan pembaikan yang boleh memberi lebih manfaat dan berkesan daripada bahan-bahan epoksi atau polimer. Keputusan ujikaji menunjukkan bahawa pertambahan pemasukan gentian keluli dalam campuran-campuran HSFM dan HSFC membawa kepada pengurangan dalam keputusan pengaliran. Justeru, sukatan SP yang lebih tinggi diperlukan untuk mencapai pembolehaliran yang diperlukan. Keputusan HSFM dengan gentian keluli menunjukkan pertambahan paling tinggi dalam kekuatan yang memampat, yang didapati dengan peratusan gentian keluli sebanyak 1.25%. Peratusan pertambahan kekuatan adalah sebanyak 20% dengan pemasukan tersebut. Sementara itu, keputusan HSFC dengan gentian keluli menunjukkan pertambahan paling tinggi dalam kekuatan mampatan, yang didapati dengan peratusan gentian keluli 1.0%. Peratusan pertambahan kekuatan mampatan adalah sebanyak 10% dengan pemasukan tersebut. Walaubagaimanapun, keputusan yang diperolehi untuk setiap HSFM dan HSFC diperkukuh dengan gentian keluli mennjukkan bahawa

pemasukan 1.5%, 1.75% dan 2.0% isipadu berkecenderungan menjadi peratusan yang paling sesuai untuk digunakan dalam aplikasi pembaikan.

Di samping itu, gentian campuran untuk setiap HSFM & HSFC menunjukkan keputusan bahawa campuran 1.75% gentian keluli + 0.25% gentian palma, 1.5% gentian keluli + 0.5% gentian palma dan 1.5% gentian keluli + 0.25% gentian palma + 0.25% gentian barcip mempamerkan prestasi yang terbaik dikalangan campuran-campuran dikaji.

hybrid gentian keluli dengan gentian palma dan gentian papan cip memperbaiki kekuatan ketegangan, kekuatan daya lentur, modul statik kekenyalan, ketahanan terhadap impak dan lain-lain untuk setiap campuran HSFM dan HSFC. Gentian palma dan kombinasi gentian palma dan gentian papan cip dalam pecahan isispadu yang rendah (0.25-0.5%) bergabung dengan gentian keluli dalam sistem komposit telah mengurangkan penyah-ikatan partikel-matriks. Oleh yang demikian, campuran gentian mempamerkan pelaksanaan yang terbaik apabila campuran HSFM atau HSFC terdedah kepada air laut.

HSFC mempunyai prestasi yang terbaik apabila kekuatan mampatan sistem yang diperbaiki diperlukan, sementara HSFM mempunyai prestasi terbaik apabila kekuatan ketegangan sistem yang diperbaiki itu diperlukan. Nilai terbaik ujian tarikan keluar diperolehi dengan menggunakan HSFM diperkukuh oleh 1.5% gentian keluli + 0.25% gentian palma + 0.25% gentian papan cip sebagai bahan-bahan pembaikan. Nilai tarikan keluar yang didapati dari HSFM dan HSFC diperkuatkan oleh gentian yang berbeza menunjukkan bahawa prestasi bahan-bahan ini dari segi pengikatannya dengan konkrit dan peneguhan keluli adalah jauh lebih baik dari epoksi, atau polimer penetap haba.

THE DEVELOPMENT OF FIBRES REINFORCED FLOWABLE HIGH STRENGTH MORTAR AND CONCRETE AS REPAIR MATERIALS

ABSTRACT

The study of flowable high strength concrete and mortar as repair materials was carried out to understand the behaviour of these materials on construction sites. The experimental tests were carried out on High Strength Flowable Mortar (HSFM) and High Strength Flowing Concrete (HSFC) mixes reinforced with different percentages of steel fibres and hybrid fibres of steel, Palm and Barchip fibres. These materials are proposed as repair materials which are more beneficial and effective than epoxy or polymer materials. The tests results revealed that the increase in steel fibre inclusions in the HSFM and HSFC mixes resulted in reduction of flow. Thus, a higher dosage of SP is needed to achieve the required flowability. The results of HSFM with steel fibres show that the highest increase in compressive strength, in order of 20%, is obtained with steel fibres fraction of 1.25%. Whereas, the results of HSFC with steel fibres show that the highest increase in compressive strength, of about 10%, is obtained with steel fibres fraction of 1.0%. The results obtained for each HSFM and HSFC specimen reinforced with steel fibres indicated that the inclusion of 1.5, 1.75 & 2.0 % by volume exhibited the most appropriate percentages to be used for repair applications.

Furthermore, the results for the hybrid fibres for each of the HSFM & HSFC showed that the mixes of 1.75% steel fibres + 0.25% palm fibres, 1.5% steel fibres + 0.5% palm fibres and 1.5% steel fibres + 0.25% palm fibres + 0.25% Barchip Fibres exhibit the best performance amongst the mixes tested.

The hybridization of Steel Fibres with Palm and Barchip Fibres enhances the tensile strength, flexural toughness, static modulus of elasticity, and impact resistance, among other characteristics for each of the HSFM and HSFC mixes. The Palm Fibres and the combination of Palm and Barchip fibres in low volume fractions (0.25-0.5%) combined with Steel Fibre in a composite system reduced the particle-matrix debonding. Therefore, the hybrid fibres exhibited the best performance when the HSFM or HSFC mixes were exposed to seawater.

The HSFC has the best performance when the compressive strength of the repaired system is necessary, whereas the HSFM has the best performance when the tensile strength of the repaired system is required. The best value of pull out test was obtained from using the HSFM mix reinforced by 1.5% steel fibres + 0.25% palm fibres + 0.25% Barchip fibres. The pull-out values obtained for the HSFM or HSFC reinforced by different fibres showed that the performance of these materials in terms of their bond with concrete and steel reinforcement is much better than epoxy.