STUDY OF COLD JOINT CONCRETE BY INFRARED THERMOGRAPHY AND ULTRASONIC PULSE VELOCITY

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ABSTRACT

Infrared thermography (IRT) has been used in civil engineering field such as highway, bridge and concrete structure. IRT provides non-destructive method to analyse defects on structure including crack. Cold joints are formed primarily between two batches of concrete where the delivery and placement of the second batch has been delayed and the initial placed and compacted concrete has started to set. The full knitting together of the two batches of concrete under vibration to form a homogeneous mass is therefore not possible, unlike the compaction of two fresh workable batches of concrete. This could be a potential plane of weakness. The objective of this research are to analyse the cold joint of concrete when loading applied and to determine uniformity of cold joint concrete using Ultra Pulse Velocity (UPV). Thermography is specialized in subsurface damage identification due to anomalies that inhomogeneity impose on the temperature field. Additionally, ultrasonic waves are constrained near the surface and therefore, are ideal for characterization of near-surface damage. In this study, an infrared camera scans cold joint beam structure and analyse crack happen at cold joint during loading. Colour summarization software will analyse the colour at cold joint and the entire beam. Through software, the difference of colour could be seen between the crack section and non-crack section. Based on the research, infrared images produced does not differentiate between cold joints section and other part of beam. Through flexural test it is found that crack formed through the cold joint as there is no other part of beam produced crack when loading applied. Unfortunately the infrared camera cannot capture the image which have brighter colour such as red, orange or yellow. The colour of the beam become blue because the machine of flexural test more dominant in temperature so the colour of one part of the machine brighter than the beam. Behind the machine itself, sunlight penetrate through the windows. Based on Ultra Pulse Velocity result, pulse velocity concrete casting day 1, day 2 and at the cold joint are higher than 4 km/s which means concrete quality is good and the speed is uniform. The UPV reading at cold joint have a decreasing trend compared to reading at same day casting section. In conclusion, the colour summarization of beam using IRT image cannot be achieved as the colour have little variation. As for UPV result, at cold joint section the reading is smaller compared to section casting on the same day and it is still under good category for time lag 24 hours.

ABSTRAK

Thermografi inframerah (TMI) telah digunakan dalam bidang kejuruteraan awam seperti jalan raya, jambatan dan struktur konkrit. TMI menyediakan kaedah bukan pemusnah untuk menganalisis kekurangan pada struktur termasuk keretakan. Ikatan sejuk terbentuk antara dua bancuhan konkrit di mana bancuhan dan pemadatan bahagian kedua telah ditangguhkan. Pencantuman penuh bersama kedua-dua bancuhan konkrit untuk membentuk jisim homogen tidak mungkin berlaku, tidak seperti pemadatan bancuhan konkrit sekali gus. Hal ini boleh menjadi masalah kepada struktur. Objektif kajian ini adalah untuk menganalisis ikatan sejuk pada konkrit apabila beban dikenakan dan menentukan keseragaman konkrit tersebut menggunakan Hadlaju Denyutan Ultrasonik (HDU) dan TMI. Thermografi penting dalam mengenal pasti kerosakan subpermukaan konkrit disebabkan anomali yang tidak homogenan apabila dikenakan ke atas kawasan bersuhu. Selain itu, gelombang ultrasonik terhasil berhampiran permukaan dan sesuai untuk mengenal pasti kerosakan berhampiran permukaan struktur. Dalam kajian ini, kamera inframerah mengimbas struktur rasuk bersama ikatan sejuk dan menganalisis keretakan yang berlaku semasa beban dikenakan. Perisian rumusan warna digunakan untuk menganalisa warna pada ikatan sejuk dan keseluruhan rasuk. Melalui perisian ini, perbezaan warna boleh dilihat antara bahagian retak dan yang tidak retak. Hasil kajian, imej inframerah dihasilkan tidak membezakan antara bahagian ikatan sejuk dan lain-lain bahagian rasuk. Melalui ujian lenturan didapati bahawa retak terbentuk pada ikatan sejuk disebabkan kelemahan bahagian tersebut. Malangnya kamera inframerah tidak boleh menghasilkan imej yang mempunyai warna terang seperti merah, oren atau kuning. Berdasarkan keputusan HDU, halaju bancuhan konkrit pada hari pertama dan kedua lebih daripada 4 km/s yang bermaksud kualiti konkrit baik dan kelajuan adalah seragam. Walaubagainamapun, bacaan HDU pada ikatan sejuk kurang berbanding bacaan pada bahagian konkrit yang normal. Secara kesimpulannya, hasil imej TMI tidak boleh dicapai kerana mempunyai variasi warna yang sedikit dan hampir sama pada sampel yang diuji. Bagi bacaan HDU, pada bahagian ikatan sejuk bacaan adalah lebih rendah berbanding bahagian konkrit bancuhan pada hari yang sama dan ia masih dalam kategori baik untuk masa pencantuman antara 2 bancuhan konkrit selama 24 jam.