

ABSTRACT

A three-dimensional finite element computer program (3DMICP) is developed in this research work to study the nonlinear response of composite concrete structures. In this program, material nonlinearities due to behaviour of concrete in compression, crushing, cracking of concrete in tension, tension stiffening and shear retention effects of cracked concrete, and yielding of reinforcement, are included. The nonlinearities due to slipping, separation and shear stress reduction after separation, at the interface (joint) between the two concrete parts, are also considered.

The developed computer program has been used for the analysis of initially cracked and monolithic reinforced concrete push-off specimens, monolithic and composite reinforced concrete T-beams in bending and composite unsymmetrical I-beams under flexure. Results obtained from analytical and experimental tests have been compared. The 8-node isoparametric surface element is used to model the interface between the two concrete parts, as that between the precast concrete stem and cast-in-place concrete flange in the composite flanged concrete beam. Concrete in compression is simulated by an elasto-plastic work hardening model, while concrete in tension is simulated by a fixed smeared crack model. Reinforcing bars are modeled as axial members embedded within the brick elements which are used to model the concrete. Perfect bond between concrete and steel bars is assumed. The behaviour of composite concrete structures at the interface is simulated by slip and separation models.

The nonlinear equations of equilibrium have been solved by using an incremental-iterative technique based on the modified Newton-Raphson method.

Parametric studies are presented . They deal with the effect of some important material parameters, at the interface , on the predicted finite element results . Other studies are made to investigate the reduction in composite action and detect the two-beam action for the composite concrete beams, and comparison between slip measurements obtained from experimental and analytical tests are presented in this work . A comparative study between the horizontal shear force developed in composite concrete beams based on experimental and analytical results and the horizontal shear force recommended by ACI code (318M-02) based on shear friction or compressive force in the supporting element , is also presented . It is found that the developed program is efficient in predicting the behaviour of composite concrete members, when comparison is made between the analytical results and the experimental tests. The ratio of predicted to experimental ultimate load has a value of (1.01) for push-off specimen , an average value of (0.98) for composite T-beams in bending , and an average value of (0.97) for composite unsymmetrical I-beams under flexure.

التحليل اللاخطي للعتبات الخرسانية المسلحة المركبة ذات الشفاه

خلاصة

يتضمن هذا البحث تطوير برنامج حاسوب يحتوى على انموذج رياضى ملائم للتحليل اللاخطى للعتبات الخرسانية المركبة باستخدام طريقة العناصر المحددة . العتبات التى اخذت بنظر الاعتبار فى البحث هى العتبات الخرسانية المركبة ذات الشفاه و المسلحة بشكل اعتيادى .

العناصر المحددة التى استخدمت فى تمثيل الخرسانة هى العناصر الطابوقية ثلاثية الابعاد ، اما حديد التسليح الاعتيادى فتم تمثيلة على شكل عناصر محورية مطمورة داخل العنصر الطابوقى الثلاثى الابعاد مع افتراض وجود ترابط تام بين الخرسانة و حديد التسليح . المفصل الذى تلتقى فيه شفة العتبة مع الساق مثل باستخدام عناصر سطحية بينية .

فى الانموذج الرياضى يعتبر تصرف الخرسانة تحت تأثير اجهادات الانضغاط تصرف مرن ثم مرن- لدن يتبعة تصرف لدن تام ينتهى بتهشم الخرسانة . اما تصرف الخرسانة تحت اجهادات الشد فتمثل باستخدام انموذج الشق المنتشر مع اعتماد انموذج تصلب الشد لتمثيل الاجهادات فى مرحلة ما بعد التشقق . ان تدهور مقاومة القص فى الخرسانة نتيجة التشقق اخذ بنظر الاعتبار من خلال تبني انموذج استبقاء القص . اما تصرف المنطقة البينية فى المنشآت الخرسانية المركبة فقد مثل باستخدام انموذجى الانزلاق و الانفصال مع اعتماد انموذج انقاص اجهادات القص فى مرحلة ما بعد الانفصال .