ABSTRACT

The use of Nano silica as an additive material in manufacturing concrete is a new technology. Tests have shown that this material enhances the mechanical properties of hardened concrete. Therefore the material gained some popularity nowadays and is now well recognized. This thesis presents a study in this direction to investigate the shear behaviour as well as determining the cracking and ultimate shear capacities of **N**ano **S**ilica **R**eactive **P**owder **C**oncrete (NSRPC) beams. The research covered four parts.

The first part dealt with experimental study of the effects of varying some "material" parameters on the mechanical properties of NSRPC. These material parameters were nanosilica content NS (0, 1%, 2%, 3%), silica fume content SF (5%, 10%, 15%) and volumentric ratio of steel fibers Vf (0%, 1%, 2%). The investigated mechanical properties of the hardened concrete were compressive strength f'_{cf} , splitting tensile strength f_{spf} , modulus of rupture f_{rf} and modulus of elasticity E_{cf}.

In the second part, sixteen simply supported NSRPC beams were cast and tested up to failure under two point loading. The beams (except one) had no stirrups and were heavily reinforced longitudinally to ensure shear failure to occur in all beams. In addition to the above mentioned "material" parameters, there were also varied "beam" parameters: longitudinal steel ratio ρ , shear span to effective depth ratio (a/d) and the use of steel stirrups.

Measurements were recorded for the cracking shear force V_{cr} , the ultimate shear capacity V_u, the deflection at ultimate load, maximum crack width and maximum longitudinal and diagonal tensile strains.

The effect of material parameters were obtained as follows:

1) When NS was increased from 0% to 3%, the following percentage increases were recorded, 31.3% in f'_{cf}, 45.3% in f_{spt}, 50% in f_{rf}, 13.4% in E_{cf} and 25.1% in V_u.
2) When SF was increased from 5% to 15%, the following percentage increases were obtained; 12.1% in f'_{cf}, 7.8% in f_{spf}, 12.2% in f_{rf}, 5.4% in E_{cf} and 10.7% in V_u.
3) When V*f* was increased from 0% to 2%, the following percentage increases were recorded; 60.8% in f'_{cf}, 242.5% in f_{spf}, 275% in f_{rf}, 24.4% in E_{cf} and 198.9% in V_u.
4) When NS and V*f* were absent from the mix, the following percentage decreases were recorded; 52.4% in f'_{cf}, 78.8% in f_{spf}, 81.1% in f_{rf}, 28.8% in E_{cf} and 74% in V_u.

The effects of beam parameters were also obtained as follows:

1) When ρ was increased from 0.0742 to 0.0911, V_u increased by 21.9%.
2) When a/d was decreased from 3.5 to 2.5, V_u increased by 54.6% for the case V*f*=2% and 48.6% for the case V*f*=1%.
3) When steel stirrups were used with amounts ϕ 6mm a 85 mmc/c in the two shear spans of the beam, V_u increased by 94.9%.

In the third part of the research, a nonlinear finite element analysis using ANSYS package, version 11 was performed to provide a numerical solution for the structural performance of the sixteen tested NSRPC beams. It was found that ANSYS numerical solution was in a reasonable agreement with the experimental results.

In the fourth part of the work, the statistical method SPSS software version 18 was used to carry out regression analyses of the experimental results. Accordingly, empirical equations were established for the prediction of f'_{cf} , f_{spf}, f_{rf} and V_u. The proposed empirical equations were found in good correlation with some existing methods.