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Mechanical properties of aerated cement slurry-infiltrated chicken mesh

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HIGHLIGHTS

- The interaction between the chicken mesh with the aerated slurry governs the ability to mobilize the chicken mesh load-bearing capacity within structurally viable ranges of deformation.
- The tensile behavior of aerated slurry-infiltrated chicken mesh relies upon the support provided by the aerated slurry against realignment of the chicken mesh wires.
- Slurry-infiltrated chicken mesh sheets exhibit a ductile behavior in tension.
- The flexural load-deformation behavior of the aerated slurry-infiltrated chicken mesh sheets was found to exhibit qualitative similarities with their tensile behavior.
- The flexural failure mode of aerated slurry-infiltrated chicken mesh sheets is dominated by a single crack, and does not exhibit the distributed failure mode observed in tension.

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ABSTRACT

Aerated slurry-infiltrated chicken mesh was evaluated as a ductile and lightweight material for building construction. The compressive strength of the aerated slurry, and the tensile, compressive and flexural behavior of the aerated slurry-infiltrated chicken mesh were evaluated. Aerated slurry provided a relatively low compressive strength, which did not suit load-bearing applications. Aerated slurry-infiltrated chicken mesh, on the other hand, provided desired mechanical properties, including significantly improved compressive strength, for load-bearing applications. The system exhibited a ductile failure mode which can be attributed to the high specific surface area and the desired mechanical interlocking of the chicken mesh reinforcement. The effects of aeration on the system behavior were evaluated. A theoretical model was developed for evaluating the mechanical behavior of aerated slurry-infiltrated chicken mesh. Aerated slurry-infiltrated chicken mesh offers a desired combination of light weight and mechanical characteristics for use as a building construction material.

1. Introduction

Aerated concrete is traditionally viewed as an insulating (non-structural) building material. This investigation evaluated the potential to improve the mechanical performance of aerate concrete through the use of a chicken mesh as a continuous reinforcement system with high specific surface area. There is a growing interest in the use of wire mesh reinforcement in concrete panels [1,2]. Within certain limits, the mesh behaves as homogeneous reinforcement, and produces concrete composites with desired tensile strength-to-weight ratio, cracking behavior and impact resistance [3]. Ferrocement, a cementitious mortar with wire mesh reinforcement, benefits from these advantages associated with the use of nearly isotropic reinforcement systems of high specific surface area and desired mechanical bonding [4]. This work is part of ongoing research that aspire smart utilization of lightweight material in congestion with chicken mesh for structural applications [5].

The main thrust of the work reported herein was to develop a construction material that combines the advantages of wood (ductility, low bulk density, convenient use of fasteners such as screws, etc.) with those of reinforced concrete (moisture, weathering and decay resistance, load-bearing capacity, etc.). Achievement of these goals required use of relatively high reinforcement ratios, which

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necessitated the use of slurry infiltration in lieu of, say, troweling of mortar that is used in the case of ferrocement. Slurry infiltration enables through embedment of the chicken mesh wire in the cementitious matrix in spite of the congestion of volume with the required chicken mesh volume ratio. Aeration of the slurry was required to reduce the bulk density of the material. Chicken mesh (poultry netting) was used in this development as a readily available reinforcement system of high specific surface area with desired mechanical bonding potential in aerated slurry.

Streamlined methods were devised for producing aerated slurry-infiltrated chicken mesh as a structural material. An experimental program was conducted in order to gain insight into the mechanical performance of this material. The effects of chicken mesh reinforcement on the compressive strength of aerated slurry was investigated. The effect of aeration of slurry on the system performance was also evaluated. A semi-empirical theoretical basis was developed for the mechanical behavior of aerated slurry-infiltrated chicken mesh.

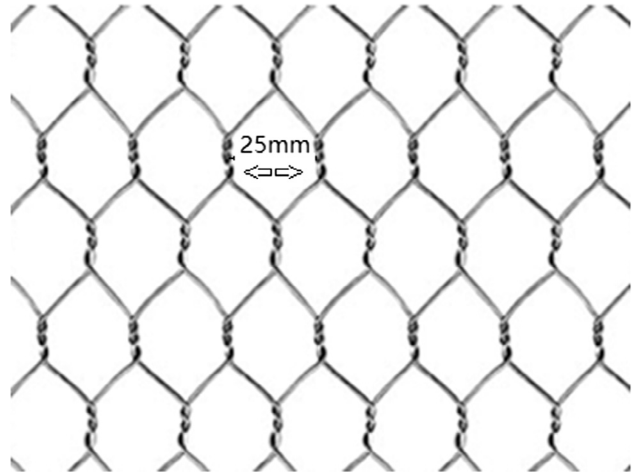

Fig. 2. The chicken mesh used in the experimental program.

2. Experimental program

2.1. Materials

2.1.1. Aerated slurry

The slurry mix was prepared in this investigation with Type I Portland cement and tap water. In one of the mixtures, in order to achieve a viable fresh mix workability, a polycarboxylate-based superplasticizer was used. The aerated slurry was prepared by adding a foaming agent to the mixing water of slurry. Aeration introduces a homogenous system of fine air bubbles into the cement paste. This is accomplished using foaming agents that stabilize the air voids generated by agitating the mixing water of slurry to which the foaming agent has been added [6–8]. Preparation of the aerated slurry started with production of foamed water. For this purpose, a foaming agent extracted from plants (saponin) was blended with the mixing water at 1200 rpm rotational speed using a mixing blade attached to a drill (Fig. 1). The resulting foamed water was then added to cement, and mixed in a mortar mixer for 6 min. Current investigations are carried out to produce aerated alkali activated cement based volcanic tuff and limestone [9].

2.1.2. Chicken mesh

This work chose chicken mesh (hexagonal 20-gauge galvanized poultry netting) as a steel reinforcement system of high specific surface area. This selection was made due to the broad worldwide availability of chicken mesh. The common mesh used in this investigation was made of steel wires of 1 mm diameter (0.785 mm^2 cross sectional area). Chicken meshes are available with different wire diameters and spacings. The spacing of hexagonally configured wires generally increase with increasing wire diameter in order to provide comparable wire cross-sectional areas per unit width. Given the relatively large layers of chicken mesh that need to be infiltrated with aerated slurry, the preference in this investigation was for chicken meshes with larger wire diameter and spacing. The chicken mesh used in this investigation was non-isotropic. The stronger direction (vertical in Fig. 2) is referred to as longitudinal in this work.

3. Experimental methods

An experimental program was conducted in order to evaluate the effects of some key variables on the mechanical properties of aerated slurry-infiltrated chicken mesh under compressive, flexural and tensile loading. The interactions of chicken mesh with aerated slurry can be characterized as more complex than those between concrete and conventional reinforcing bars. More attention should be paid to the contributions of the aerated (slurry) matrix towards timely mobilization of the load-bearing capacity of the multiple chicken mesh layers tightly incorporated into the aerated slurry. Test results would be critical to understanding these complex interactions. Aerated slurry-infiltrated chicken mesh can, due to the high specific surface area of steel reinforcement, provide distinctly high levels of ductility and energy dissipation capacity. In addition, the high specific surface area and close

(a) Prior to stirring (b) Foaming after stirring

Fig. 1. Preparation of foamed water by stirring the mixing water incorporating the foaming agent.