STRENGTHENING UNREINFORCED MASONRY HOUSES WITH NATURAL FIBER REINFORCED CEMENT COMPOSITES

天然繊維強化セメントを用いた組積造住宅の耐震補強工法の研究

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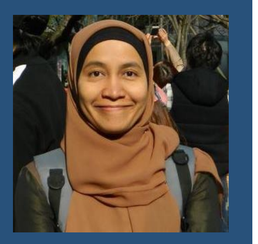

1.Research Background

A huge loss of lives due to the big earthquakes has occured in the developing countries, such as Indonesia, India, Pakistan, Iran and so on, are due to the falling objects, especially from unreinforced masonry houses. Regarding this condition, there is a need to strengthen a masonry house. Some retrofitting materials, such as FRP, steel mesh cage, and seismic wallpaper have been investigated, but these synthetic materials are expensive and are not available in many parts of the world. Therefore, a new retrofitting material which is abaca fiber reinforced cement composites is proposed in this research. Abaca is a natural fiber which is local available and has high tensile strength.

2. Objective of Research

To develop a new retrofitting material which have high strength, ductility, energy dissipation capacity, durability, locally available, easy to apply and low in cost.

Tensile Test of Abaca fiber

Tensile test of nine samples of abaca fiber was performed to investigate the tensile strength of the fiber (Fig. 1). From the test, the average tensile strength is 867 MPa (Fig. 2).

Fig. 1. Tensial test of abaca fiber

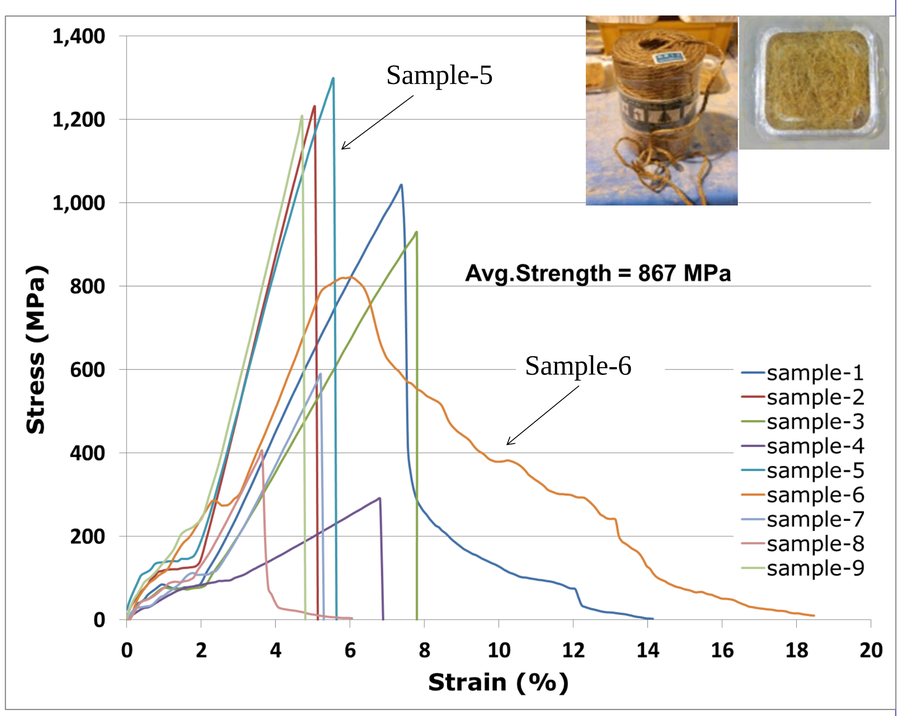

Fig. 2. Result of abaca fiber tensial test

Fiber reinforced cement composites - Diagonal compression tests -

The in-plane diagonal compression test was carried out to evaluate the effect of retrofitting masonry walls by fiber reinforced cement composite, using masonry wallets with and without retrofitting in order to assess their seismic performance. The wallet dimensions were $300 \times 300 \times 50$ mm³ and consisted of 7 brick rows of 3.5 bricks each (Fig. 3). The mortar joint thickness was 5 mm. A mortar mix of cement:lime:sand = 1:7.9:20 and cement/water ratio = 0.14 was used.

Fig. 3. Diagonal compression test of fiber reinforced cement composite

Specimens were tested 28 days after construction under displacement control condition. The loading rate was 0.15m/min and 0.25mm/min for unretrofitted and retrofitted cases, respectively.

Fiber reinforced cement composites – Performance comparison –

Fig.4.UnRetrofitted wallet (without fiber)

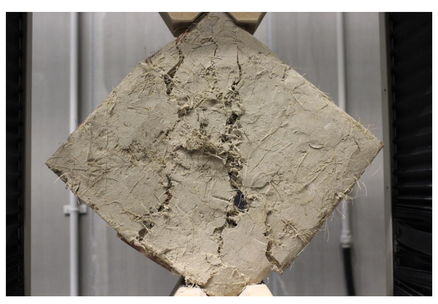

Fig. 5. Retrofitted wallet with 30 mm fiber length

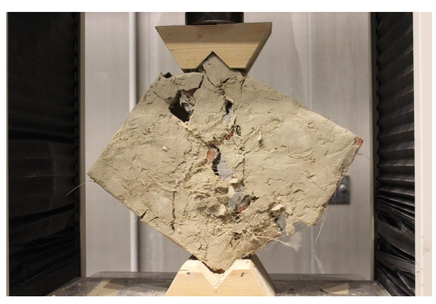

Fig. 6. Retrofitted wallet with 100 mm fiber length

Three samples for each condition (unretrofitted and retrofitted) were tested for in-plane diagonal compression test. As it can be seen in Fig. 4, unretrofitted wallets split into two pieces after the diagonal initial crack occurred and no residual strength was left. On the other hand, wallets with fiber reinforced cement composites performed with higher strength and bigger deformation than unretrofitted one, due to the fiber inside the mortar (Fig. 5 and Fig. 6). The average strength of unretrofitted wallets is 2.7 MPa, while retrofitted wallets with 30 mm fiber length and 100 mm fiber length have an average strength of 3.3 MPa and 3.6 MPa, respectively. Based on the test, composites with longer fibers (fiber length 100 mm) shows a slightly higher strength and bigger deformation compared to composites with shorter fibers (Fig. 7).

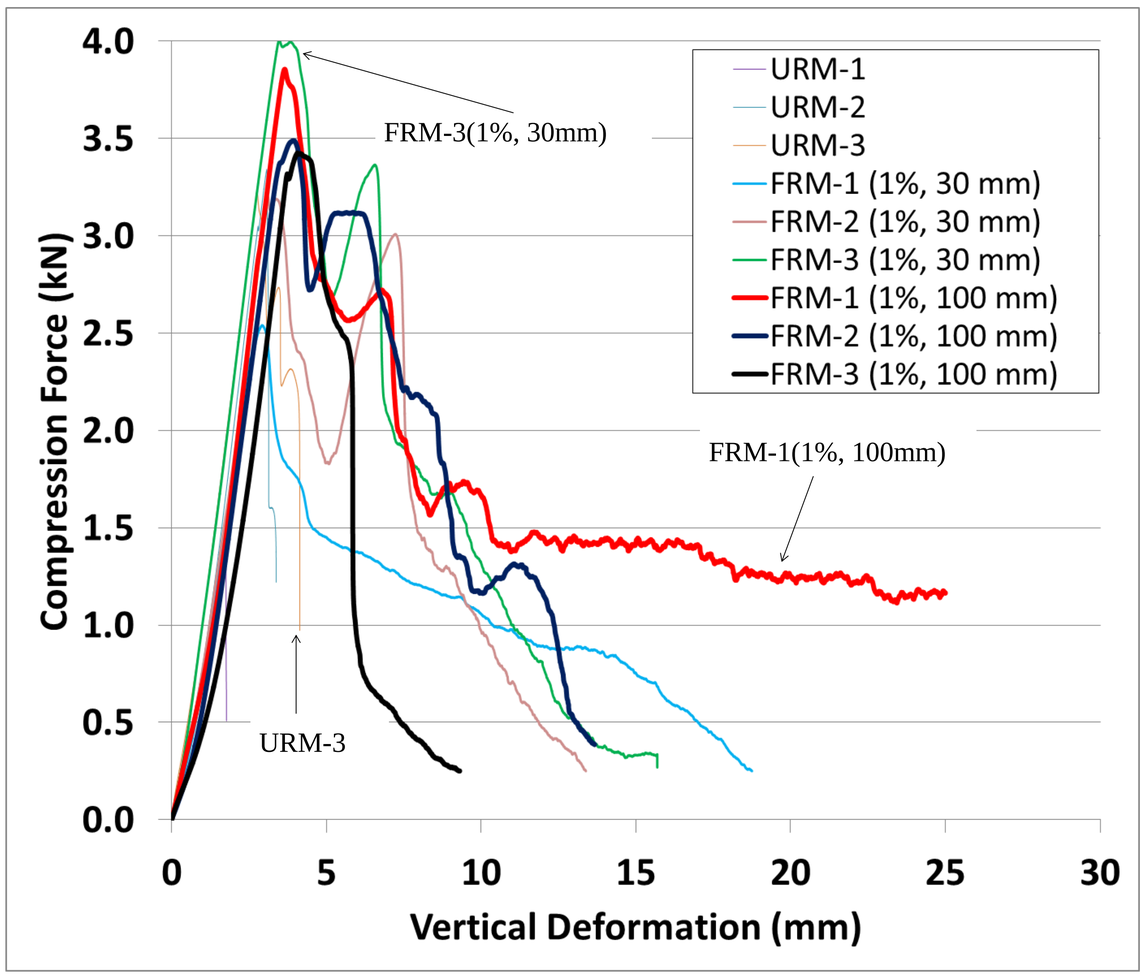

Fig. 7. Result of diagonal compression test