Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 8, Issue 07, July-2021

Performace of Mud Insulated Sandwich panels

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Abstract:- *Mud insulated sandwich panel (MISP) is the combination of expanded polystyrene sandwiched between two mud layers. Conventionally shotcrete is applied on polystyrene sandwiched panels, however, the used of locally available mud is preferred due to its improved thermal insulation and brining sustainability in environment. In this research, performance of full-scaled sandwich panel insulated with mud made from difference size soil was investigated by subjecting panels to concentrated load. The force-deformation behavior of these specimens were compared. It was concluded from experimental results that finer size soil mud have more effective in increasing the load carrying capacity of insulated sandwich panels..*

Keywords: *Mud Insulation, Sanwich panels*

1. Introduction

Sandwiched panel is the combination of polystyrene and steel wire mesh of square pattern. Sandwich panels, when insulated, usually with shotcrete, to give stablility and insulating properties, are rigorously used in building, roads and retaining structures. Insulating material is of prime importance since it control the behaviour of sandwich panel (Humphrey Danso, 2015; Hrvoje Mikulčić et.al, 2013). Over the years, shotcrete insulated sandwich panels (SISP) are used in buildings and it imporved the overall strength of building [add few references], however, the emission of CO_2 assoicated with cement hydration used in shotcrete was identified as key environmental issue (A. Benayoune, A. A., 2008).

Soil that is available in abundantly around the globe is a natural resource and used in construction industry for many years and still is used in most parts of the world due to its pleasing properties and meeting with sustainable goals. Use of mud as a insulating material for sandwich panel has been rarely put in practice as few studies are conducted (Fudzee, M. F., 2013; J. Daniel Ronald et.al, 2016). Most of the studies conducted were fouced on the effect of soil in improving the thermal insulation of panels compared to shotcrete insulated panels (Noridah Mohamad, 2014). However, no study to the knowledge of author has been conducted on the strength performance of mud insulated sandwich panels.

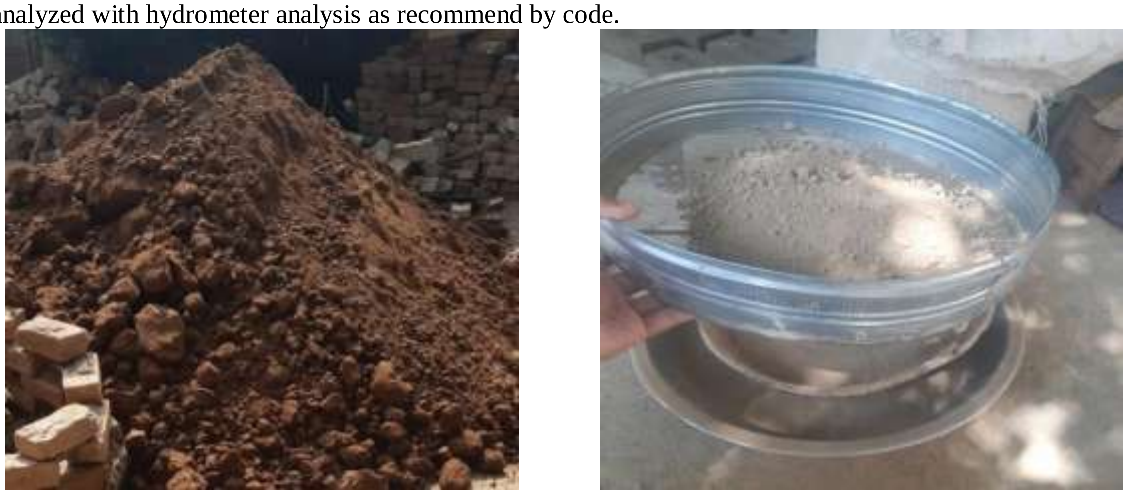
In this research, different size soil has been used to study its effect on the structural performance of mud insulated sandwich panels. Three type of soil were used in test samples. Various lab tests were performed on the soil sample before using in sandwich panels. Test samples were subjected to concentated load.

2. Research Methodology

2.1. Material Characterisation

2.1.1 Particle Size Analysis

The soil samples were collected from a three different site where the earth has been excavated for for construction purpose. The soil samples were marked as type A, type B and type C. All the three samples were stable pure soil and free from any debris or other content as shown in Figure 1(a). The soil was first dried at 100 degree centrigade to facilitate the sieving process and hydrometer analysis. It is important to mention that drying was done to find the particle size distribution of soil, however, the soil was used directly to sandwich panels. After drying the samples were sieved through sieve #8 (Coarser size) to #200 (Finer size) as shown in Figure 1(b). The soil sample which pass through sieve #200 was further analyzed with hydrometer analysis as recommend by code.



(a) (b)

Figure 1: (a) Soil Sample ;(b) Soil Sieveing

2.1.2 Liquid limit, LL

The liquid limit is important parameter to find out the moisture content at which plasticity in soil will loose and it will behave as a liquid. Since the soil will be applied upon adding water, therefore, liquid limit should be known in order to avoid excess water addition to soil for application on sandwich panel. The liquid limit test was performed on all soil samples with Casagrande apparatus as shown in Figure 2. A Number of trails were performed on each soil samples. The soil after every trail was kept in over for 24 hrs to dry out in order to find out the moisture content. Finally, a graph was established for each trial blows against the mositrue content. The value of moisture content corresponding to 25 blows is known as liquid limit.

Figure 2: Cassagrande apparatus for liquid limit test

2.2. Experimental program

The sandwich panel are made of polystyrene materials with steel wire mesh of 100mm by 100 mm square shapes. The polystyrene thickness is 38 mm. The steel wire mesh of diameter 3 mm was used. The steel wire mesh is provided on both side of polystyrene form as shown in Figure 3.

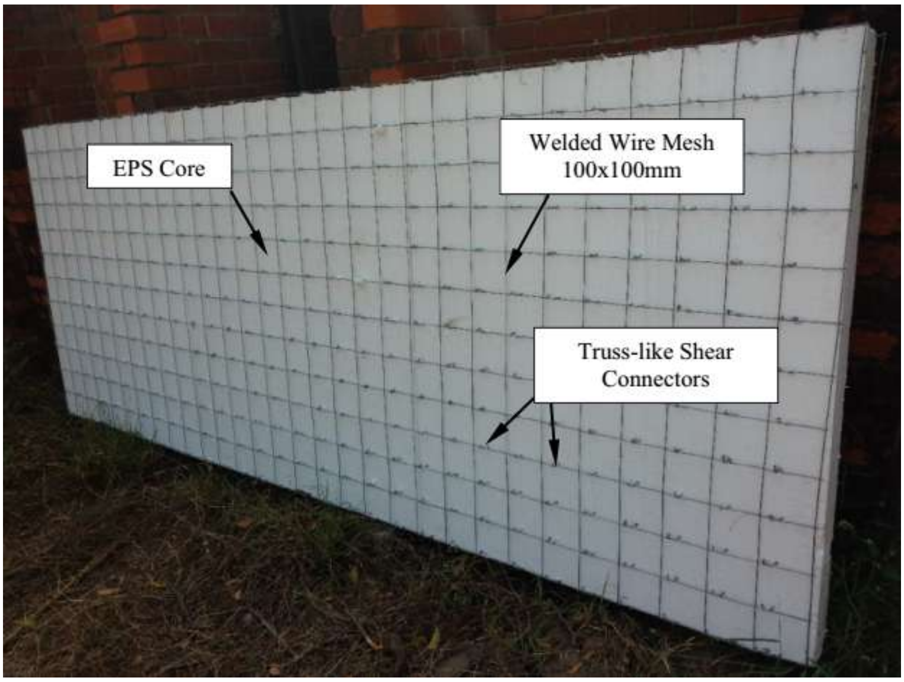


Figure 3: Polystyrene form sandwich between steel wire mesh

The mud was prepared by adding water equal to 85% of liquid limit. Water was added to soil and left for an hour, in order to water to be absorb by soil particles, before mixing. The soil was then mixed thoroughly and converted into mud. Once the mud prepared, it was applied to sandwich panel. The mud insulated sandwich panel is then remained for 10 days in order to be dry out the mud. At the end of drying duration, the mud insulated sandwich panel were shifted to laboratory for testing. A concentrated load by hydraulic static actuator was applied. The load was applied gradually until the load carrying capacity was dropped or the mud cracked enough and spalls from sandwich panel. The test setup of mud insulated sandwich panel is shown in Figure 4.

Figure 4: Experimental test Setup

3. Results and discussion

3.1 Particle Size Analysis

The sieve analysis and hydrometer analysis were done on all three type of soil. The particle size distribution of all the soil samples is shown in Figure 5. It can clearly seen that type C soil is much finer in all of soil samples. The maximum particle size for type C soil is 0.25 mm and is well distributed soil as nearly every size particle is present in it. type B soil is well graded soil, however, it was not much finer as type C. Similarly, type A is coarse soil in all of the samples.

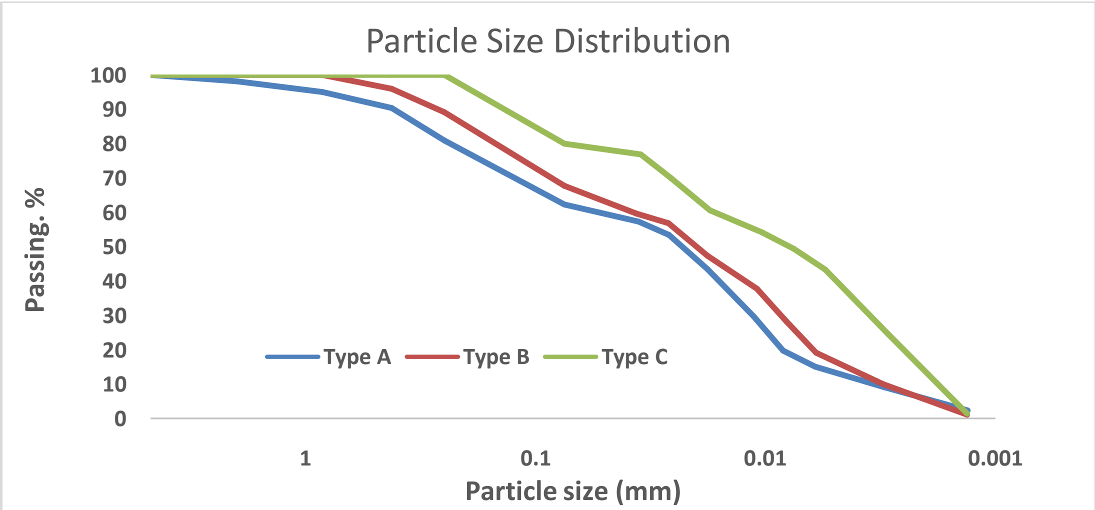


Figure 5:Particle size distribution of all soil types

3.2 Liquid limit, LL

The liquid limit test performed on three type of soils. The test result shows that type C soil is having much higher liquid limit. This mean that more water is needed for this soil to flow. The higher demand in water for type C soil is due to smaller particle size as discussed earlier. The lower the particle size, the greater is surface area and ultimately higher is water demand to allow the particles to flow out to close the gap in cassagrande apparatus. In similar fasion, the liquid limit for type B is higher than type A. The increase in water demand is directly proportional to particle size. The smaller particle size have more surface area. The test results for liquid limit is shown in Figure 6. It was observed that soil with large particle size is more workable since it can easily flow at same effort applied which is obvious from liquid limit test as well.

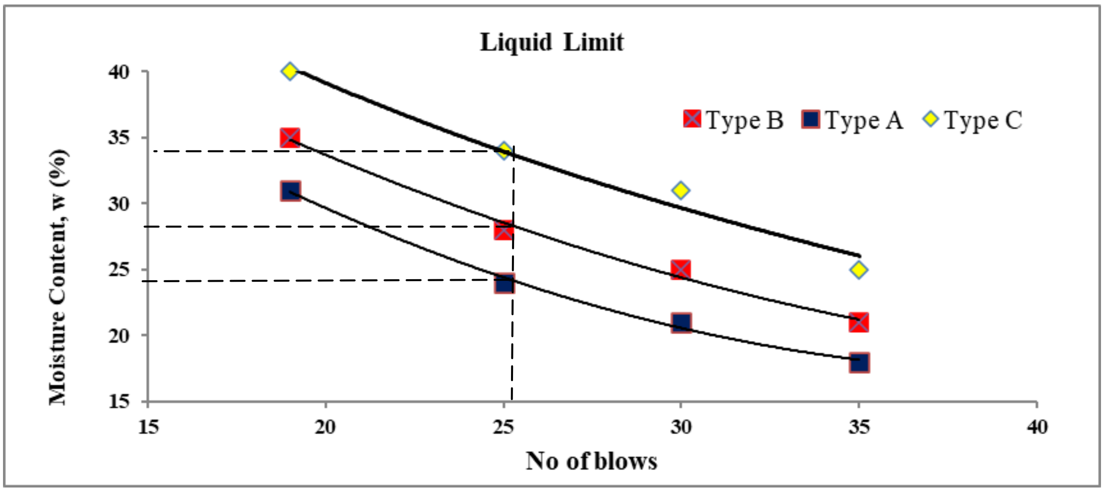


Figure 6: Liquid Limit test of soil samples

3.3 Force-Deformation Behavior

The force-deformation behaviour was established by measureing the displacement of mud insulated sandwich panel and noting down the corresponding load. The load versus displacement values were plotted to obtain force deformation curve. The force-deformaiton curves for all the samples are shown in Figure 7.

The sandwich panel insulated with type C soil show better response as the load carrying capacity of was 16 kN which is maximum of all sample tested as shown in Figure 7. The peak deformation in this case was 58 mm. The maximum load carrying capacity is attributed to presence of smaller particle size and well graded soil. Since the presence of all type of particles in soil fell the voids between large particles, thus, it act as a much solid body as compared to one where the voids remains vacant and causing weak zone. Another important factor that type C soil samples having smaller particle size try to make get around the with steel wire mesh and thus produce a strong bond with steel wire mesh that act as a composite material. It is worth to mention that load carrying capacity doesn't dropped but the contribution of mud is ultilized fully as the cracks were produced in mud and it is detached from sandwich panel.

Similarly, the samples insulated with type B and type A soil have shown comparable response in load carrying capacity with maximum load recorded as 12.5 kN and 13.8 kN, respectively. The peak deformation recorded was 40 mm and 43 mm in type A and type B soil samples, respectively. The reason for such similar response is due to the almost same size particles as shown in Figure 5. Since the large particle size doesn't make a proper bond with steel wire mesh, thus, leaving a weak connection and consequently lower the load carrying capacity.

Comparing the maximum load carrying capacity and peak deformation of all the samples suggested that type C soil samples have 28% and 16% higher load carrying capacity than type A and type B soil samples, respectively. Similarly, the peak deformation of type C soil sample was 45% and 34% higher than type A and type B soil sample, respectively.

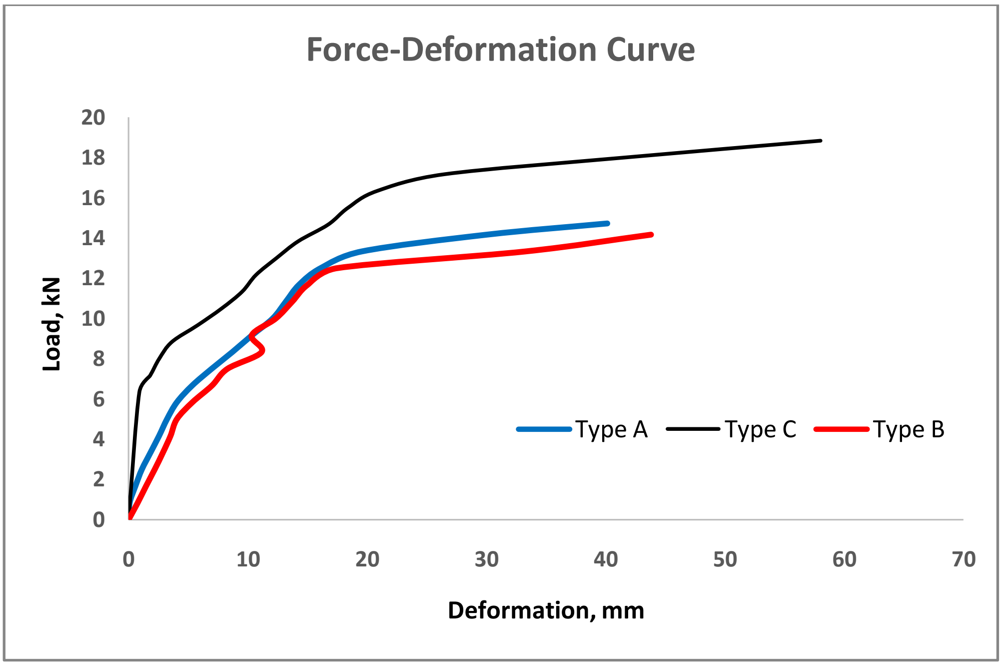


Figure 7: Force-deformation curve for all soil type samples

4. Conclusion

A comprehensive experimental study was conducted on mud insulated sandwich panels by using different size soil. Results from experimental study suggested the following conclusions;

1. The smaller size particles in soil increased the water demand.
2. It is observed that coarser size particles have much higher workability and can be easily applied on sandwich panel, whereas, the small particle size soil have less workable.
3. The force-deformation response is maximum when the well graded soil with small particle size is used.
4. The small size particles soil give much higher stiffness as observed in type C soil, where, for same deformation, the load was maximum.

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