3.2 Effect of OPKS on Compressive Strength

The effect of percentage of OPKS on compressive strength of mortar is shown in Figure 5. The sand was replaced with 25, 50, 75 and 100 % of OPKS. With the increasing OPKS percentage, the compressive strength decreased. This is due to the properties of OPKS, which was derived from palm oil waste as reported by other researcher [4]. The compressive strength of the mortar was affected by the strength, thickness, and density of OPKS aggregate. The OPKS have flaky shape which causes reduction in strength of the mortar. Besides, the aggregate strength and binder strength were important factors in reducing the compressive strength [11].

Figure 5 Effect percentages of OPKS on compressive strength of mortar

3.3 Water Absorption

The water absorption of POFA based mortar is shown in Figure 6. The percentage of water absorption increases as the percentage of OPKS increase. This was due to the porous surface of OPKS that tend to absorb more water during mixing [5]. Previous researchers have mentioned that the average water absorption for OPKS mortar varied between 14-33 % [12]. However, the result shows that the water absorption was less than 10%. This is due to the high volume of POFA used in the mortar that made the mortar more dense and durable.

Figure 6 Water absorption of mortar with different percentage of OPKS

Meanwhile, Figure 7 shows the relationship between water absorption and compressive strength of mortar. The $R^2$ value was 98% for the linear equation. The compressive strength of mortar increases with decrease in water absorption due to less porosity inside the mortar.

Figure 7 Relationships between water absorption and compressive strength of mortar

3.4 Microstructural Analysis

Figure 8 shows the morphology of POFA based mortar with 50% and 100% replacement, respectively. The morphology was determined using a FESEM machine. From the Figures, the 50% replacement of OPKS shows the existence of more bonding between binder and fine aggregate. This was due to the calcium silicate hydrate gel from the reaction between POFA and cement [13]. Besides, OPKS also contributed to some silica content which increases the pozzolanic reaction. Obviously, the presence of higher silica content influences the pozzolanic reaction to produce extra calcium silicate hydrate gel, thus making the mortar more durable and denser [14]. However, with the addition of 100% OPKS, the reaction reduced, thus decreasing the compressive strength of the mortar. This could be due to the excessive amount of filler and the flaky shape of OPKS [15]. Besides, the compressive strength of OPKS also depends on the bond between the fine aggregate and the strength of OPKS itself [4, 16].

3.5 Type of Mortar

Figure 9 shows different types of mortar produced with different percentage of OPKS at 28 days. With 50% replacement, the strength was 30MPa and comparable with conventional mortar, but with lower density. Therefore, this would help to reduce the material cost of construction by approximately half compared to the normal cost. The density of the low strength mortar produced was 1090kg/m³ and it is within the range for lightweight mortar according to