

Carbohydrate Polymers for Green Multi-Purpose Mortar

Rr. M. I. Retno Susilorini^{1*}, Riska Suryanto², Yehuda Pramana²

¹Department of Infrastructure and Environmental Engineering, Faculty of Environmental Science and Technology, Soegijapranata Catholic University, Jl. Pawiyatan Luhur IV/1, Bendan Dhuwur, Semarang 50234, Indonesia

²Department of Civil Engineering, Faculty of Engineering, Soegijapranata Catholic University, Jl. Pawiyatan Luhur IV/1, Bendan Dhuwur, Semarang 50234, Indonesia

*Corresponding author: ORCID 0000-0001-8531-7485

Abstract

Concrete and mortar polymer have been developed to gain high strength and durability. Instead of chemical polymer, organics polymer is widely used as material innovation. This research aims to investigate the performance as well as its compressive strength of carbohydrates polymer for multi-purposes mortar with amyllum powder and honey to be used for multi-purpose mortar. There were 285 cubes of mortar specimens 50 x 50 x 50 mm with basic composition weight ratio of cement : sand : water = 1 : 1 : 0.6 with addition of amyllum powder and honey tested for compressive strength. The result found optimum composition of specimen series is KT-M-0-G which contains honey 0.03% and amyllum 0.1% of cement weight with compressive strength of 37.44 MPa. The comparison of compressive strength of mortar in current investigation to the previous researches as reference has shown higher compressive strength of specimen series without honey but very low compressive strength to specimen series with honey. This research confirms that mortar with carbohydrates polymer can be used for multi-purpose mortar because it has high performance of strength and durability.

Keywords: carbohydrate polymer, green, multi-purpose, mortar.

I. INTRODUCTION

Polymer mortar and concrete widely used because of its high performance and functionality as well as sustainability [1]. In certain composites, polymer used as co-binder because it works together with Portland cement [2]. Generally, the use of polymer is important to improve the mechanic properties such as compressive strength, bond mechanism, setting time, water absorption, vibration damping, etc [3]. Some chemical and organic polymers have been used and developed to gain high performance of mortar and concrete [3– 10]. However, there is still an uncertainty about the performance of organic polymer mortar as green material (spending less energy than chemical ones) which has high performance and durability as well as the chemical ones, as it is debatable to claim that polymer concrete or mortar will gain maximum strength at short or long term [11].

Carbohydrates polymer mortar and concrete researches [10][12][13] have been carried out to confirm the advantage of carbohydrates polymer for multi-purposes mortar as

investigated in this research [13]. Carbohydrates polymers used in this research were amyllum powder and honey. Amyllum powder used is rice flour manufactured product that has advantage of high viscosity, gelatinization, and amylase content [14] which contributes great bonding mechanism and compactness. The use of honey for admixture has been popular because of its 'sugar effect' which increased the compressive strength of mortar and concrete [15][16], since honey contained 38.4% of fructose and 30.3% of glucose [17]. Those previous researches reported that carbohydrates polymer mortar have good compressive strength in aggressive environment such as seawater, brackish water, and tidal flood water [13] while carbohydrates polymer concrete have good compressive and tensile strength [10], [12]. Hence, this research aims to investigate the performance of carbohydrates polymer for multi-purposes mortar with amyllum powder and honey to be used for green multi-purpose mortar. It is also questioned whether the compressive strength of the specimens will be higher compared to previous investigations.

II. MATERIALS AND METHODS

II.I. Materials

Mortar specimens comprised of 285 cubes of 50 x 50 x 50 mm with basic composition weight ratio of cement : sand : water = 1 : 1 : 0.6. Carbohydrate polymers added into mortar were amyllum powder and honey (Fig 1 and Fig 2). Mix design of mortar detailed by Table 1.



Fig 1. amyllum powder which was rice flour manufactured product



Fig 2. Honey

Table 1. Mortar mix design

specimen code	honey	amylum	total specimens
	(% of cement weight)		
KT-M-0-A	0	0.1	15
KT-M-0-B	0	0.2	15
KT-M-0-C	0	0.5	15
KT-M-0-D	0	1	15
KT-M-0-E	0	2	15
KT-M-0-F	0	5	15
KT-M-0-G	0.03	0.1	15
KT-M-0-H	0.03	0.2	15
KT-M-0-I	0.03	0.5	15
KT-M-0-J	0.03	1	15
KT-M-0-K	0.03	2	15
KT-M-0-L	0.03	5	15
KT-M-0-M	0.3	0.1	15
KT-M-0-N	0.3	0.2	15
KT-M-0-O	0.3	0.5	15
KT-M-0-P	0.3	1	15
KT-M-0-Q	0.3	2	15
KT-M-0-R	0.3	5	15
KT-M-0-S (control)	0	0	15
Total specimens			285

II.II. Experimental Program

After curing, all specimens were tested for compressive strength with Compression Machine CO-325 (Fig 4) that referred to ASTM C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars. Compressive strength may be calculated by Equation (1).

$$\sigma = \frac{P}{A} \tag{1}$$

Where:

- σ = compressive strength (MPa)
- P = load (kN)
- L = cross-section area (mm²)



Fig 4. Compression Testing Machine

III. RESULTS AND DISCUSSION

Mortar specimens were produced (Fig 5) that were tested for compression test and getting broken in many various pattern (Fig 6). Current investigation found the compressive strength development of most specimens as described by Fig 7 to Fig 10 as modified from [18].



Fig 5. Mortar specimens



Fig 6. Broken mortar specimens after compressive test

Fig 7 describes compressive strength of specimen series without honey that increase from age 7 days to 28 days respectively. It was found that KT-M-0-E achieved highest compressive strength of 33.44 MPa. Specimen series with honey 0.03% of cement weight also performed good development of compressive strength as shown by Fig 8.

Highest achievement was found on specimen KT-M-0-G of 37.44 MPa. Different behaviour found for specimen series with honey 0.3% of cement weight that there was no data available for compressive strength of the specimens at age 7 and 14 days. The unavailability of data caused by collapse specimens at testing because of softens mortar cubes.

Compressive strength of all series of specimens has shown interesting phenomenon as described by Fig 9. High compressive strength of specimens found at KT-M-0-A to KT-M-0-G series of specimens without honey and one series of specimen (KT-M-0-H) with honey of 0.003% of cement weight. After that series, the development of compressive strength has gradually decreased at the rest series of specimens with honey 0.03% of cement weight. The compressive strength of specimens has fallen down started at KT-M-0-M to KT-M-0-R series where specimens contain honey of 0.3% of cement weight. It was noted that the highest compressive strength of KT-M-0-G of 37.44 MPa was 10.90% higher compared to control specimen KT-M-0-S of 33.76% MPa.

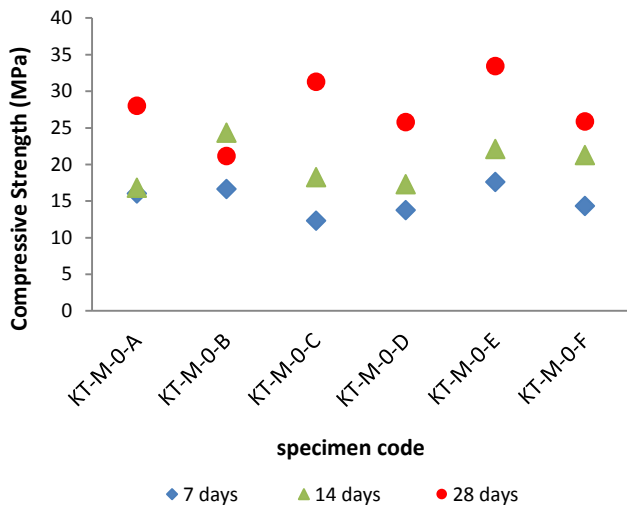


Fig 7. Compressive strength of specimen series without honey modified from [18])

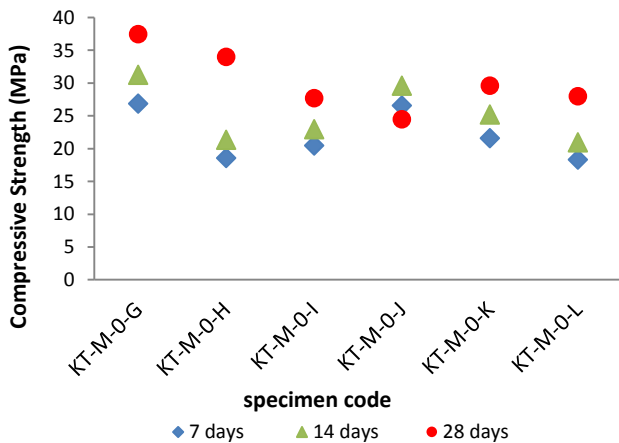


Fig 8. Compressive strength of specimen series with honey of 0.03% of cement weight (modified from [18])

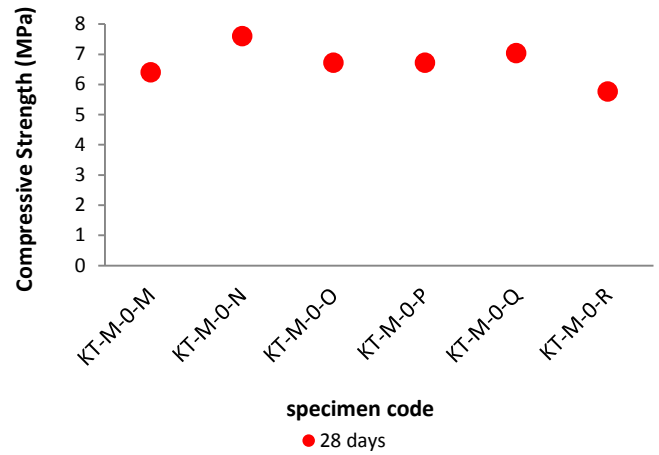


Fig 9. Compressive strength of specimen series with honey of 0.3% of cement weight (modified from [18])

Previous researches [10][12][13] have reported compressive strength of concrete and mortar in aggressive environment curing (seawater, brackish water, and also tidal flood water), with addition of the same carbohydrates polymers, amyllum powder and honey. Those investigations have become good reference for this current investigation as shown by Fig 11. The comparison of compressive strength of mortar in current investigation to the previous researches as reference has shown higher compressive strength of specimen series without honey (KT-M-0-A to KT-M-0-G). This performance didn't work with series specimens with honey (0.03% and also 0.3% of cement weight) that the compressive strength of those specimens series decreased and even jumped down. It was also interesting that specimen series without honey have higher compressive strength compared to concrete specimens but have fallen down for specimen series with honey.

Optimizing the composition of specimen series may carried out by analysing data of Fig 12 and Fig 13. The data of Fig 12 has shown the highest compressive strength achieved by specimen series with honey 0.03% of cement weight and amyllum 0.1% of cement weight. It was also found at Fig 13 that amyllum 0.1 % of cement weight had higher compressive strength with honey 0.03% of cement weight. Therefore, optimum composition of specimen series is KT-M-0-G which contains honey 0.03% and amyllum 0.1% of cement weight with compressive strength of 37.44 MPa.

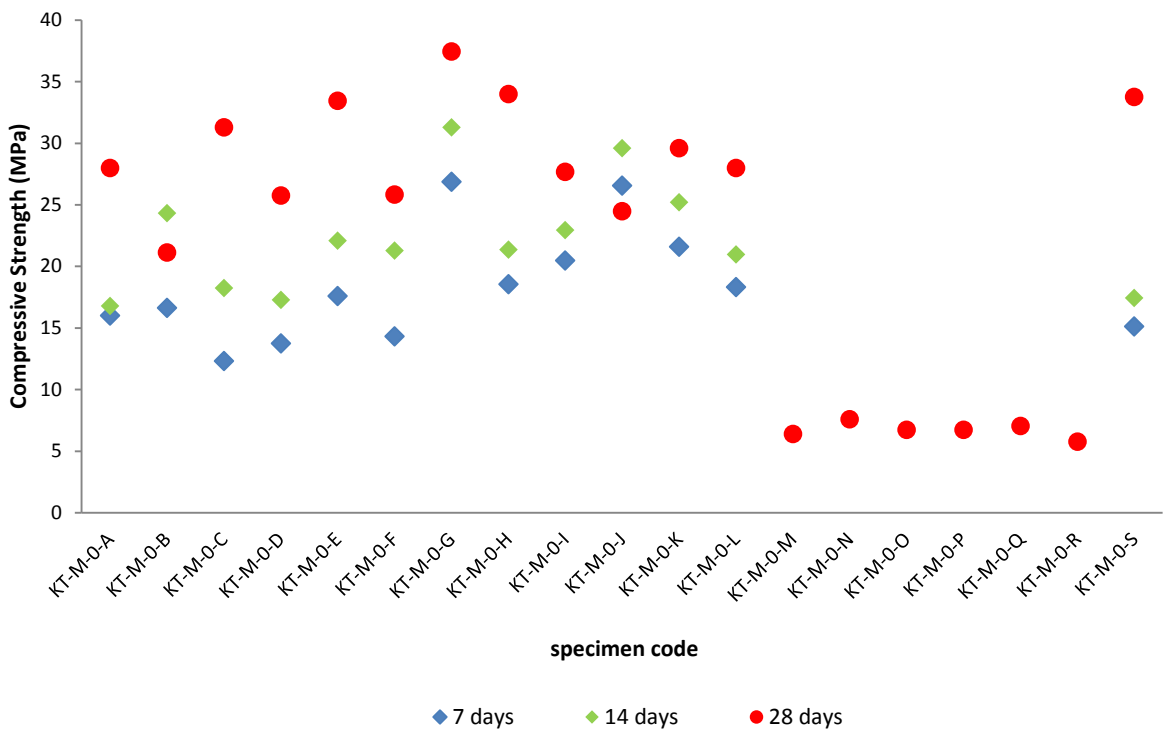
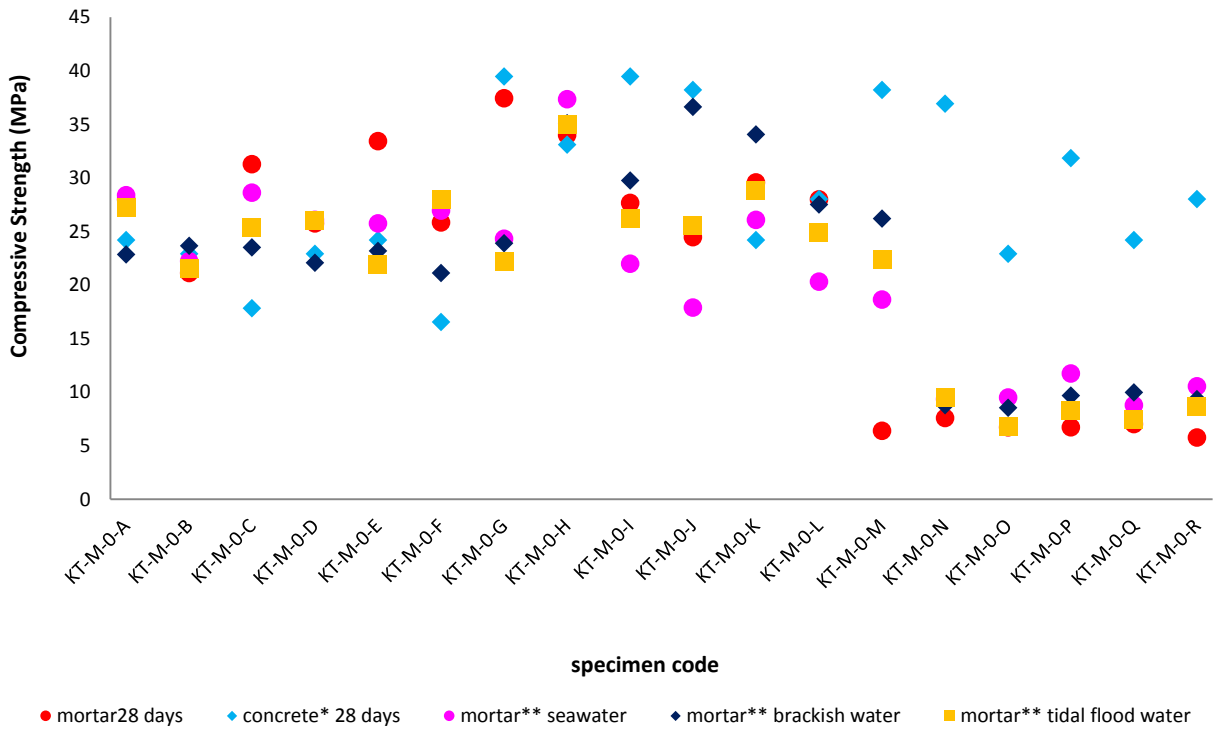


Fig 10. Compressive strength of all specimens (modified from [18])



*Compressive stress of concrete at 28 days of [10] and [16]

**Compressive stress of mortar cured in seawater, brackish water, and tidal flood water at 28 of [17]

Fig 11. Comparison of compressive strength of specimens of current investigation and several researches (*, **)

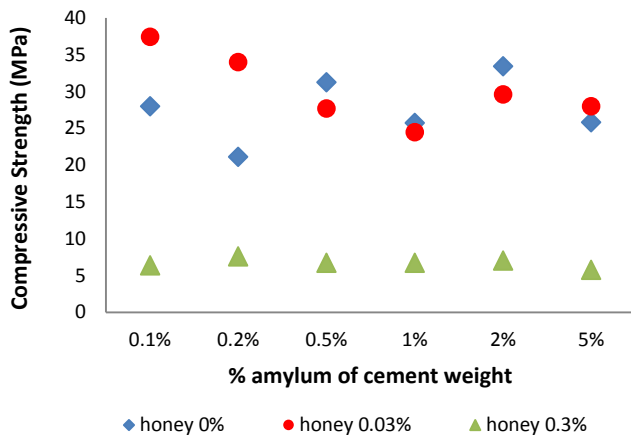


Fig 12. Compressive strength of specimens with function of % honey of cement weight

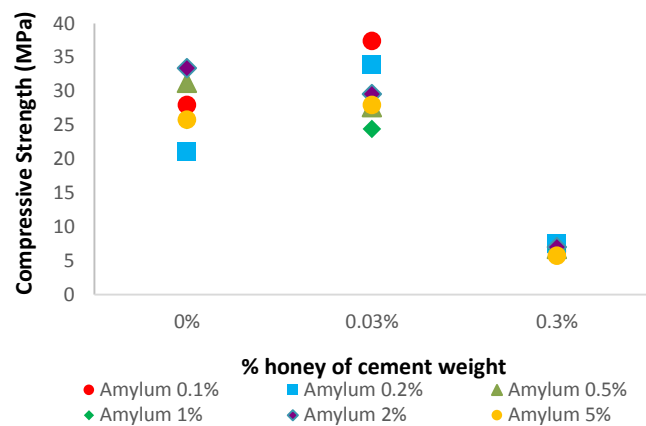


Fig 13. Compressive strength of specimens with function of % amyllum of cement weight

VI. CONCLUSION

KT-M-0-G is optimum composition which contains honey 0.03% and amyllum 0.1% of cement weight with compressive strength of 37.44 MPa. It is found that compressive strength of mortar in current investigation to the previous researches as reference has shown higher compressive strength of specimen series without honey but very low compressive strength to specimen series with honey.

The findings of this research have proven that mortar with carbohydrates polymer can be used for multi-purpose mortar because it has high performance of strength and durability. For normal condition of this current investigation, carbohydrates polymer mortar gives advantage of high compressive strength.

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