USING PARA RUBBER MIXED IN MODERATE LIGHTWEIGHT CONCRETE

Prachoom Khamput*

Abstract:

This research is to use latex from para-rubber as an admixture for improving the strength and insulation properties of autoclaved aerated lightweight concrete. In mix design, cement-sand ratio is 1:1 (by weight). The aluminum powder (3% by weight) is added, water-cement ratio is 0.5 (by weight not include water in latex), five percent of lime and gypsum (by weight of cement) are added. To provide latex from para-rubber, the solution of ammonia at 15% of concentrdtion is added into para-rubber at amount of 3% (by weight of para-rubber). Concrete must be added 4% (by weight of cement) of the nonionic surfactant. The latex per cement ratios that use in this experiment are 0, 0.10, 0.15 and 0.20 (by weight of cement). Then mixing and streaming follow TIS (Thailand Industrial Standard) and test the density by volume, compressive and bending strength at ages of 3, 7, 14 and 28 days. The absorption of water is measured at 7 and 28 days. The elongation and coefficient of thermal conductivity are measured under ASTM standard. From the results, it is found that the compressive strength and density of lightweight concrete reverses variation with latex-cement ratios while the bending strength and water absorption of concrete is Propostion to latex-cement ratio. The elongation has an uncertainty for each latex-cement ratio. The coefficient of thermal conductivity is slightlg larger than normal lightweight concrete. The suitable latex-cement ratio is 0.10 (by weight of cement). By consider all of results, this can be produced as a moderate lightweight concrete in which high strength and good insulation are highlighted.

Introduction

Thailand had area of planting para-rubber trees around 20,000 Km^2 and exporting value was around 131,617,514 million baths per year [2]. There were 7 million people of farmers that had occupation about para-rubber in the country. This cauxd the para-rubber to be the main income of the country. The application of para-rubber in many products was largely increased from 250,000 tons to 500,000 tons in year of 2006 [3]. By previous reason, the government encouraged the planting of para-rubber trees in north-east area of the country and waited for the products in the next 2-3 years. Although, para-rubber gove high rate of price, 100 baths/kg, and average price was around 76 baths/Kg but para-rubber was the primary product that can be replaced by the other products

*Department of Civil Engineering, Faculty of Engineering, Rajamangala University of Technology Thanyaburi Pathumthani, Thailand, 12110 e-mail: choomy_gtc@hotmail.com

(i.e. synthetic rubber) then there was an occasion for reducing the price in the near future. Since para-rubber contains the properties of high flexibility and excellent thermal insulation, then the study of para-rubber for construction materials that have property of insulation was initiated by [4]. However for light weight concrete blocks mixing with para-rubber, there is no one evaluating the property of insulation of this type of concrete blocks. Then in this paper the investigation of properties of this type of concrete blocks will be examined for possibility of new type of construction material.

Materials and Methods

Preparation of the samplings: prepare latex from para-rubber by using 3% (by weight of para-rubber) [5] of ammonia solution that has concentration of 15%, cement portland type 1 (see TIS standard [6]), lime under standard of TIS 319 [7], gypsum, fine sand that passes sieve #100, aluminum powder, non-ionic surfactant and water

Preparing the specimens:

1) Assign the fixed ratios for cement:sand ratio is 1:1 by weight, aluminum powder is 3% of total ingredient, water cement ratio is 0.50 by weight (not include the weight of water in latex), lime is 5% by weight of cement. The latex is prepared from adding 3% ammonia solution (concentration of 15%) by weight of para-rubber and 4% of non-ionic surfactant by weight of cement.

2) The variable parameter is latex cement ratios (P/C) which equal 0, 0.10, 0.15 and 0.20 by weight of cement.

3) Cast the moderate light weight concrete blocks specimens followed as TIS 1505-2541 [8]

4) Test the density under TIS 1505-2541 [8].

5) Test the absorption of this type of concrete blocks under TIS 1505-2541 [9].

6) Test compressive strength by TIS 1505-2541 [8].

7) Test bending strength by ASTM C 62-69 [9].

8) Test the elongation of light weight concrete by TIS 1505-2541 [8].

9) Test coefficient of thermal conductivity of light weight concrete by ASTM C 177 [10].

Results and Discussion

1) Density by volume

From Fig. 1, it is found that density reverses proportion to the age of lightweight concrete. Initially, all of ingredients; cement, sand, lime, gypsum, aluminum powder, latex and water are mixed together. There are many reactions such as crystallization that forms thin film layer and hydration of aluminum powder and water that form the bubbles in concrete. The rest of water performs the hydration reaction of water and cement. When the time is increased the reactions are also impseceed [11]. This leads to the reduction of weight and then the density of light weight concrete is decreased.

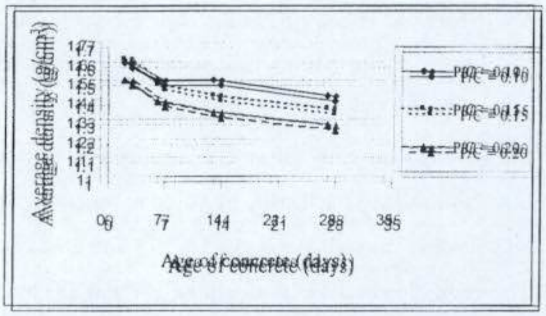

Fig. 1 Relationship between age and average density of concrete

From Fig.2, when consider the density of the light weight concrete with various values of latex cement ratios, it is found that there is no difference in first 3 days. At 28 days, the density reaches the maximum value with latex cement ratio at 0.10 and descending with values of latex cement ratios are 0.15 and 0.20 respectively. This results from water content of 55% in latex [12].

The water content in latex is reacted with aluminum powder and results in increasing the bubble in concrete. This leads to the reduction in density of concrete when latex cement ratio is increased.

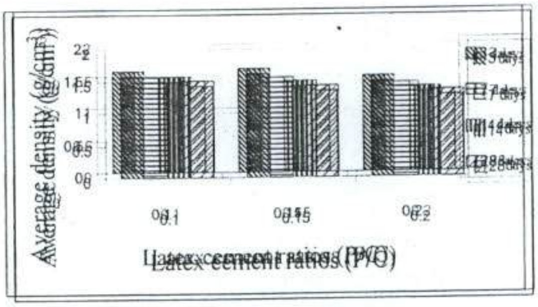

Fig. 2 Relationship between latex cement ratios and density

2) Water absorption

From Fig. 3 and 4, it is found that water absorption at age of 7 days is less than water absorption at 28 days for every ratio of P/C. This is because at age of 7 days there is a lot of water content in concrete. The hydration reaction is not complete however, at 28 days the reactions of water and cement and water and aluminum powder is complete succeeded. This results in many bubbles in content of concrete which means increasing in porosity. The increasing of porosity affects the increasing of water absorption. As can be observed from Figs 3 and 4, when latex is not added, the water absorption is high but when latex is added the water absorption will be decreased. Because latex forms the thin film (polymer type) of para rubber in content of concrete and makes the high density of concrete decreasing the bubble and low penetration of water. However because of water content in latex, the increment of latex will not provide the decreasing of water absorption. There is an optimum point of latex cement ratio P/C that mores the lowest value of water absorption. This is latex cement ratio (P/C) at 0.10. If the latex cement ratio increases from this point such as 0.15 and 0.20, the water absorption is increased.

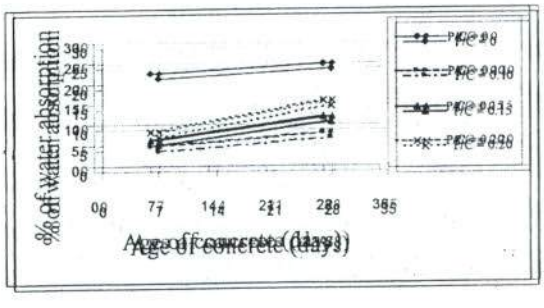

Fig. 3 Relationship between age and water absorption of concrete

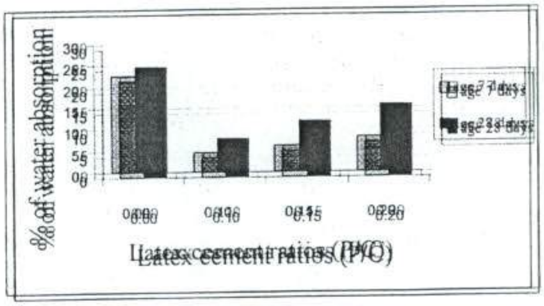

Fig. 4 Relationship between latex cement ratios and water absorption of concrete

3) The compressive strength

From Fig. 5, the compressive strength is proportion to the age of concrete, when age of concrete is increased the compressive strength is increased. This results from the well known reaction, hydration reaction, in concrete.

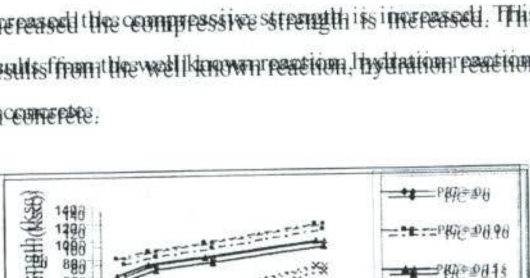

Fig. 5 Relationship between age and compressive strength of concrete

From Fig. 6, the compressive strength reverses proportion to latex-cement ratio (P/C). The maximum compressive strength is 115.64 ksc when latex-cement ratio P/C equals 0.10 and descending into 98.03 and 69.61 ksc for latex-cement ratios of 0.15 and 0.20, respectively. However when latex is not added into concrete, the compressive strength is lowest. This conflicts with the previous results in which compressive strength reduces as latex-cement ratio increases. This may be the effect of the thin film in the concrete when latex is added. According to the previous results that the optimum point of maximum density is P/C = 0.10, this leads to maximum compressive strength at this point. When latex-cement ratios are 0.15 and 0.20 the compressive strength is reduced because these points are not optimum point of density. This indicates that the suitable point of adding latex into concrete is P/C = 0.10.

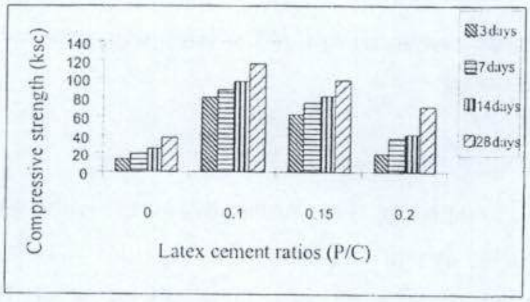

Fig. 6 Relationship between latex-cement ratios and compressive strength of concrete

4) Tensile strength (in term of modulus of rupture)

From Fig. 7, the modulus of rupture of lightweight concrete at edge wise is larger than flat wise due to larger depth of lightweight concrete. The modulus of rupture increases as age of lightweight concrete increases and linear proportion to latex-cement ratios (opposite with compressive strength). This is the effect of thin film that performs as binding agent [13]. This thin film is formed as layer that reinforces the concrete for resisting the tensile load in concrete. Then increasing in modulus of rupture is the result.

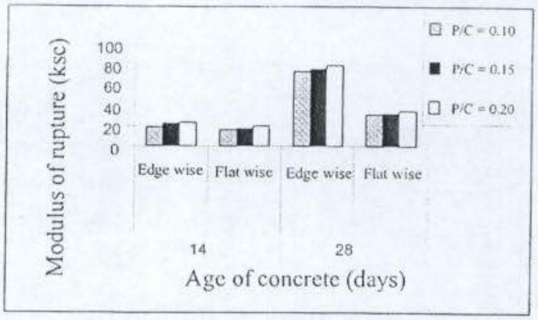

Fig. 7 Relationship between age and modulus of rupture of concrete

5) Elongation of concrete blocks

From table 1, every specimen has elongation over .05% (0.05% is the standard of TIS 1505-2541 [8]). The closest value to the standard is 0.054 for latex-cement ratio at 0.10. The maximum value of elongation is 0.308% for latex-cement ratio at 0.20. This large elongation may affect the crack of the wall when loads are transferred. This may be the cause of the irregular distributed bubbles in the content of concrete or high flexibility of para-rubber which must be investigated and solved this problem in the future.

Table 1. Elongation at age of 28 days

Latex-cement ratios (P/C)	Sample no.	% of elongation
0.10	1	0.071
	2	0.139
	3	0.139
0.15	1	0.146
	2	0.244
	3	0.180
0.20	1	0.054
	2	0.064
	3	0.308

6) The coefficient of thermal conductivity

The results which are obtained from Department of science service, Ministry of Science and Technology are shown in Table 2.

Table 2. Coefficient of thermal conductivity of concrete blocks

Latex-cement ratios (P/C)	Coefficient of thermal conductivity (Watt/M-Kelvin)
0.10	0.154
0.15	0.175
0.20	0.197

From Table 2, the coefficient of thermal conductivity is slightly higher than normal lightweight concrete [14]. The highest value of coefficient of thermal conductivity is 0.197 Watt/M-Kelvin for latex-cement ratio of 0.20. The coefficient of thermal conductivity decreases as latex-cement ratio decreases. This shows that adding the little value of latex will improve the insulation property. This paradoxes with previous results that the density of lightweight concrete reaches the maximum value when uses a little value of latex in which, normally, high density materials have low insulation property (high coefficient of thermal conductivity) [1]. Reside, a large number of thin films when the latex is increased, these thin films infiltrofe the space of bubbles then the number of bubbles reduce and density increases which result in high coefficient of thermal conductivity.

Conclusions

The conclusions of the results are as follows;

1) The density reverses proportion to latex-cement ratios; increasing in latex decreasing in density.

2) Water absorption is proportion to latex-cement ratios; increasing in latex increasing in water absorption.

3) The compressive strength reverses proportion to latex-cement ratios.

4) The tensile strength (in term of modulus of rupture) is proportion to latex-cement ratios.

5) Elongation must be located in pending state due to the results did not directly indicate the effect of latex to elongation (fluctuation of the results). However we can tell that the elongation decreases as latex increases.

6) Thermal conductivity increases as latex increases.

7) Type of failure in this test is tensile failure.

References

[1] Energy conservation encouragement office, Heat insulation, Department of Renewable Energy and Energy Conservation, Ministry of energy, http://www2.dede.go.th. (in thai)

[2] A. Prugumphai, Handbook of para-rubber, Pet-plant publishing, 1st edition, Bangkok, 2547. (in thai)

[3] Thailand Research Fund (TRF), Announcement for submitting small project of para-rubber, National project: division of para-rubber industry, 2548. (in thai)

[4] V. Suwanprecha, Lightweight paracrete bricks, http://www.thailandrubber.thaigov.net, 2548. (in thai)

[5] American Society for Testing and Materials, *Standard Specification for Building Brick, ASTM C 62-69.*, Philadelphia, 2001.

[6] Thailand Industrial Standard, Industrial standard of portland cement vol. 1 quality specifications (TIS. 15 vol 1-2532), Bangkok, 2532. (in thai).

[7] Thailand Industrial Standard, Industrial standard of limes (TIS 319-2541), Bangkok, 2541. (in thai)

[8] Thailand Industrial Standard, Industrial standard of autoclaved aerated concrete (TIS. 1505-2541), Bangkok, 2541. (in thai)

[9] American Society for Testing and Materials, *Standard Specification for Building Brick*, ASTM C 62-69, Philadelphia, 2001.

[10] American Society for Testing and Materials, *ASTM C177*, Philadelphia, 2001.

[11] P. Chindaprasert and C. Jaturaphitakkul, Cement, Pozzolan and Concrete, Siam Cement Industry Co.Ltd., special edition, Bangkok, 2549. (in thai)

[12] S. Chuaijulraijit, Rubber technology, Department of material science, Faculty of science, Chulalongkorn University, Bangkok, 2548. (in thai)

[13] Ohama, Y., *Principle of Latex Modification and Some Typical Properties of Latex-Modified Mortars and Concretes*, ACI Materials Journal, Title No. 84-M45, p. 511-518, 1987.

[14] Project of study the status of energy consumption and guide to encourage the conservative energy in houses, Characteristics and specifications of building materials, http://www.dede.go.th, 2549. (in thai)

[15] C. Saitabhut, Concrete technology, Construction materials and products Co. Ltd., 5 th edition, Bangkok, 2540. (in thai)