

PAPER • OPEN ACCESS

THE EFFECT OF COMPOSITION OF PLASTIC WASTE LOW DENSITY POLYETHYLENE (LDPE) WITH SAND TO PRESSURE STRENGTH AND DENSITY OF SAND/LDPE COMPOSITES

To cite this article: I M Susila *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **539** 012043

View the [article online](#) for updates and enhancements.

THE EFFECT OF COMPOSITION OF PLASTIC WASTE LOW DENSITY POLYETHYLENE (LDPE) WITH SAND TO PRESSURE STRENGTH AND DENSITY OF SAND/LDPE COMPOSITES

I M Susila¹, N P G Suardana¹, C I P K Kencanawati¹, I N A Thanaya² and I W B Adnyana¹

¹Mechanical Engineering Udayana University

²Civil Engineering Udayana University

Email: npgsuardana@unud.ac.id

Abstract. Plastic waste especially plastic bags have not been widely reused or recycled so that the amount increases polluting the environment every day. One way to overcome this problem is by utilizing plastic waste into paving blocks as a substitute for cement. The problem is how the composition of plastic and sand. The purpose of this study is to determine the effect of using LDPE waste into a mixture of sand with ratios of 1:3, 1:5, and 1:7 with heating temperature of 200°C to the compressive strength and density of sand/LDPE composites. Based on the results of the study, the highest average compressive strength was resulted by the sample which has a ratio of 1:3 plastic and sand with 3mm sand grain and a heating temperature of 200°C which is equal to 32.7MPa. While the lowest average compressive strength was obtained by the sample which has a ratio of 1:7 plastic and sand, 3mm granules and temperature 200°C with a compressive strength of 12.0 (MPa). Increasing the mixture of plastic and sand 1:3, 1:5, 1:7 in which of the followed by increasing of density of the sample.

1. Introduction

Plastic has become an important component in this life. Almost all people use plastic material in their daily activities. Moreover, plastic material could change the woods and metal because of its characteristics such as light and strong, anti-corrosive, transparent and easy to be colored as well as having a good isolative characteristic. The use of plastic can be said not eco-friendly since it is hardly degraded by the environment without any limit. If this problem is not seriously handled so it will be a serious issue for our environment or the earth. Therefore, there should be an alternative of reusing plastic waste. The applicable alternatives that can be done are through cutting, melting, and mixing the plastic waste with the brace of sand to create one of new materials i.e. paving block from the plastic waste and reduce environmental pollution caused by plastic. Plastic waste functions to reduce the use of cement in making paving. This study aimed to produce paving high compressive strength and good material density by adding LDPE (*Low Density Polyethylene*) plastic matrix into mixture of paving forming material (Arumi D, et.al, 2012).

2. Research Method

The sand was washed to omit the dust and other dirt and then dried naturally under the sunshine for 24 hours. Cleaning up the plastic waste, and then dried up under the sunshine. Cut the plastic with plastic cutting machine. Melt the plastic waste on a stove with temperature variation of 200°C on the stove and mix with sand with some composition of plastic: sand (1:3, 1:5, and 1:7) and sand grains 3mm (6 Mesh). Cut the test specimen with standard ASTM D695 for compressive test and density test by using ASTM D 792-08.



3. Result and Discussion

Data collection was done since the beginning of material mixing process i.e. material of the LDPE plastic and sand with ratios of 1:3,1:5,1:7 of 3 mm sand grains in 200°C, continued to specimen molding process until testing process such as compressive test, density test and SEM. The following is the research findings:

3.1. Data of Compressive Test

Collection of compressive test data was done by using mortar compression machine to find out the paving compressive strength. The following table is the calculation result of paving compressive strength by using mortar compression machine.

Table 1. The Calculation Result of Compressive Strength by Using Mortar Compression Machine

Comparison of Paving Mixture	Sample	Press Load (KN)	Cross section (Cm ²)	Compressive Strength (Mpa)	Average (MPa)
Mixture. 1:3, Grain 3mm, Temperature 200°C	Specimen 1	115	36	31.9	32.7
	Specimen 2	120	36	33.3	
	Specimen 3	118	36	32.8	
Mixture 1:5, Grain 3mm, Temperature 200°C	Specimen 1	70	36	19.4	20.8
	Specimen 2	95	36	26.4	
	Specimen 3	60	36	16.7	
Mixture 1:7, Grain 3mm, Temperature 200°C	Specimen 1	40	36	11.1	12.0
	Specimen 2	50	36	13.9	
	Specimen 3	40	36	11.1	

3.2. Discussion of Compressive Test

Based on the result of specimen molding and testing, the measurement of compressive strength with mixture variation of LDPE plastic and sand that has been made resulted data of average compressive strength from every samples as described by Fig. 1 which showed that different mixture of plastic and sand influences the paving compressive strength. In the testing process by placing the specimen in the middle of testing device and then turning the machine on as well as arranging the pressure to the maximum and finally turning the machine off to record the applied force. On the specimen of the mixture component of plastic and sand with ratio of 1:3, 3mm sand grain in temperature 200°C recorded the compressive strength of 32.7 (Mpa). On the specimen of the mixture component of plastic and sand with ratio of 1:5, 3mm sand grain in temperature 200°C recorded the compressive strength of 20.8 (Mpa). On the specimen of the mixture component of plastic and sand with ratio of 1:7, 3mm sand grain in temperature 200°C recorded the compressive strength of 12.0 (Mpa). Based on the result of measurement, the highest average compressive strength was resulted by the sample which has a ratio of 1:3 plastic and sand with 3mm sand grain and a heating temperature of 200°C which is equal to 32.7 (MPa). Meanwhile the lowest average compressive strength was obtained by the sample which has a ratio of 1:7 plastic and sand, 3mm granules and temperature 200°C with a compressive strength of 12.0 (MPa). It is because the composite in sample with ratio of 1:3 got all of the sand were bounded by matrix (as shown by SEM Fig. 3) so the compressive

strength was better than specimen with ratio of 1:7, in which there were many cavities found as resulted by the lack of matrix to bound the entire surface of the sand as shown by SEM Fig. 4.

Afterward, the data were plotted into bar graph to describe the average of compressive strength of the specimens.

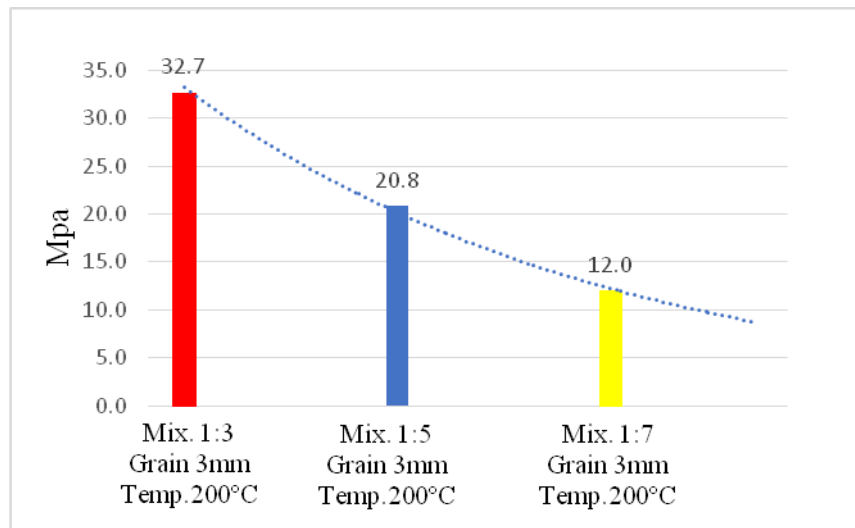


Figure 1. Graph of Compressive Strength Average of the Specimen with Plastic and Sand Mixture Ratios of 1:3,1:5,1:7 of 3 mm Sand Grains in 200°C.

3.3. Data of Density Test

Data of the density test was collected by comparing samples mass by using digital scale and recorded as dry mass (ms). Then, the sample was soaked in water and the mass was recorded as wet mass (mb) and the sample that was hanged by wire in water (mg).

Table 2. Data of Density Test

Variation	Sample	mk (gr)	ms (gr)	mg (gr)	mb (gr)	ρ (gram/cm ³)	Average
Mix.1:3, Grain 3mm, Temp.200°C	1	2.21	19.04	9.12	20.08	1.443	1.455
	2	2.21	19.13	9.17	20.11	1.452	
	3	2.21	19.45	9.21	20.20	1.471	
Mix.1:5, Grain 3mm, Temp.200°C	1	2.21	19.89	9.43	20.40	1.506	1.545
	2	2.21	20.35	10.11	20.96	1.537	
	3	2.21	20.43	10.59	21.33	1.574	
Mix.1:7, Grain 3mm, Temp. 200°C	1	2.21	21.41	13.11	23.61	1.680	1.765
	2	2.21	21.55	13.59	24.11	1.688	
	3	2.21	22.65	14.35	25.05	1.749	

Afterward, the data were plotted into bar graph to describe the average of density of the specimens.

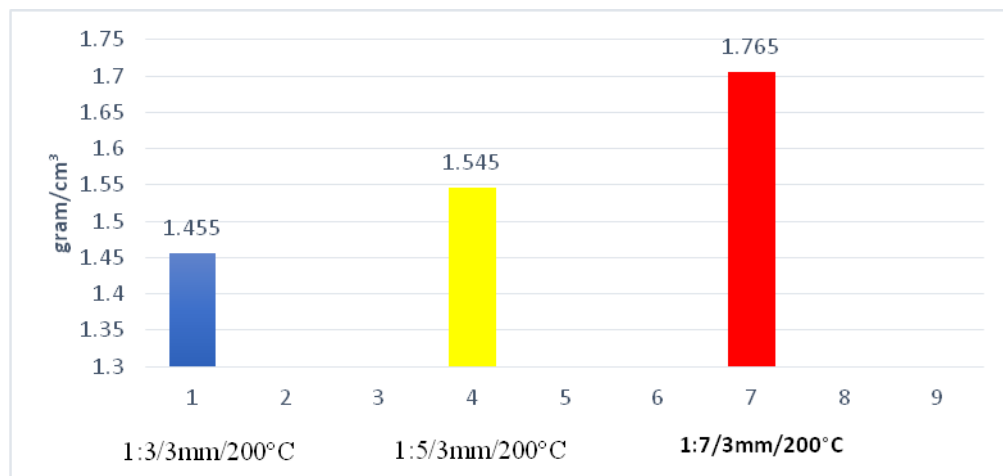


Figure 2. Graph of Density Average of the Specimen with Plastic and Sand Mixture Ratios of 1:3,1:5,1:7 with 3 mm Sand Grains in 200°C.

3.4. Discussion of Density Test

The measurement of density with mixture variation of plastic and sand that has been made resulted data of average density from every samples as described by Fig. 3. Fig. 3, shows that the highest density was gained from mixture variation of plastic and sand of 1:7 with 3mm sand grain in temperature 200°C while the lowest average was gained by sample of 1:3 with 3mm sand grain in temperature 200°C. It is caused by the composition of plastic on ratio 1:7 was fewer than ratio 1:3 in the same volume in which plastic density is lighter than the sand so it influences the composite density.

3.5. The Result of Material Characteristic by Using SEM (Scanning Electron Microscope) Type Phenom G2 Pro.

The following is the result of SEM observation upon the paving block specimen test with ratio variation of 1:3, 1:5 and 1:7 by using 3 mm sand grain in temperature of 200°C.

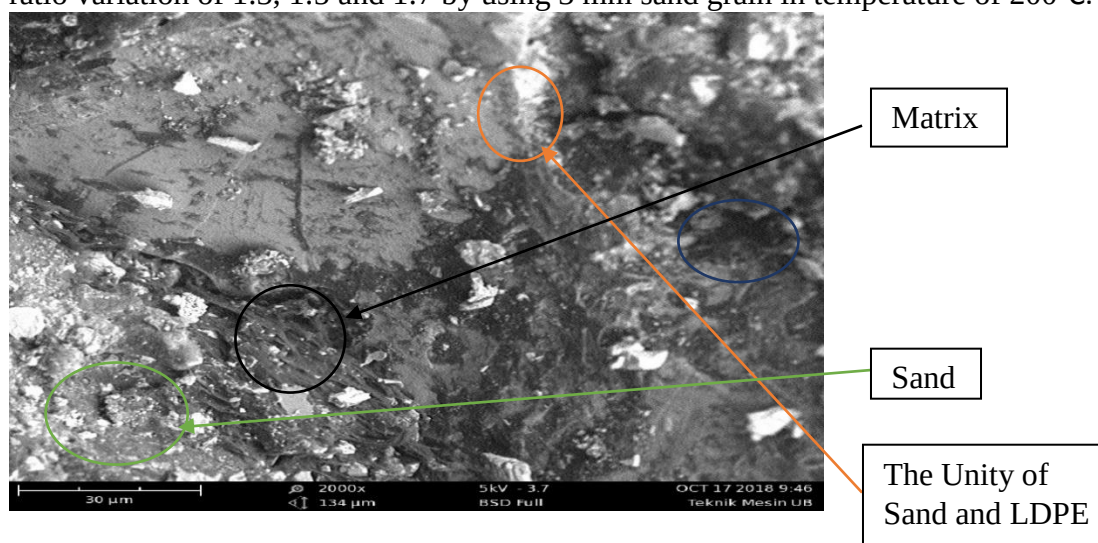


Figure 3. The Result of Micro Structure from the Specimen with Ratio of 1:3, with 3 mm Sand Grains in 200°C with 2000x Magnification.

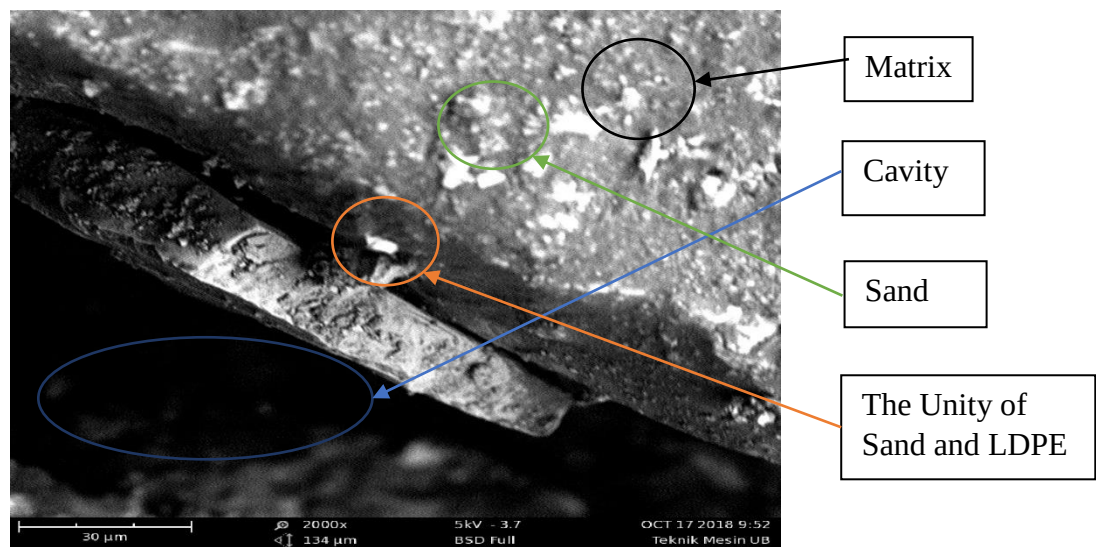


Figure 4. The Result of Micro Structure from the Specimen with Ratio of 1:7, with 3 mm Sand Grains in 200°C with 2000x Magnification.

4. Conclusion

Based on the research result and discussion on previous chapters, some conclusion can be drawn as follows:

1. The higher the ratio of plastic and sand, the lower the compressive strength of the composite.
2. The higher the ratio of plastic and sand, the higher the density of the composite.

Acknowledgment

This work was supported by the Directorate of Research and Community Services, Directorate General of Research and Development Strengthening, Ministry of Research, Technology, and Higher Education of Republic Indonesia, with agreement letter No. 171.120/UN14.4.A/LT/2018

References

- [1] Aditya Bhardwaj, 2017.et.al. Int.Journal of Engineering Research and Application www.ijera.com ISSN : 2248-9622, Vol. 7, Issue 4, (Part -4), pp.79-81
- [2] AR Hakim, 2012. *Pemanfaatan Limbah Padat (plastik) Sebagai Bahan Baku Pembuatan Bahan Bakar Pengganti Bensin*. Jurnal Jurusan Teknik Lingkungan FTSP UPN “Veteran” Jatim.
- [3] Arumi, D, dkk, 2012. *Ecoplafie Paving (Economic Plastic Fiber) Sebagai Produk Perkerasan Jalan Berkonsep Ramah Lingkungan..* Jurnal Teknik Sipil Universitas Sebelas Maret.
- [4] Astm American Society for Testing And Materials, Copyright © 2004, West Conshohocken, PA. All rights reserved.

- [5] Kumar S., Panda, A.K., dan Singh, R.K., 2011, A Review on Tertiary Recycling of High-Density Polyethylene to Fuel, Resources, Conservation and Recycling Vol. 55 893– 910
- [6] Nasrun, Eddy Kurniawan, Inggit Sari 2016 *Pengolahan Kantong Plastik Jenis Kresek Menjadi Bahan Bakar Menggunakan Proses Pirolisis*. Jurusan Teknik Kimia, Fakultas Teknik, Universitas Malikussaleh Kampus Bukit Indah, Muara Satu, Lhokseumawe, Aceh 24352
- [7] Ngakan Putu Gede Suardana, Min Seuck Ku, Jae Kyoo Lim, Effects of diammonium phosphate on the flammability and mechanical properties of bio-composites. *Bahans and Design* 32 (2011) 1990–1999.
- [8] Ravindra N. Patil, Shubham D. Kothawade, Hitesh A. Shinde, Rahul G. Katore, Prerak Jha, Himani P. Rane, 2017. *International Journal of Innovative Research in Science, Engineering and Technology* (An ISO 3297: 2007 Certified Organization) Website: www.ijirset.com Vol. 6
- [9] Sherliana, 2016. *Studi Kuat Tekan Paving Block Dengan Campuran Tanah, Semen, Dan Abu Sekam Padi Menggunakan Alat Pemadat Modifikasi*.
- [10] Surono, Untoro Budi, 2013. *Berbagai Metode Konversi Sampah Plastik Menjadi Bahan Bakar Minyak*. Jurnal Teknik VOL. 3 NO.1, hal. 32-40
- [11] Syafitri, C. 2001, *Analisis Aspek Sosial Ekonomi Pemanfaatan Limbah Plastik*, Program Pascasarjana Institut Pertanian Bogor.
- [12] R. Manikandran, D. S. Nirmala, G. Dhinakaran 2015. *Effect Of Ldpe Raw Material On Strength, Corrosion And Sorptivity Of Concrete*, Journal of Engineering Science and Technology Vol. 10, No. 4 (2015) 485 - 495 © School of Engineering, Taylor's University