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RAILWAY BEARING PROTOTYPES BASED ON PLASTIC WASTE HDPE AND NYLON-RESIN FIBER *EPOXY*

Ajeng Tyas Damayanti[1], Muharjito[2], Hanif Prasetyo[3]
Railway Mechanics Technology, Indonesian Railway Polytechnic Madiun

ajeng@ppi.ac.id[1], muharjito@ppi.ac.id[2], hanif.tmp1909@ppi.ac.id[3]

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ABSTRACT
Introduction: *Material composite is ingredient congested when two or more materials, each with characteristics, are combined to make material new which nature more superior than component the main thing is in certain applications.* ***Method:*** *In this study, composite bearing specimens were made using the method compression molding with two variation composition that is HDPE 60% + fiber nylon 5% + epoxy 35% and composition HDPE60% + 10% nylon fiber + 30% epoxy. This manufacturing method is done by inserting recycled HDPE, fiber, nylon, and epoxy resin into the mold. Next, the pressing process is carried out with a hydraulic press and heated at a temperature of 220°C using oven electricity.* ***Results:*** *Results testing material shows strong bendinghighest on variation composition HDPE 60% + fiber nylon 10% + Epoxy 30% that is as big as 17.21 MPa. Strength bendingin this composition has increased from previous studies with a bending strength of 15.66 Mpa, but not yet. Fulfill standard bearing rail composite JIS E 1203:2007 as big as 17.5 MPa. Results testing pull with standard ASTMD638 obtained the highest tensile strength at 60% HDPE + 10% nylon fiber + 30% epoxy of 8.64 Mpa. Tensile strength on composition this experience enhancement from a previous study of 0.5041 MPa.* ***Conclusion:*** *Prototype bearing rail train fire composite made to a 1:4 scale of the original size, which refers to standard JIS E 1203:2007. Prototype bearing rail train fire conducted material testing using bending and tensile tests.*

Keywords: *Bearing train, compression molding, composite, HDPE, fiber nylon, resin epoxy*

Corresponding Author: Ajeng Tyas Damayanti
E-mail: ajeng@ppi.ac.id

INTRODUCTION

Usage goods made from base plastic such as drink bottles, cutlery, and so onthe more many used. Waste plastic is a type of waste that is difficult to decompose, so it will take hundreds of years to decompose (Karuniastuti, 2013). This causes a number of piles of plastic waste that could pollute the environment. Based on data from the Ministry of Environment Life and Forestry, the amount of rubbish in Indonesia reached 68 million tons in 2019 (Purwaningrum, 2016). The contributor's most extensive second waste plastic in the ocean is Indonesia, with a total of 187.2 million tons (Jambeck et al., 2015). Not only polluting the environment but also processing plastic waste by burning can endanger human health through pollution of the air generated.

In maintenance transportation, train firenaturally needed means nor railway infrastructure. Railway facilities are vehicles that can move on railroads, such as locomotives, trains, carriages, and special equipment (Rosyani & Susilo, 2011). For the facility to operate, it is necessary to infrastructure the railway, which consists of track train fire, station train fire, and facility train fire.

Track train fire uses Street rail with constituent components, namely rails, bearings, ballast, sub-reply, and fasteners (Munawwarah & Herijanto, 2020).

Bearing is a component composer railroad that serves as a rail pedestal (Jaya, 2017). Their bearing consists of various materials, including wood, steel,and concrete. Therefore, the bearing must have the strength to withhold burden on. Most railway lines in Indonesia use bearing concrete to replace bearing wood because material wood is less, and the concrete cushion has a much longer service life than wooden bearings.However, bearing concrete is considered less elastic heavy weight, so that troublesome in process installation, possibility occurs damage on processtransfer or rapture. No one coulddampen vibrations and noise (Purwono et al., 2017).

From the problem, the so writer researches bearing replacementconcrete with ingredient composite made from plastic base waste. (Ramadhani, 2021) has donea study that discusses making prototype railroad sleepers made of waste plastic HDPE (*High-Density Polyethylene*) and *epoxy* resin. This composite bearing *prototype was made*with the *hot press molding method,* which is heated at a temperature of 180oC, – then in *press* with tools*press* hydraulic capacity 1 ton. However, after testing bending, *the prototype* bearingThis composite has a bending strength of 62.64 Mpa and has not met the bearing requirements composite with standard JIS E 1203:2007, 70MPa.

Bearings work tie rail use fastener andreceive the load from the means that move above rail (Karim, 2013). The material used on bearing, among others wood, concrete, and steel. Wood is the material first time used on bearing because have characteristics which suitable for withholding burden dynamics (Zulkifli, 2021). Bearing which moment this used that is bearing concrete. Based on Regulation Minister No. 60 the Year 2012 (Number, 60 CE) that bearing concrete with wide track rail 1067 mhas technical specification dimensions as follows:

Table 1. Specification of Rail Width Bearing Dimension 1067 mm

Long	2000 mm
Maximum width	265 mm
Tall maximum	220 mm

Composites are objects or materials formed by combining two or more materialswith different elements, and no reaction occurs by a chemical in the mixing. A blendof composite materials such as matrices and amplifier or filler determines the nature of a composite material (Tjahjanti, 2018).

METHOD

Test several specimen tests will be carried out at the State Polytechnic of Malang, and the types of testing conducted that is test pull by standard ASTM D638 and test bending with JIS E 1203:2007 standard. In research Tasks Recently, the manufacture of a prototype of railroad sleepers fire made from base waste plastic HDPE use method *compression molding*. *Compression molding* is a method by pressing a mixture of test specimen materials that have been heated to a temperature of 220 °C in print with a tool *press hydraulic* 1-ton capacity until the size desired (Mawardi, 2019). Specimen test for testing bending made with scale reduction standard JIS E 1203:2007 which have size long 1400 mmm, wide 200 mmm, and tall 140 mm Becomes 1:4 that is with long 350 mmm, wide 50 mm and tall 35mm.

Tools and materials used in this research include *recycled* HDPE, *epoxy resin* + catalyst, lubricant print or *mold releases,* fiber nylon, print, tool heating or oven electricity, glass measuring *digital* scales, and *hydraulic press* tools. The manufacturing steps are explained in more detail as follows:

1. Prepare tools and ingredients which will be used in the process of making specimens test.
2. Coating or applying *for mold release* on print makes it easy to release specimen tests on print.
3. Prepare to *recycle* HDPE, nylon fiber, and resin *epoxy* following calculation composition,which has been determined.
4. Put *recycled* HDPE and *epoxy resin* into a bowl and mix thoroughly.
5. Insert mixture *recycle* HDPE and *epoxy* resin into print.
6. Insert nylon fiber with a size of 350 mm into the print.
7. Reinsert HDPE *recycle mix* and resin *Epoxy* for coat fiber entered the print.
8. Give pressure on print with use tool *hydraulic press*.
9. Key Closing print so that pressure inprint no experience change.
10. Heat the mold using a tool heating at 220 °C for 1 hour to speed up the process of drying and elementthe composer can be tied with perfectly.
11. Wait for specimen until cold.
12. Let go specimen test from print.

The method of analyzing the data for this research is to make several specimen tests made from base HDPE plastic waste, nylon fiber, and *epoxy resin* with the use method of *compression molding*. Comparison of the composition used on study this which is equal to: *recycle* HDPE 60% + 5% nylon fiber + 35% epoxy and *recycle* HDPE 60% + fiber nylon 10% + *epoxy* 30%. After the specimen is made, it will be tested with several specimens by each tester. The test used is a tensile test with standard ASTM D638 and test bending with JIS E 1203:2007 standard to find out the natural mechanics of the specimen. After testing several specimens, results averaged and analyzed according to the standards used will be obtained. So that obtained results best which following standardand could replace concrete pads.

RESULTS AND DISCUSSION

1. Composite Bearing Specimen Manufacturing

Composite bearing test specimens are fabricated with the use method of *compression molding*. The *compression molding method* used in This research includes the composition, which consists of *recycled* waste plastic HDPE, fibernylon, and resin *epoxy* in print which is then *pressed* using a press tool *hydraulics*. After in *press,* print the heated at 220^{o} C for one hour so that composition could be perfect and speed upthe drying specimen test-bearing composite process.The following is the process of making test specimens for composite railroad sleepers made from *recycled* waste plastic HDPE, fiber nylon, and resin *epoxy.*

Calculation of composition (volume fraction) in making specimen test bearing composite rail the train is the first step that must be done to produce test specimens that desired. On study this use 2 variation comparison composition that is *recycle* HDPE 60% + nylon fiber 5% + *epoxy* 35% and *recycle* HDPE 60% + fiber nylon 10% + *epoxy* 30%.The following composition will be used to manufacture railroad-bearing specimens composite, as seen in table 4.

Table 2. Specification of Rail Width Bearing Dimensions 1067 mm

Composition	HDPE 60% + nylon fiber 5% + *epoxy* 35%	HDPE 60% + 10% nylon fiber + *epoxy* 30%
Recycle HDPE	357.2 grams	357.2 grams
Fiber	35.5 grams	71.05 grams
resin	214.4 ml	183.75 ml

If data calculation composition has been obtained, then the process of making specimens is carried out with steps as follows:

1. Prepare tools and ingredients which will be used in the process of making specimens test.
2. Coating or smear *mold is release*d equally with the use kit as a lubricant on print and closedprint to make it easy torelease specimen tests from the mold.
3. Prepare to *recycle* HDPE with a composition of 60 % on every variation composition of 357.2 grams.
4. I am weighing a nylon fiber with a length of 35 cm which is well used as mixture bearing composite with variation fiber 5% and 10%, respectively, which is 35.5 grams and 71.05 grams.
5. It is mixing *epoxy resin* with a hardener with a comparison 1:1 with a variation composition of 35% resin *epoxy* and 30% resin *epoxy* in a row equal to 214.4ml and 183.75 ml.
6. Mixing HDPE *recycles and* resin *Epoxy* in the receptacle, stir it up to mix equally.
7. After recycling HDPE and resin *epoxy* mixed equally, following that enters the mixture *recycle* HDPE and resin *epoxy* into print.
8. Inserts 350 mm nylon fiber into the mold with the appropriate longitudinal directionwith variations in the composition of HDPE 60% + fiber nylon 5% + *epoxy* 35% and HDPE 60% + fibernylon 10% + *epoxy* 30% in a row that is as big as 35.5 grams and 71.05 grams.
9. Add return mixture *recycle* HDPE and *epoxy resin* for fiber coating nylon.
10. Close and give pressure on print with use tool *press* hydraulic.

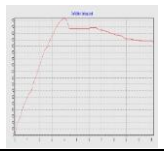
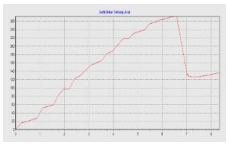
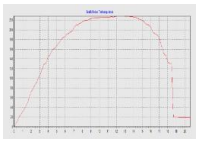
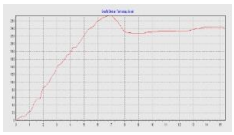
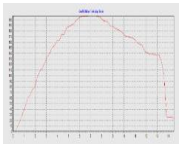
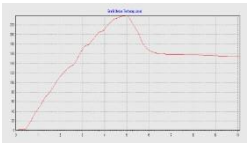
11. Key Closing print so that pressure inprint no experience change.
12. Insert the mold into the heater, then heat at a temperature of 220 °C. During 1hour for speed up process drying, its constituent elements can be bound to perfect.
13. Wait for the specimen until cold; thenremove the test specimen from print.

2. Composite Bearing Specimen Test Results

After making specimen bearing composite with a scale of 1:4, next carried out material testing with a bending test and tensile test, which aims to determine the mechanical properties of the composite bearings that have been made (Budiyanto, 2020). The following are the bending test result and testing pull.

Test bending done with method *three points bending*. Following data chart which obtained from the results of the bending test of 2 variations the composition is HDPE 60% + nylon fiber 5% + *epoxy* 35% and HDPE 60% + nylon fiber 10% + *epoxy* 30% with use each 3 specimens in each variation.

Table 3. Chart Test Bending PrototypeBearing Rail Train

Test Bending	**HDPE 60% + fiber5% nylon + *epoxy* 35%**	**HDPE 60% + fibernylon 10% + *epoxy* 30%**
Specimen1		
Specimen2		
S specimen3		

Based on chart results testing bending with the fulcrum distance of 280 mm above, the load maximum on every specimen listed in the table follows:

Table 4. Score *Peakload* Test Bending

Burden maximum (Peakload)				
Test bending	**HDPE 60% + fiber nylon 5% + *epoxy* 35%**		**HDPE 60% + fiber nylon 10% + 30% *epoxy***	
Specimen 1	184.20 kg	1,806 N	263.60 kg	2,585 N
Specimen 2	228.60 kg	2,242 N	265,80 kg	2607 N
Specimen 3	207,40 kg	2.034 N	239.60 kg	2.350 N

From data in on next conducted calculation three-point bending on all specimen for knowing voltage bendingeach specimen on two variation composition.Here are the results of the bending test. After it is done, process calculation with the use of equality three-point bending with two composition variations:

Table 5. Bending Strength 2 Composition Variations

Strength Bending (Mpa)		
Test bending	**HDPE 60% + nylon fiber 5% + *epoxy* 35%**	**HDPE 60% + nylon fiber 10% + *epoxy* 30%**
Specimen 1	12.38 Mpa	17.73 MPa
Specimen 2	15.37 Mpa	17.87 MPa
Specimen 3	13.94 MPa	16.11 MPa
Flat - flat	**13.89 Mpa**	**17.21 Mpa**

Bending test results after processing calculation using the equation *three-point bending* with two variation composition, specimenbearing composite have different strength bending. Variation composition HDPE 60% + fiber nylon 5% + *epoxy* 35% obtained strong bending average as big as 13.89 MPa. Strong bendingThe highest was obtained in specimen 2, which was 15.37 Mpa, and the lowest bending strength obtained on specimen 1 was 12.38 MPa.

Based on data strength bending of two variation composition in on. In addition, the percentage of nylon fiber affects the strength bending (Dantes, 2021). This is because fiber nylon works as enhancer strength (reinforcement) from prototype bearings. In addition, as much as 5% proven fiber nylon couldadd strength to bending from prototype railroad sleepers and bending strength in variations composition HDPE 60% + nylon fiber 10% + Epoxy 30% experience enhancement strength from previous studies with a bending strength of 15.66 MPa. However, on the variation, this does not yet Fulfill JIS E 1203:2007 composite bearing standards are 17.5 MPa. Less Bending Strength from standard produce prototype bearingthe character brittle or have flexiblesolid which is not enough. Strength bending bearing prototype rail train fire made from base waste HDPE plastic, nylon fiber, and *epoxy resin* with *compression molding* method with a temperature of 220oC not yet Fulfill *standard*. This is because at temperature 220oC, fiber nylon experience depreciation and charred, so HDPE and resin *Epoxy* predominates.

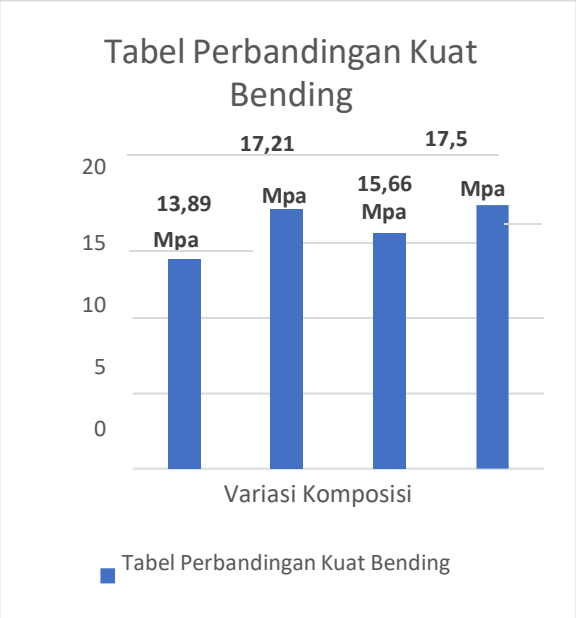


Figure 1. Comparison of Clear Strength

Test pull conducted withthe manufacture of tensile test specimens referring to ASTM D638 standard with dimensions of 13 mm wide,thick seven mmm, and long beginning 57 mm. Aftera tensile test is carried out to obtain maximum load data and increase long from testing pull with use 2 variation composition i.e. HDPE 60% + nylon fiber 5% + epoxy 35% and i.e. 60% HDPE + 10% nylon fiber + 30% epoxy as follows:

Table 6. Maximum Load and Length Gain

Test Pull	HDPE 60% + fiber nylon 5% + epoxy 35%		HDPE 60% + fiber nylon 10% + 30% epoxy	
	Burden	L	Burden	L
Specimen 1	65,40 kg	4.17 mm	86 kg	4.18 mm
Specimen 2	51,20 kg	2.41 mm	80,20 kg	3.74 mm
Specimen 3	57 kg	3.29 mm	74.20 kg	4.17 mm

After obtaining the data burden maximum, Next, the tensile strength is calculated. Strain and modulus of elasticity. Here is an example calculation of tensile strength, strain, and modulus elasticity specimen one on variation composition HDPE60% + fiber nylon 5%+ Epoxy 35%.

From the calculation of tensile strength, strain, and modulus elasticity obtained nature mechanic material after tensile testing at two variations of composition HDPE 60% + nylon fiber 5% + *epoxy* 35% And HDPE 60% + nylon fiber 10% + *epoxy* 30% yang seen in the table following:

Table 7. Mechanical Properties of Tensile Test Materials

Variation	Specimen	⍰ (%)	Modulus elasticity (Mpa)	Strongpull (Mpa)
	1	7.32	97.26	7.05
1	2	4.22	130.1	5.52
	3	5.77	106.4	6.14
	1	7.33	126.4	9.27
2	2	6.56	131.8	8.65
	3	7.31	109.2	7.99

Based on data calculation of two variations, the composition of the above railroad sleeper prototype obtained different tensile strengths at every specimen. On variation composition HDPE 60% + 5% nylon fiber + 35% *Epoxy* obtained strength. The greatest tensile strength in specimens 1 and 3 is 7.05 Mpa and 6.14 MPa, whereas strong pull, the lowest, was obtained in specimen two at 5.52 MPa. On variation, this obtained strength pull flat-an average of 6.24 Mpa. Here is a graph stress-strain on HDPE composition 60% + 5% nylon fiber + 35% *epoxy.*

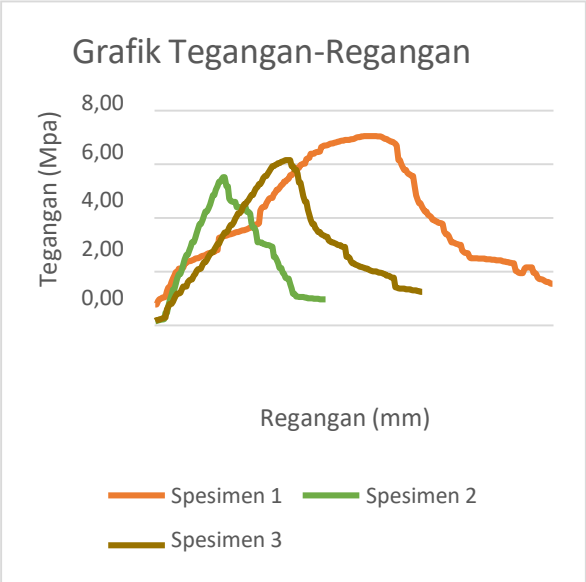
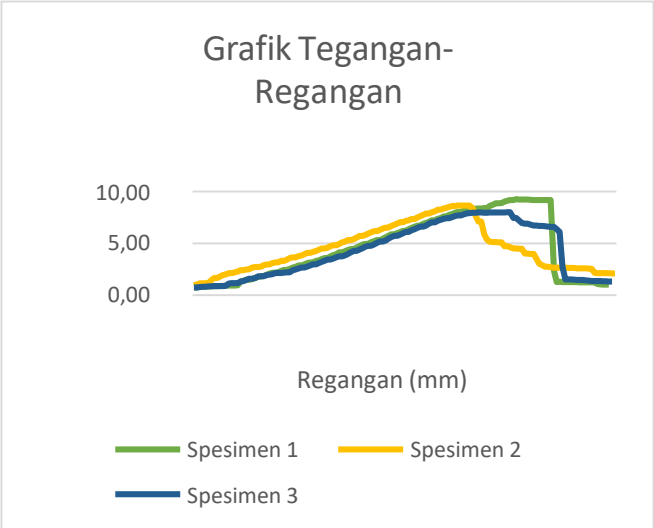


Figure 2. Stress-Strain Variation 1

On variations in the composition of HDPE 60% + fiber nylon 10% + Epoxy, 30% obtained tensile strength the largest in specimens 1 and 2, equal to 9.27 Mpa and 8.65 Mpa, while the lowest tensile strength obtained in specimen 3 of 7.99 Mpa. On variation, this obtained strength pull average as big as8.64 MPa. Following is chart voltage strain at 60% HDPE + nylon fiber composition 10% + epoxy 30%.



Picture 3. Stress-Strain Variation 2

Of the two variations of the composition of the railroad sleeper prototype, the composition of 60% HDPE + nylon fiber 10% + 30% *epoxy* has an average tensile strength bigger than 8.64 Mpa compared to the composition of 60% HDPE + 5% nylon fiber + 35% *epoxy,* i.e., as big as 6.24 MPa. Strength pull on two compositions this experience enhancement from a study previously by (Purwono et al., 2017) about technological innovation of railroad sleepers made from raw plastic waste that has tensile strength as considerable as 0.5041 MPa.

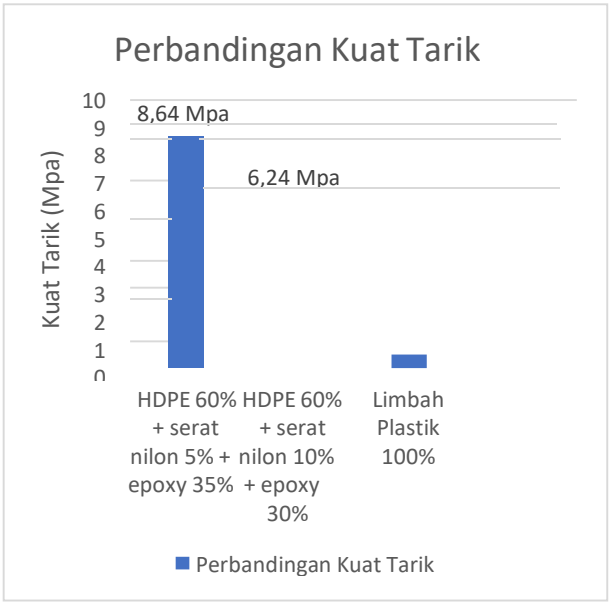


Figure 4. Comparison Strong Pull

Based on the tensile strength data of the two composition variations above. The addition of percentage fiber nylon takes effect on strength pull. This isbased on fiber nylon reinforcement of the prototype bearings. In addition, as much as 5% proven fiber nylon could

add strength pull from prototype bearing rail train fire. Strength pull is materially influenced by power tie fiber with a matrix, even laying fibers and fiber length. While in the tensile test specimen prototype bearing rail train fire, this has spread fiber which no equally, so that obtained strong pull which very low or less than optimal.

CONCLUSION

Prototype bearing rail train fire composite made to a 1:4 scale of the original size, which refers to on standard JIS E 1203:2007.Manufacturing of railroad bearing specimens use 2 variation composition that is HDPE60% + fiber nylon 5% + *epoxy* 35% and composition HDPE 60% + nylon fiber 10% + epoxy 30%. Method making used in a study is compression molding with *recycled* HDPE, nylon fiber, and resin *epoxy* in print. Next conducted, the process pressing with a hydraulic tool press and heated at a temperature of 220oC using the oven electricity.

Prototype bearing rail train fire conducted material testing using bending and tensile tests. Results testing pull obtained strong pull highest at 60% HDPE + fiber composition nylon 10% + epoxy 30%, which is 8.64 MPa. It was bending test resultswith the highest bending strength obtained at composition HDPE 60% + nylon fiber 10% + *Epoxy* 30% that is as big as 17.21 MPa. This variation does not meet bearing standards. JIS E 1203:2007 composite is 17.5 MPa.

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