

# UMB IJIMEAM

## 36658-104546-1-ED(1)

 36658 Wangge

---

### Document Details

**Submission ID**

trn:oid::3618:125175765

**Submission Date**

Dec 26, 2025, 1:43 PM GMT+7

**Download Date**

Dec 26, 2025, 1:48 PM GMT+7

**File Name**

36658-104546-1-ED(1).docx

**File Size**

2.4 MB

**14 Pages**

**4,885 Words**

**26,407 Characters**





# 10% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.




## Exclusions

▸ 9 Excluded Sources

## Match Groups

-  **44 Not Cited or Quoted 9%**  
Matches with neither in-text citation nor quotation marks
-  **0 Missing Quotations 0%**  
Matches that are still very similar to source material
-  **4 Missing Citation 1%**  
Matches that have quotation marks, but no in-text citation
-  **0 Cited and Quoted 0%**  
Matches with in-text citation present, but no quotation marks

## Top Sources

- 6%  Internet sources
- 6%  Publications
- 6%  Submitted works (Student Papers)

## Integrity Flags

0 Integrity Flags for Review

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

### Match Groups

- **44 Not Cited or Quoted 9%**  
Matches with neither in-text citation nor quotation marks
- **0 Missing Quotations 0%**  
Matches that are still very similar to source material
- **4 Missing Citation 1%**  
Matches that have quotation marks, but no in-text citation
- **0 Cited and Quoted 0%**  
Matches with in-text citation present, but no quotation marks

### Top Sources

- 6% Internet sources
- 6% Publications
- 6% Submitted works (Student Papers)

### Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	Publication	Sahibzada Muhammad Hamza, Ahmet Faruk Aysan, Umar Nawaz Kayani. "Cultur...	1%
2	Publication	Floyd Rey P. Plando, Joel T. Maquiling. "Construction potential of rice husk ash as ...	<1%
3	Internet	open.uct.ac.za	<1%
4	Publication	Md Nazmul Hasan Dipu. "An overview of additive manufacturing technology: Gen...	<1%
5	Internet	lib.buet.ac.bd:8080	<1%
6	Internet	www.arcat.com	<1%
7	Student papers	Texas A & M University, Kingsville (Blackboard LTI 1.3) on 2025-12-03	<1%
8	Publication	Maria C. Stratoura, Gerasimina-Ersi D. Lazari, Efstratios G. Badogiannis, Vagelis G....	<1%
9	Internet	innspub.net	<1%
10	Internet	ijracs.rumahpeneleh.or.id	<1%

11	Internet	store.astm.org	<1%
12	Student papers	International School of Berne on 2020-03-07	<1%
13	Student papers	Middle East Technical University on 2023-05-12	<1%
14	Student papers	Universitas Islam Riau on 2025-05-27	<1%
15	Internet	docobook.com	<1%
16	Internet	ejournal.undiksha.ac.id	<1%
17	Internet	espace.curtin.edu.au	<1%
18	Internet	ojs.unr.ac.id	<1%
19	Internet	ojs.wiserpub.com	<1%
20	Internet	sinta3.ristekdikti.go.id	<1%
21	Internet	www.freepatentsonline.com	<1%
22	Publication	"Advances in Manufacturing Engineering and Materials II", Springer Science and ...	<1%
23	Publication	Deng, Jiamei, and Qingjun Liu. "Study on Physical Performance of Steel Slag and R..."	<1%
24	Internet	www.jurnal.unsyiah.ac.id	<1%

25	Publication	"Advances in Material Sciences and Engineering", Springer Science and Business ...	<1%
26	Publication	Andik Purwanto, Eko Risdianto, Desy Hanisa Putri, Fitri Masito, I Gusti Agung Ayu ...	<1%
27	Publication	Asena Karslioğlu-Kaya, Mehmet İnanç Onur. "Optimization of physical, mechanic...	<1%
28	Student papers	Universitas Islam Indonesia on 2025-11-30	<1%
29	Internet	d197for5662m48.cloudfront.net	<1%
30	Internet	ouci.dntb.gov.ua	<1%
31	Internet	www.tdx.cat	<1%
32	Publication	Madhu Puttegowda, Sharath Ballupete Nagaraju, Yashas Gowda Thyavihalli Girija...	<1%
33	Student papers	Singapore Institute of Technology on 2023-07-21	<1%

12  
33



# Composite Innovation from Plastic Waste and Rice Husk Ash for Home Ceilings in Sikka Regency

Gusti FXWara Wangge<sup>1</sup>, Yohanes Viva Servianus<sup>2</sup>, Thadeus Rande<sup>3</sup>

<sup>1,3</sup> Cristo Re Polytechnic, Automotive Engine Maintenance Study Program

<sup>2</sup> Cristo Re Polytechnic, Mechanical Technology Study Program

\*Corresponding Author: [aguswangge96@gmail.com](mailto:aguswangge96@gmail.com) (JQP)

14  
10

## Research Abstract

This aim For analyze influence variation composition of polyethylene (PE) and ash rice husk ash (RHA ) against characteristic mechanic composite recycling redeveloped as ceiling material friendly environment . Composite sample made through the enumeration process waste PE plastic (3–5 mm), burning rice husk at 600–700°C and 200 mesh sieving , melting plastic at 160–170°C, as well mixing with three variation composition : 80:20, 70:30, and 60:40 ( PE:RHA ). Each mixture printed in 50×50 mm print and tested in accordance ASTM D695 standard for compression test and ASTM D792 for density test . Test results show that variation composition influential significant to strong compressive strength , modulus of elasticity , and strain . The 80:20 composition produces the most elastic material with strong pressure of 15.59 MPa and modulus of elasticity of 463.50 MPa, however easy broken after beyond the elastic limit . The composition of 60:40 provides strong press highest of 125 MPa and a strain of 56.6%, however is brittle because the modulus of elasticity is very low (7.5 MPa). The composition of 70:30 shows most balanced performance with strong pressure 61.65 MPa, strain 18.20%, and behavior stable ductile . Based on analysis overall characteristic mechanical , 70:30 composition is recommended as optimal formulation because give combination best between strength , stiffness , and resilience deformation , so that it is most suitable For application non- structural ceilings that require light , strong , and non-combustible materials easy cracked .

**Keywords:** Rice husk ash; Plastic; Testing; Efficiency; Composite.

## Article Info:

Accepted: xx xxx 2025

Revised: xx xxx 2025

Accepted: xx xxx 2025

Available online: xx xxx 2025

**Keywords:** Rice Husk; Plastic; Testing; Efficiency; Composite

© 2025 The Author. Published by Mercu Buana University (Indonesia). This article is an open access article under the [CC BY-SA License](https://creativecommons.org/licenses/by-sa/4.0/).



## 1. Introduction

Problems waste plastic has become issue urgent environment both at the global level and national . Polyethylene (PE) plastic is one of the waste domestic the biggest Because its nature is not easy decomposed and many found in trash House stairs , markets, and facility public [ 1]. In Sikka Regency , the 2023 Environmental Service report noted embossed rubbish reaching 57,600 m<sup>3</sup> per year , where the waste plastic become component dominant and not yet managed optimally . Conditions This demand existence innovation utilization waste plastic become products that are useful and friendly environment . [2].

On the other hand , rice husk is results side abundant and undeveloped rice farming utilized in a way maximum [ 3]. Rice husk ash (RHA) is known own content high silica and has utilized as a filler in concrete , mortar, and other materials composite polymer Because capable increase strength pressure and dimensional stability . A number of study previously has study composite based plastic and RHA, however part big application focused structural light , paving, protective material thermal , or composite technique general [ 4].

A number of study previously has study composite based plastic and RHA, however part big application focused structural light , paving, protective material thermal , or composite technique general [ 5]. Until moment this , not yet there is research that is special evaluate performance PE–RHA composite for application ceiling home , especially considering need mechanic specific like strong

compression, stiffness, and flexibility required. For prevent cracked, sagged, or deformation permanent.

Studies on the use of polyethylene (PE) plastic waste and rice husk ash (RHA) as composite materials for ceiling applications still show an unfilled research space. To date, there has been no research that thoroughly describes the mechanical behavior of PE-RHA composites specifically designed for ceiling needs [6]. In addition, comparisons of the performance of various PE-RHA mixtures based on standard test procedures such as ASTM are still rarely carried out, so the most effective composition cannot be determined. Studies that link mechanical parameters—such as compressive strength, modulus of elasticity, and strain—with the functional requirements of ceilings in tropical climates, including the environmental characteristics of Sikka Regency, are also still very limited [7].

In addition, other studies used polypropylene (PP) and rice husk in various mixture ratios (50:50, 60:40, 70:30, and 80:20). The results showed that almost all compositions met the density and water content test criteria, although not all passed the water absorption and mechanical strength tests. Meanwhile, research combining recycled HDPE plastic with the addition of Maleic Anhydride (MAH) as a compatibilizer showed increased cohesion between the filler and the matrix, as well as strengthening the bond between the material phases [8].

This research novelty presents a new contribution through the utilization of local waste from Sikka Regency to produce PE-RHA composite as a ceiling material, which has never been studied before. This study also uses a more structured testing approach by evaluating three composition variations, namely 80:20, 70:30, and 60:40, through ASTM test standards to obtain a more accurate picture of mechanical performance. In addition, this research is directed to find a composite formulation that provides the best performance and is suitable for application in non-structural ceilings that are light-weight and environmentally friendly.

In line with this innovation, this study aims to examine how different mixtures of polyethylene (PE) and rice husk ash (RHA) affect the compressive strength, elasticity, and strain of the composite. This study also aims to compare the three compositions studied and ultimately determine the most suitable formulation for use as an alternative ceiling material based on standardized mechanical testing results.

## 2. Method

The research method used in this study, namely Research & Development (R&D), is a structured approach used to create new products or improve existing products, processes, or methods through systematic and continuous research stages. This approach focuses not only on collecting data or theory, but also on utilizing research results to create real products or innovations [8].

### Research methods:

The research began with the collection of PE and PP plastic waste from a temporary landfill as a source of matrix material. The obtained plastic material then underwent a sorting process to ensure homogeneity, followed by a washing stage to remove dirt and surface residue. Once clean, the plastic was dried and then shredded to a particle size of approximately 3–5 mm to meet the requirements for the melting process.

In the reinforcing material stage, rice husks are collected as the raw material for ash production. The husks are burned at a temperature of 600–700°C for approximately two hours, producing rice husk ash (RHA) with a stable silica content. The resulting ash is then sieved through a 200-mesh sieve to achieve a uniform size distribution.

The next process involves melting PE/PP plastic at 160–170°C, then mixing the melted material with rice husk ash in several composition ratios, namely 80:20, 70:30, and 60:40. The homogenized mixture is poured into a 50×50 mm mold and pressurized to produce a composite specimen. The formed specimens then underwent cooling and conditioning stages according to ASTM D618 standards to ensure the stability of the material properties before testing. Physical testing was performed using density measurements according to ASTM D792, while mechanical characteristics were evaluated using compression tests according to ASTM D695.

1

All test results were then systematically analyzed to identify the relationship between variations in material composition and the mechanical response of the composites. The research process concluded with the formulation of conclusions and recommendations relevant to the findings.

**Standard Tests Used**

Study This use standard international following :

- ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics[9].
- ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement → used for composite density testing [10] .
- ASTM E11 – Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves → used for standardization of plastic particle size and rice husk ash.
- ASTM D618 – Conditioning Plastics for Testing → used to ensure all samples have a stable moisture content and condition before testing. → used for PE–RHA composite compression test.

**Tools and materials**

- Polyethylene (PE/PP) Plastic Waste  
Plastic obtained from the Maumere City TPS and selected based on characteristic physical ( density , flexibility , color) uniform ). The process of selecting , washing , drying , and chopping done follow internal standardization based on ASTM E11 for size particles 3–5 mm. Final water content conditioned following ASTM D618.
- Rice Husk Ash (RHA)  
Husk comes from from rice mill in Alok District and burned use *Waste Oil Stove* at 600–700°C for 2 hours. RHA then sifted using mesh 200 ( ≤ 75 μm ) according to ASTM E11. Composition RHA chemistry refers to research previously reported content SiO<sub>2</sub> of 85–95%.
- Electronic scales  
A digital scale is a mass or weight measuring instrument that uses electronic sensors to detect the load and displays the measurement results in the form of numbers on a digital screen. Digital scales are generally equipped with a load cell that converts pressure or gravity into an electrical signal. This signal is then processed by an electronic circuit and displayed as a weight value in grams (g), kilograms (kg), or other units.
- Measuring Pot  
measuring jug is receptacle shaped like teapot ( kettle ) equipped with scale volume measurement in parts side outside . This tool used For measure comparison ash rice husks and shredded rice rubbish plastic in amount certain with more easy and practical compared to glass measuring normal .
- *Waste Oil Stove*  
A used oil stove is a heating device that uses used oil, typically vehicle engine oil, as an alternative fuel. This stove is used for melting plastic and mixing rice husk ash.

**Making process Composite**

- Plastic Melting
  - PE/PP flakes are melted at 160–170°C using a waste oil stove.
- Mixing
  - RHA added in a way gradually to in melted plastic .
  - Mixing mechanical done using a resistant stirrer heat at 350–400 rpm for 5–7 minutes .
- Variation Composition  
Three Compositions tested
  - 80:20 ( PE:RHA )
  - 70:30 ( PE:RHA )
  - 60:40 ( PE:RHA )
- Sample Printing  
Mixture poured to in 50×50 mm steel mold with thickness 8–10 mm.  
a number of sample compacted use tool manual press .
- Cooling and Mold Release  
Cooling carried out at a temperature room until sample harden .
- Sample Conditioning  
All sample conditioned for 24 hours according to ASTM D618 before testing .

6

11

**Composite Testing**

• **Compressive Strength Test (ASTM D695)**

Pressure test done using Universal Testing Machine HK 2B FST ( capacity 20 tons) with provision :

- Speed loading : 5 mm/min
- Test mode: compressive load
- Sample: solid cylinder according to size mold
- Parameters measured : Compressive strength maximum (MPa ), Modulus elasticity (MPa), Strain at the time broken (%), Behavior elastic – plastic .

Test results in the form of curve *load–displacement* and *stress–strain*.

• **Density Test (ASTM D792)**

Density test on composite materials implemented with utilise method displacement using water as the measuring medium . Procedure This assisted by digital scales with level accuracy 0.01 grams For ensure mark mass obtained truly accurate . Through testing these two main parameters succeed determined , namely density composite in  $g/cm^3$  units and specific gravity values as comparator characteristics mass type materials . The resulting data from measurement This used For evaluate level density composite as well as observe How the addition of RHA contributes to decline total mass of material. Analysis results density the Then become base For evaluate whether the resulting composite fulfil criteria as material ceiling light .

• **Visual and Morphological Analysis ( Optional )**

Visual and morphological analysis was performed macroscopically to directly observe the surface characteristics of the composite. This examination focused on three main aspects: the distribution of the filler within the matrix, the presence of air voids that may have formed during the mixing or molding process, and the level of surface homogeneity of the material. Through these observations, the extent to which the mixing quality and uniformity of the composite structure have been achieved can be assessed [11].

**3. Results and Discussion**

The results of this study are composite specimen test data with various mixture variations between PE plastic and rice husk ash, with the research method using the Research and Development (RnD) approach. There are 3 variations of the mixture composition tested in this study, shown in Table 1, and the test pattern is shown in the figure. The specimen test data was obtained from the results of the compression test using the Universal Testing Machine Double Column Cap 20 Ton HK 2B FST. The following are the test data and analysis results displayed in the form of graphs and tables.



Figure 2. Composite Compression Test Using Universal Testing Machine Double Column Cap 20 Ton HK 2B FST



Figure 3. Cross-section of the composite mold

171

172



Figure 4. PE waste and rice husk ash

173

174



Figure 5. The process of melting PE waste and mixing rice husk ash

175

176



Figure 6. Print results with composition ratios: 80:20, 70:30, 60:40

177

178

179

❖ Test Data 01

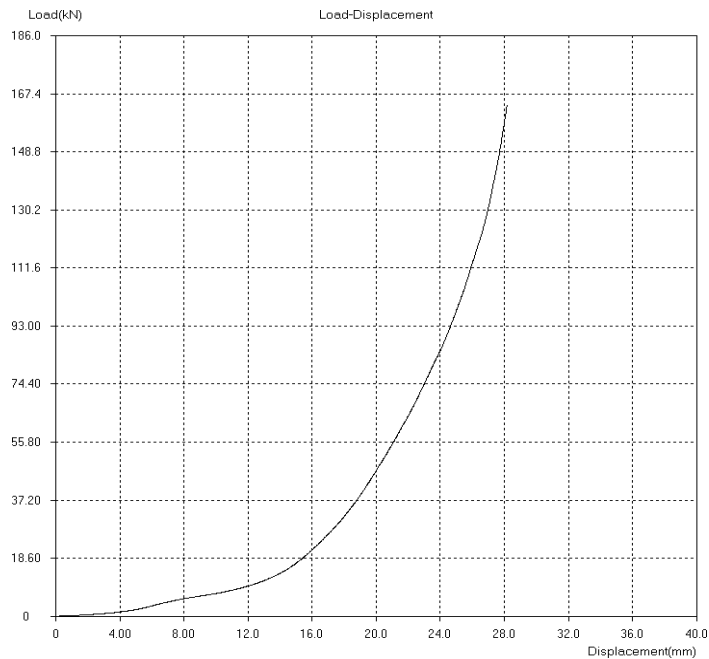


Figure 7. Graph Load Transfer

180

Based on the compression test graph, the relationship between load (stress) and strain shows a typical pattern:

181

182

1. In the initial stage, the graph rises linearly, which means the material is still in an elastic state.
2. As the load increases, the graph begins to curve, indicating a transition from the elastic region to the plastic region.
3. The peak of the graph shows the maximum compressive strength value (ultimate compression strength) that can be achieved by the mixture of rice husk ash and plastic material.
4. After passing the peak point, the graph decreases indicating damage to the internal structure of the material, cracks, and a decrease in load-bearing capacity.

183

184

185

186

187

188

189

190

191

192

193

194

195

196

197

198

Table 1. Displacement Load Test Results

199

Transfer (mm)	Load (kN)	Emphasize (MPa)	Pressure
0.00	0,000	0,000	0.000000
2.00	0.800	0.320	0.066667
4.00	4,200	1,680	0.133333
6.00	7,500	3,000	0.200000
8:00	11,000	4,400	0.266667
at 10:00	15,500	6,200	0.333333
12.00	20,000	8,000	0.400000
14.00	28,000	11,200	0.466667
at 4:00 PM	37,000	14,800	0.533333
at 6:00 PM	50,000	20,000	0.600000
20.00	74,000	29,600	0.666667
at 10:00 PM	95,000	38,000	0.733333
at 24.00	120,000	48,000	0.800000
at 26.00	142,000	56,800	0.866667
27.50	160,000	64,000	0.916667
28.00	165,000	66,000	0.933333

❖ Composition Behavior Analysis 01

- Initial stage (0–10 mm, load 0–15.5 kN, stress ≤ 6.2 MPa, strain ≤ 0.33): The material is still in the elastic region. The load-displacement relationship is quite linear.
- Intermediate stage (10–20 mm, load 15.5–74 kN, stress 6.2–29.6 MPa, strain 0.33–0.66): The material enters the elastic–plastic region, the load increases significantly, the deformation becomes larger.
- Final stage (20–28 mm, load 74–165 kN, stress 29.6–66 MPa, strain 0.66–0.93): The material is in the plastic region until it approaches the maximum load (165 kN with a displacement of 28 mm). After this point, the material usually fails.

The table shows that the material can withstand loads up to 165 kN with a maximum stress of 66 MPa before failure. The material exhibits good initial elasticity, then enters a plastic phase with a high strain of nearly 93% before reaching its ultimate strength.

22

225  
226  
227  
228  
229  
230  
231  
232  
233  
234  
235  
236  
237  
238  
239  
240  
241  
242

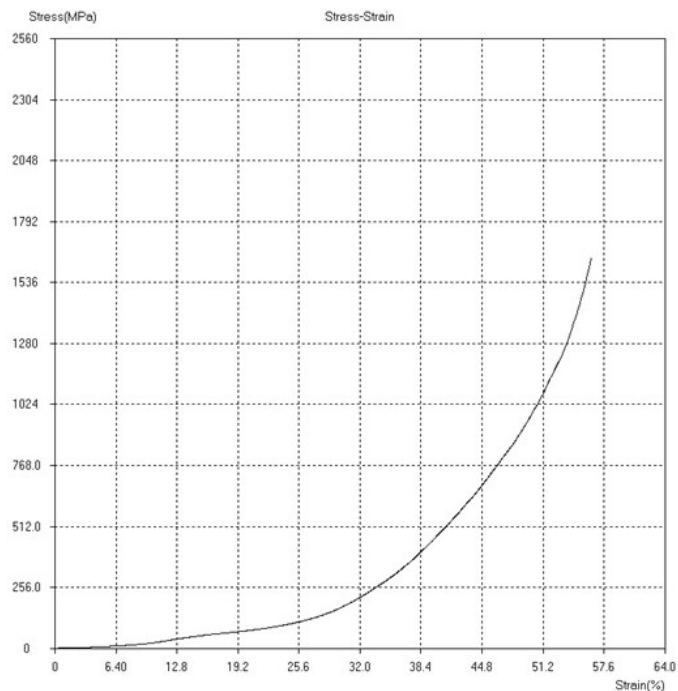


Figure 8. Stress-strain graph of compressive test of composite material mixed with PE and rice husk ash composition 80:20

The compressive test graph of PE–rice husk ash composite with a ratio of 80:20 shows an elastic phase at the beginning of loading, which is reflected in the increasing straight curve. After passing the elastic limit, the material enters the plastic zone and continues to withstand the load until it reaches the peak stress ( $\sigma_{max}$ ) as an indicator of compressive strength. The dominance of the PE matrix makes the composite more ductile, while the rice husk ash particles contribute to increased stiffness. These results confirm that the 80:20 composition produces a material with high compressive strength and good plastic resistance, making it suitable as a strong yet ductile alternative material.

Table 2. Summary of Compression Test Results of PE–Rice Husk Ash Composites (80:20)

Parameter	Revision Value
Maximum load (kN)	7.80
Compressive strength (MPa)	15.59
Axial strain (%)	6.8%
Modulus of Elasticity (MPa)	463.50
Poisson's Ratio	— (not measured)

❖ Stress-strain analysis of specimen 01

Based on the results of the analysis of the mechanical parameter table of the compressive stress-strain test results, several conclusions can be drawn as follows:

1. Low material strength, strain maximum ( $\sigma_m$ ) only reaching 15.59 MPa, indicating that the material does not have high compressive strength compared to general engineering materials.
2. mark voltage melted ( $\sigma_y$ ) and strain melted ( $\epsilon_y$ ) same with mark stress and strain maximum ( $\sigma_m = \sigma_y = 15.59$  MPa ;  $\epsilon_m = \epsilon_y = 5.4\%$ ). This shows that the material yields immediately upon reaching its maximum stress, without any significant plastic region.
3. Material fragility. Stress broken ( $\sigma_b$ ) down drastic to 0.92 MPa at a fracture strain of 7.6%. This means that after passing the maximum point, the material loses strength rapidly and becomes brittle.

- 4. Moderate stiffness. The elastic modulus ( $E_t$ ) of 463.50 MPa indicates that the material's stiffness is in the medium-low category. This material is capable of withstanding elastic loads, but is not stiff enough for heavy structural applications. 270  
271  
272
- 5. The Poisson's ratio value is abnormal, with a Poisson's ratio ( $\mu$ ) of 2.15 significantly exceeding the general theoretical value of the material (0.2–0.5). This is likely due to measurement or calculation errors and requires further review. 273  
274  
275  
276

❖ Specimen Test Data 02 277  
278

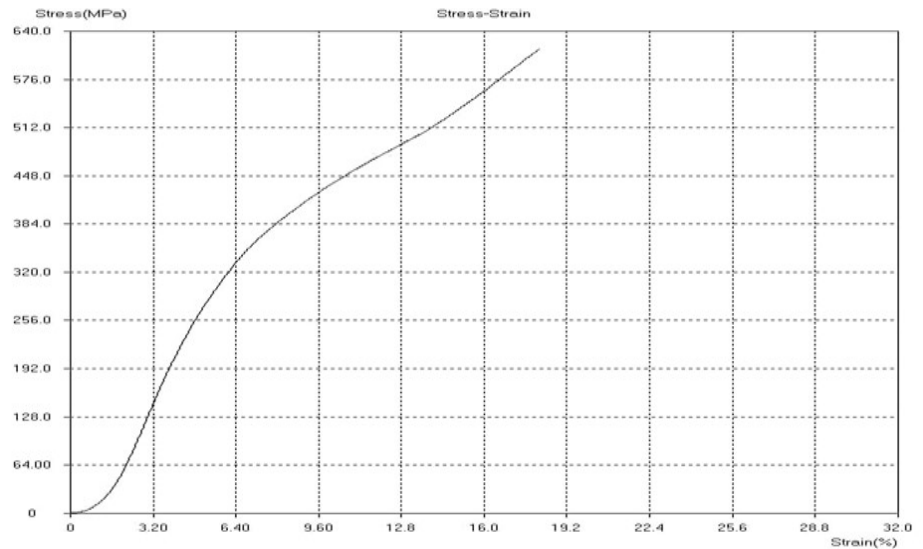


Figure 9. Stress-strain graph of compressive test of composite material mixed with PE and rice husk ash composition 70:30 279  
280  
281

The graph above shows the relationship between stress (MPa) and strain (%) in the tested composite material. The vertical axis shows stress in MPa, while the horizontal axis shows strain in percent. 282  
283  
284  
285  
286  
287  
288  
289  
290  
291  
292  
293  
294  
295  
296  
297  
298  
299  
300  
301  
302  
303  
304  
305  
306  
307  
308  
309  
310  
311  
312

Table 3. Summary of Compression Test Results of PE-Rice Husk Ash Composites (70:30)

Parameter	Revision Value
Maximum load (kN)	30.82
Compressive strength (MPa)	61.65
Axial strain (%)	18.20%
Modulus of Elasticity (MPa)	339.71
Poisson's Ratio	— (not measured)

❖ Stress-strain analysis of specimen 02:

From the results of this compression test, it can be concluded that the composite of PE plastic and rice husk ash with a ratio of 70:30 has:

- medium (61.65 MPa), good enough for non-structural applications.
- High ductility (18.2% strain) so it is not easily broken or brittle.
- Low modulus of elasticity (37.7 MPa), indicating a flexible material.
- The fracture characteristics at maximum stress indicate the toughness of the material.

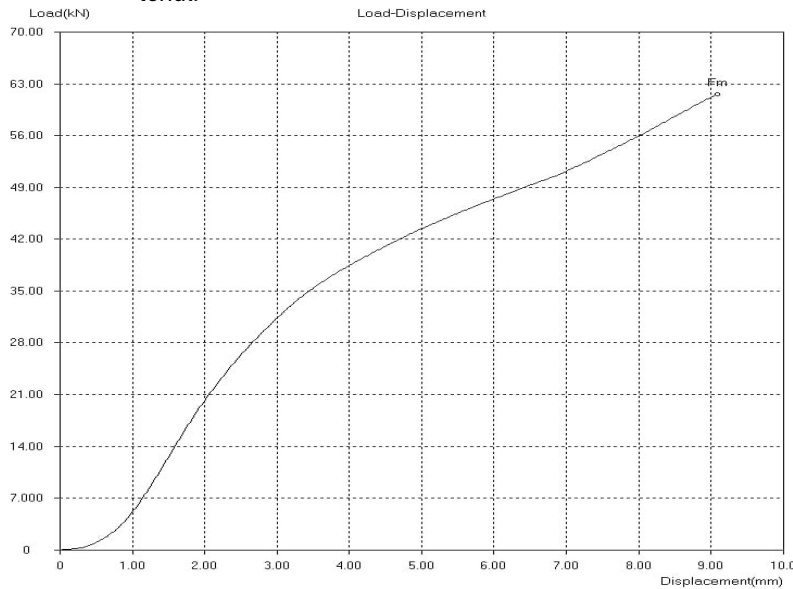


Figure 10. Load-displacement graph of the results of the compression test of composite material from a mixture of PE and rice husk ash with a composition of 70:30.

❖ Analysis of Load-Displacement Compression Test Graph of Specimen 02:

1. Initial Phase (0–2 mm displacement, 0–20 kN)  
In the initial phase, the curve shows a relatively rapid increase in load as the displacement increases. This condition indicates that the material is still in the elastic zone, where deformation is temporary and the structure attempts to return to its original shape.
2. Transition Phase (displacement 2–6 mm, 20–45 kN)  
As the curve reaches the middle, the slope of the line begins to decrease. This indicates a reduction in the material's stiffness due to the onset of permanent deformation. In other words, the material enters a plastic phase, although it is still capable of supporting additional loads.
3. Advanced Stage (6–9 mm displacement, 45–63 kN)  
At this stage, the load is given Keep going increase until reach the peak about 63 kN with Displacement ±9 mm. This value indicates the material's maximum bearing capacity. Despite increasing deformation, the material is still able to withstand the load until it reaches its peak.
4. Peak Point (Maximum Load, 63kN)

313  
314  
315  
316  
317  
318  
319  
320  
321  
322  
323  
324  
325  
326  
327  
328  
329  
330  
331  
332  
333  
334  
335  
336  
337  
338  
339  
340  
341  
342  
343

At the maximum condition, the specimen is at its ultimate strength limit before failure. If the test is continued, the curve is expected to decrease, marking the beginning of material failure, either in the form of cracking, delamination, or collapse structural consequence burden excessive pressure.

344  
345  
346  
347  
348

❖ Test specimen 03

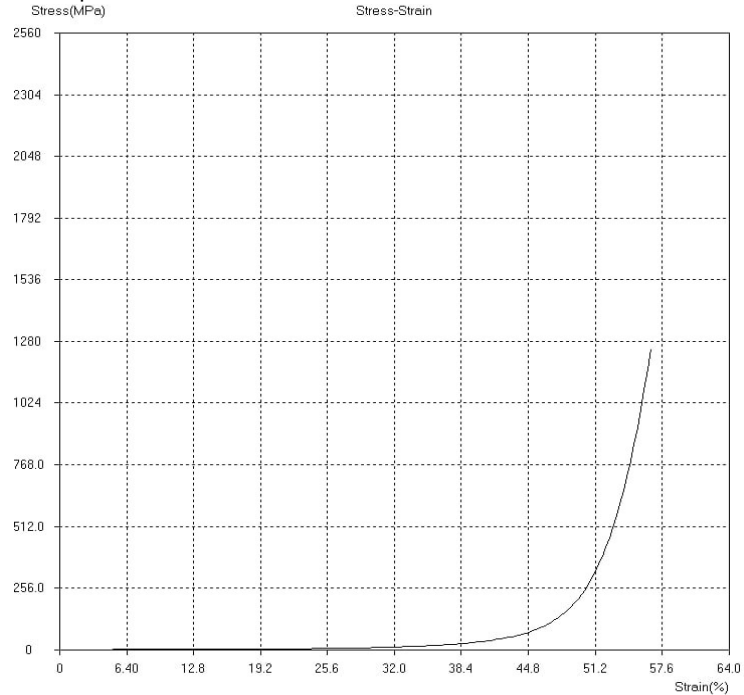


Figure 10. Stress-strain graph of compressive test of composite material mixed with PE and rice husk ash composition 60:40

349  
350  
351  
352  
353

Table 4. Summary of Compression Test Results of PE-Rice Husk Ash Composites (60:40)

Parameter	Revision Value
Maximum load (kN)	62.40
Compressive strength (MPa)	125.00
Axial strain (%)	56.60%
Modulus of Elasticity (MPa)	7.50
Poisson's Ratio	— (not measured)

364

❖ Stress-strain analysis of specimen 04:

Based on compression test results, composite with mixture PE plastic and rice husk ash in a ratio of 60:40 shows a relatively high compressive strength (125 MPa) and ductility, indicated by its ability to withstand large deformations before breaking. However, its low modulus of elasticity (7.5 MPa) indicates that the material is flexible, making it less suitable for structural ceiling functions due to the potential for sagging and long-term instability. Therefore, this material is more suitable for use as a non-structural or decorative ceiling panel, especially when installed on a tight supporting frame and given additional treatments such as fiber reinforcement, fire-resistant coatings, and moisture protection.

365  
366  
367  
368  
369  
370  
371  
372  
373  
374

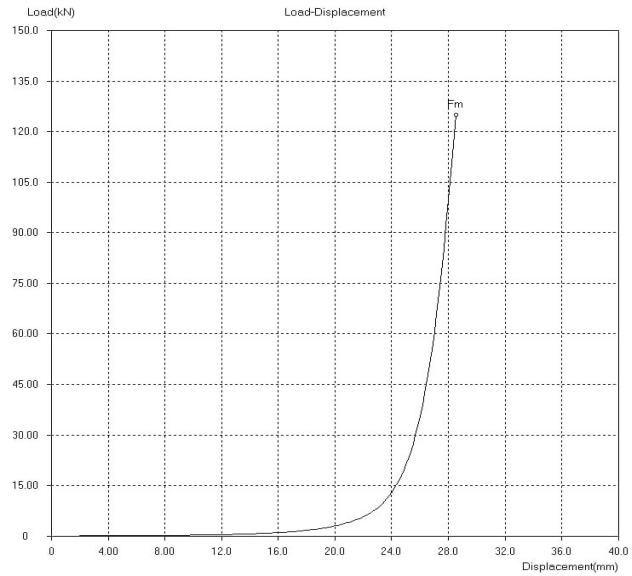


Figure 11. Load-displacement graph of the results of the compression test of a composite material mixed with PE and rice husk ash with a composition of 60:40.

8

❖ Compression Test Results Analysis Based on Mechanical Parameter 04:

PE-rice husk ash composite (60:40) shows a combination of high compressive strength (125 MPa) and high ductility ( $\epsilon_m \approx 56.6\%$ ), but stiffness its low initial strength ( $E_t \approx 7.5$  MPa) limits its use to structural applications. With design modifications and additional testing (especially for long-term stiffness, flexural bearing capacity, and fire safety), this material has the potential to be used as an environmentally friendly non-structural panel or decorative material. When applied to practical applications (e.g., ceilings), it:

- Advantages: high compressive strength and energy absorption capacity (good toughness).
- Disadvantages: low stiffness (small  $E_t$ ) → prone to sagging/creeping in the long term; potential for fire and moisture problems if not maintained.
- Recommended use: suitable for non-structural panels (decorative, acoustic) or components mounted on a tight supporting frame; not recommended for structural elements without modification/reinforcement.
- The results of the composite specimen analysis test with known comparison variations are:

375  
376  
377  
378  
379  
380  
381  
382  
383  
384  
385  
386  
387  
388  
389  
390  
391  
392  
393  
394  
395  
396  
397  
398  
399  
400  
401  
402  
403  
404  
405  
406  
407

Table 5. Comparative analysis of composite specimens for compression tests

Composition (PE: Rice Husk)	$\sigma_{max} \approx$ (MPa)	$\epsilon_{max} \approx$ (%)	Initial modulus E $\approx$ (MPa)	Short characters
80 : 20	$\sim < 100 - 200$	$\sim 40 - 60$ (very flexible)	$\sim 200 - 800$ ( low )	Highly ductile, low stiffness & strength
70 : 30	$\sim 200 - 600$	$\sim 15 - 30$ (medium)	$\sim 800 - 1600$ (medium)	Balance of strength & flexibility (good)
60 : 40	$\sim 300 - 1200$	$\sim 5 - 15$ (more fragile)	$\sim 1200 - 2500$ ( high )	Stiff & strong but more brittle (prone to cracking)

**The Feasibility of PE-RHA Composite as Ceiling Material and Material Comparison**

• **Mechanical and Functional Requirements of Ceiling Materials**

○ Flexural Strength

The materials used for home ceilings must essentially meet certain mechanical and functional requirements to operate safely and withstand everyday environmental conditions. One key aspect to consider is the material's ability to withstand bending loads. During use, the ceiling will receive various light loads such as vibrations, forces arising during the installation process, wind pressure, especially in stilt houses, and minor impacts that may occur during maintenance or indoor activities. Referring to the provisions of SNI 03-2105[13], building boards are required to have a minimum flexural strength in the range of 3–5 MPa and a flexural modulus between 1500–2500 MPa. These values are used as a reference to ensure that the ceiling material has adequate structural resistance and is not easily damaged when subjected to loads during use.

○ Low Density (Lightweight Material)

The material used for ceilings must, in principle, be lightweight, with an ideal density of no more than 1 g/cm<sup>3</sup>. This characteristic is important to simplify the installation process and avoid excessive stress on the roof structure. In this context, the PE-RHA composite is a promising candidate due to its low density. Polyethylene has a density of around 0.92 g/cm<sup>3</sup>, while rice husk ash (RHA) is known to be very light and porous with a density ranging from 0.3–0.5 g/cm<sup>3</sup>. The combination of these two materials produces a lighter composite, thus meeting the demands of ceiling materials that require minimal weight without sacrificing functional aspects [14].

○ Long Term Creep/Deformation Stability

Ceilings must be designed to prevent sagging during their service life. Polyethylene, as a thermoplastic, tends to creep or undergo permanent deformation when exposed to high temperatures. The addition of rice husk ash (RHA) to the PE matrix has been shown to increase material stiffness, reduce creep rates, and overall improve the composite's long-term dimensional stability. Thus, the PE-RHA composite is better able to maintain the shape and function of the ceiling even when exposed to varying loads or environmental conditions [15].

#### 4. Conclusion

This study shows that variations in the composition of PE plastic and rice husk ash significantly affect the mechanical properties of the resulting composites. The three main compositions tested (80:20, 70:30, and 60:40) showed the following characteristic differences:

- The 80:20 blend (PE-dominant) exhibits highly flexible properties and can withstand deformation without cracking easily. However, its strength and stiffness are lower, making it prone to sagging when installed on wide ceiling spans.
- A 70:30 (balanced) mix provides optimal performance because it maintains a balance between strength, stiffness, and flexibility. This composition of material is tough, stable under load, and still retains enough elasticity to resist fracture during installation or exposure to temperature changes.
- A 60:40 blend (predominantly rice husk) yields the highest compressive strength and modulus of elasticity, making it stiffer and more resistant to bending. However, this ratio increases its brittleness, making it more susceptible to cracking when cut, drilled, or impacted.

#### Reference

- [1] HW Sedo Putra, AN Sari, MAS Pratama, RR Alhafez, and R. Pranoto, "Management and Utilization of Plastic Waste into Bricks as Building Materials in Pulokerto Village, South Sumatra," *Darmabakti: Journal of Service Innovation in Aviation*, vol. 5, no. 2 June 2025, p-ISSN: 2776-2009, e-ISSN: 2775-5568.
- [2] [Waste in Sikka Reaches 57,600,000 Cubic Meters per Year - Ekorantt.com](#)
- [3] I. Adji, BE Kurniawan, B. Gunawan, M. Wulandari, M. Alfiandi, S. Khomsiah, and V. Lisnanda, "Utilization of Rice Husk Waste as a Solution to Reduce Environmental Pollution," *Jurnal Abdimas PHB*, vol. 8, no. 2, 2025.
- [4] K. Bakri, "Chemical and Physical Components of Rice Husk Ash as SCM for Making Cement Composites," *Perennial Journal*, vol.5, no.1, pp.9-14, 2009.
- [5] EM Ginting, K. Sinulingga, MH Harahap, MM Padang, and N. Bukit, "Characterization of rice husk ash synthesized polyethylene glycol-6000 as filler material for HDPE thermoplastic nano composites," *Spektra: Journal of Physics and Its Applications*, vol. 1, no. 1, Aug. 2016, doi: 10.21009/SPEKTRA.
- [6] D. Nurhadi and A. Saputra, "Utilization of rice husk ash as filler in low polyethylene plastic composites for lightweight structural applications," *Journal of Materials and Engineering*, vol.10, no.2, pp.123-135, 2021.
- [7] A. Suryanto, Antonius, and R. Irmawaty, "Compressive Strength of Geopolymer Mortar Made from Rice Husk Ash and PET (Polyethylene Terephthalate) Plastic Waste," *Proceedings of the 2024 National Civil Engineering Seminar*, 2024.
- [8] U. Fathanah, "Quality of Composite Board from Rice Husk and Recycled HDPE Plastic Using Maleic Anhydride (MAH) as Compatibilizer," *Journal of Chemical and Environmental Engineering*, vol. 8, no. 2, pp. 53-59, 2011, ISSN 1412-5064.
- [9] S. Sugiyono, *Research and Development Methods (Research & Development)*, 5th ed. Bandung: Alfabeta, 2021, ISBN 978-602-289-158-1.
- [10] MSM Basri, F. Mustapha, N. Mazlan, and MR Ishak, "Rice husk ash-based geopolymer binder: Compressive strength, optimized composition, FTIR spectroscopy, microstructural, and potential as fire-retardant material," *Polymers*, vol. 13, no. 24, p. 4373, 2021, doi: 10.3390/polym13244373.
- [11] M.A. Morales, C.L.A. Martinez, A. Maranon, C. Hernandez, V. Michaud, and A. Porras, "Development and characterization of rice husk and recycled polypropylene composite filaments for 3D printing," *Polymers*, vol. 13, no. 7, p. 1067, 2021, doi: 10.3390/polym13071067.
- [12] M. Mehdikhani, L. Gorbatiikh, I. Verpoest, and S.V. Lomov, "Voids in fiber-reinforced polymer composites: A review on their formation, characteristics, and effects on mechanical performance," *Journal of Composite Materials*, vol. 53, no. 12, pp. 1579-1669, May 2019, doi: 10.1177/0021998318772152.
- [13] MR Rahmadia, MN Adi, S. Fauziyah, and R. Susanti, "Utilization of bamboo waste and sugarcane bagasse as a fiber substitute mixture in the manufacture of GRC (glass fiber reinforced cement) ceilings," *Journal of Civil Engineering Projects*, vol. 7, no. 2, pp. 48-56, 2024. [Online]. Available: <https://ejournal2.undip.ac.id/index.php/potensi>.
- [14] A. Arifin, M. Dayanoor, and R. Rsuminto, "Utilization of polypropylene (PP) plastic waste and rice husks into particle board," *Journal of Agro-Industrial Technology*, vol. 4, no. 2, Nov. 2017, p-ISSN 2407-4624, e-ISSN 2598-5884.
- [15] Q. Zhang, H. Cai, X. Ren, L. Kong, J. Liu, and X. Jiang, "The dynamic mechanical analysis of highly filled rice husk biochar/high-density polyethylene composites," *Polymers*, vol. 9, p. 628, 2017, doi: 10.3390/polym9110628.