

## The Application of Recycled Materials in Construction Building : A Brief Review

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**Abstract:** Excessive and uncontrolled production of waste will have a detrimental effect on nature. Due to that, the concept of 3R (reuse, reduce, recycle) was introduced as early as 1976. Recycling is the process of converting waste into new materials or objects that can be used. This study focuses on the application of recycled materials in construction materials and discover the alternative measures in recycled materials. The waste management depends on the type of waste and the recycled product from the waste. The most distinguish result from recycling process are development of sustainable concrete, pavement, and even thermal insulation on buildings. Based on the review study, waste management encourage to recycled and reuse in order to minimize the environmental pollutions.

**Keywords:** Recycled waste material, solid waste, building construction, environmental impact, sustainable material

### 1. Introduction

Reduce, reuse, and recycle are concepts that are beginning to be understood and applied by communities around the world in daily life. The principle of 3R (reuse, reduce, and recycle) is quite basic but it is very important to maintain a sustainable life [1]. Thus, this 3R concept needs to be emphasized so that it is not forgotten by the new generation for the sake of the environment. The first 3R concept is reuse which implies the material can be reused such as cooking oil, water and fragrances bottles. The second 3R is reduce that is to minimize the use of a material for example, tissue can be replaced with a towel to wipe spilled water. The last 3R concept is recycled. Recycling is the process of converting the waste into new products.

It is an alternative method from the conventional waste disposal that can save material and help reduce greenhouse gas emissions. Recycling can reduce the disposal of goods that potentially beneficial in other area such reducing the consumption of natural resources. Thereby reducing energy usage, air pollution (from incineration), and water pollution (from landfilling). Recyclable materials include glass, paper, cardboard, metal, plastic, tires, textiles, and electronics. Currently, recycling is taken as one of

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the most important actions in reducing environmental pollution impacts and taken as one of the most dynamic action in the plastics industry [2].

Waste materials from construction brings major environmental problem and has become a threat to the environment. It is important to ensure these materials is properly dispose possibly implementing 3R beforehand [2]. It has caught attention to the community how important it is to implement 3R actions before environment pollutions becomes uncontrollable. Due to that, this study are conducted to review the application of recycled materials in construction.

## 2. Methodology

Previously, there are many researches in analyzing and reviewing the recycling material management practices in order for this approach to remains implemented and related journal articles were gathered from Science Direct and Google Scholar database.

A three-stage strategy approach is taken in order to identify the most relevant research papers namely, identify database selection, criteria screening based on eligibility and exclusions, and refining the sample. In the first step, identifying the database selection is used to retrieve journal articles from the selected database. Table 1 shows the database and keywords used in searching the articles. The main database used is Science Direct and followed by Google Scholar as additional database. These databases are recommended in article's search.

**Table 1: Keyword and Searching Information Strategy**

Database	Keyword used
Google Scholar	("recycled material in building") AND ( "waste material in building )
Science Direct	("recycled material in building") AND ( "waste material in building ),

The second stage is the criteria examination for the articles which based on qualifications and exclusions. This is an important stage where articles from previous stage were undergone a comprehensive screening. The criteria are divided into the selected literary type, language, timeline, and even index. The type of literature that is eligible during the selection of the journal is the index of the journal which consists of research articles and some systematic review of the journal is studied and also used as a reference. Two main languages were considered in this study; Bahasa Malaysia as it is native language of Malaysia and English as international language. The third criterion is the timeline, which is in between 2015 to 2020. Finally, the index used are "building" and "construction". Table 2 shows the selection of criteria based on eligibility and exclusions more easily.

**Table 2: Inclusion and Exclusion Criteria**

Criterion	Eligibility	Exclusion
Literature type	Indexed Journal (research articles) , Systematic review journals	Non indexed journals, chapter in book, conference proceeding
Language	English, Bahasa Malaysia	Non-English (except Bahasa Malaysia)
Time line	Between 2015-2020	<2015

Indexes	“building” and “construction”	Non related indexes
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Lastly, the stage was to re-screening all selected articles from the first and second stage. The articles were saved in one different folder created in Mendeley software to ensure there is no duplicates. If there is a journal that needs to be removed immediately then the latest journal needs to be reviewed again hence that the journal meets the objectives of this study. A total of 60 articles have been collected and only 30 were chosen by the end of screening process.

### 3. Results and Discussion

Recycled materials can be applied in various ways. In this study, various products can be recycled for use construction purposes such in highway pavement, aggregates, thermal insulation, additives in building materials, and also used as main structure element. The use of sustainable materials in buildings has become an important factor in producing sustainable buildings. The building materials will be added or replaced with some waste materials and recycled materials to make the building materials more environmentally friendly. As shown in Table 3, the summarize from each articles on the waste materials with its recycled products produced and applied to buildings.

**Table 3: Types of waste and its recycled products on buildings application**

Waste Material	Recycled Product	References
Recycled concrete aggregates	Sustainable highway pavement	[4]
Recycled paper mill sludge	Filler in asphalt mixture	[5]
<b>Solid waste material</b>		
Recycled plastic	Fine aggregate in cementitious	[6]
Textile waste	Thermal insulation building material	[7]
Recycled construction and demolition wastes	Alkali-activated building materials	[8]
Seashell waste	Concrete	[9]
Sisal fiber	Precast concrete slabs	[10]
Recycled gypsum plaster and wastes	Building components - Bricks	[11]

**Table 3: Types of waste and its recycled products on buildings application (cont.)**

Waste Material	Recycled Product	References
Paper sludge powder	Building materials - Ceiling and insulation panels	[13]
A core-shell recycled plastic aggregate (RPA) consisting of grinded WEEEP (core)	Building materials - Replacement for sand in cement mortar.	[14]
Recycling of construction debris	Aggregate	[15]
Recycled aggregate	Concrete	[16]

<b>Recycling of end-of-life vehicles (ELVs)</b>	Building products	[17]
<b>Raw rice husk</b>	Magnesium oxysulfate cement-based lightweight building materials	[18]
<b>Concrete aggregates</b>	Structural use	[19]
<b>Sustainable panels with recycled materials</b>	Building applications- acoustic panel	[20]
<b>Waste materials - Foam glass and high-impact polystyrene</b>	Construction industry- Modifiers composition of basic construction materials	[21]
<b>Natural or recycled materials</b>	Thermal and acoustic insulating materials	[22]
<b>Recycled use of solid wastes</b>	Building materials - standard mix design of building materials, concrete	[23]
<b>Recycled solid wastes</b>	Green building materials	[24]
<b>Waste paper</b>	Composite Material Clay Cement Paper	[25]
<b>Recycled materials</b>	Sustainable construction	[26]
<b>Recycled aggregate</b>	Concrete applications	[27]
<b>Rice husk panels</b>	Building applications - Thermal, acoustic	[3]
<b>Recyclable materials, plastic bottles</b>	Buildings	[2]

**Table 3: Types of waste and its recycled products on buildings application (cont.)**

<b>Waste Material</b>	<b>Recycled Product</b>	<b>References</b>
<b>Recycled materials - charcoal ash, rice-husk ash, wood ash, natural pozzolans, GGBFS, silica fume, and other similar pozzolanic materials</b>	Environmental-friendly durable concrete	[28]
<b>Solid wastes</b>		
<b>Reuse of cotton and recycle paper mill waste</b>	Building material - Waste crete bricks	[29]
<b>Recycled materials</b>	Road construction	[30]
<b>Recycling carbon fibre/epoxy composite wastes</b>	Building materials - Conventional Portland cement	[31]

Among the recycled materials studied for its processing are recycled concrete, natural materials, textile, paper, and even plastic. Yet, an important part of applying recycled materials in a building is the way the material is being processed beforehand. These material needs to undergone filter stage where all unwanted foreign matter is eliminated. The processing of concrete recycled materials is easier because of its unique properties that are suitable for use in building materials. While textile, natural materials, paper, and even plastic should be studied the characteristics of the material because the effect should be taken into account if applied in building materials. Apart from recycled concrete suitable for use are natural materials such as a seashell, coffee chaff, rice husk, coal ash, and sisal fiber. These materials has its own strength in its nature form hence further exploitation may requires. The most popular natural material at the moment that is often used and experimented in building materials is rice husk as shown in Figure 1.

Nevertheless, the recycled material used in construction needs to be tested thoroughly. Some materials require additional materials as supports to strengthen the structure. For an example, the rice husk recycled material used as sound insulation on the wall conducted a sound absorption test and the result is illustrated as in Figure 2.



Figure 1: Rice husk (RH) glued: a) acoustic and b) thermal measurement samples. [3]

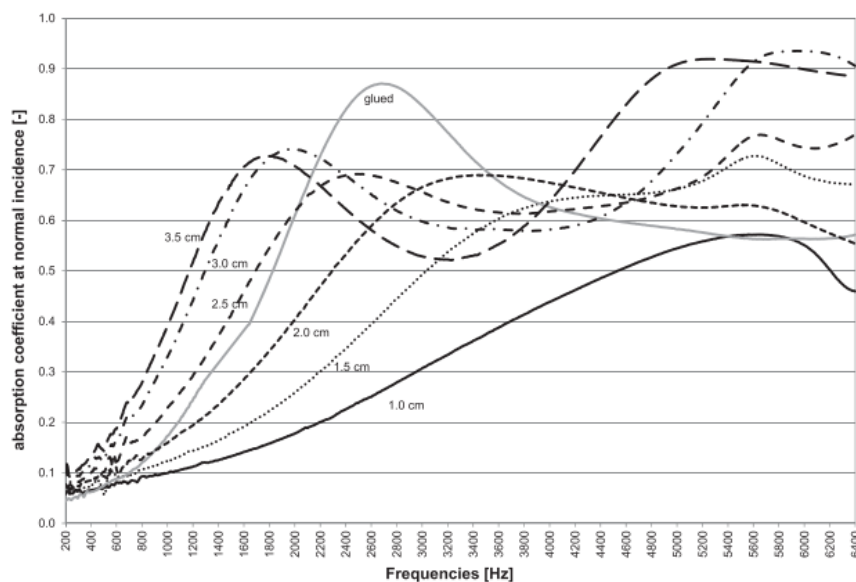


Figure 2: Sound absorption coefficient trends of the loose rice husks by varying the thickness [3]

#### 4. Conclusion

Recycled materials need to be handled in the right way so as not to leave a bad impression on nature. The community can identify the use of recycled materials creatively depending on the situation. It is confirmed that all materials can and shall be recycled in order to minimize the environmental pollution. However, some materials require a lot of tests before it can be applied. Due to that, the recycling management needs to be address vigorously to the community as it will encourage them to practice 3R. As a start, the community will have better knowledge of which materials can easily be recycled at home and which materials should be sent to recycled centre.

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