Perforated metal made from recycled material in the application of building façade

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Abstract. Building material can be acquired effortlessly nowadays, but it still has limit and eventually the resources we have will run out. Building material decomposed in various time, some of it even take hundreds of years. This paper focus on the recycling metal waste material in form of perforated metal that used as building facade element. As we know that sustainable architecture not a simple design, and because of the lack of information until no interest in trying to execute the sustainable concept. Building material in metal form can be recycled and reused more easily thanks to the advanced technology invented. Perforated metal that can be designed in various ways and size can be used as building facade that enhance not only building performance but also the aesthetic aspect which emerged from the building.

Keywords: recycled material, perforated metal, building facade

1. Introduction
Architectural reuse processes include adaptive reuse, conservative disassembly, and reusing salvaged materials. This definition is broad and inclusive permitting many different interpretations; however, the underlying objective is that architectural reuse be understood as an evolutionary process occurring over time [4]. The paper focuses on the recycling metal waste material in the context of environmental and sustainable architecture. The use of recycled materials depends on clients and the architect with strong commitment to use recycled materials as part of sustainable architecture design.

Metal also considered as an environmentally and friendly building material. Although that metal is acquired from mined from the earth, large amount of metals already available thanks to the emphasis increased on metal recycling. The issue of the use of recycled materials and its relevance to architecture and sustainability relates directly to the initial and final phase of a building. The initial phase occurs prior to the building’s existence and concerns how the materials that will constitute the building are sourced and manufactured. The end phase involves the end of the building’s life, and in this phase most of the materials are demolished and “are disposed of in a landfill, where they are effectively unrecoverable and may have a variety of adverse environmental impacts” [2]. The use of recycled materials in buildings positively affects both landfill waste created at the end of a building life and the waste produced in the initial creation of buildings as well as decreasing the use of raw materials and energy. Metals also can be returned to the production process without impairing the
quality of subsequent products. In fact, recycling represents an advantage because it requires much less energy to melt down the metal. The reuse quota for scrap metals sent for recycling is 90% [1]. Wittmann’s study, titled "Architects perceptions regarding barriers to sustainable architecture” said that for architects the imperative of sustainability is not a very urgent one. She found that most architects surveyed were ‘Not committed to lower the adverse impacts of their designs can have on the environment '. Wittmann found that this is not an isolated attitude to architects and concluded that ‘the main barrier to sustainable architecture is of societal significance rather than a problem confined to architects alone '. Architects perceived four main barriers preventing them from engaging in sustainable design. Amongst these are a lack of information, lack of interest by clients, developers, and the profession itself.

2. Literature Review

2.1. Building Facade
Smardong in Gultom (2006) said that the visual value of a building is shown by the physical quality formed by the relationship or interrelation between visual elements in each urban landscape, its evaluation criteria such as:

- Privileges which are an unforgettable visual impression, formed by the presence of elements or visual units that stand out and are interesting.
- The uniqueness that becomes the visual character, the visual source, the visual quality is strange or rarely found.

2.2. Recycled Material
Recycling was found to have the highest energy saving potential of 53% while the energy saving potential of reusing was 6.2% and that of incineration was only 0.4%. As recycling of building materials could reduce the environmental burden associated with the materials in the building and could reduce the total life cycle energy by 30% [6].

2.3. Perforated Metal
Perforated metal is sheet metal in various shape that has been manually or mechanically stamped to create a pattern or designed pattern of holes, slots, or shapes. Materials used to manufacture perforated metal include stainless steel, cold rolled steel, galvanized steel, aluminum, and more. Perforated metal in architecture use can be utilized as panels, sunshade, cladding, column covers, fencing, building facade or even in interior design use.

3. Methodology
The methodology uses a literature review approach in understanding the potential and process of metal material recycling by converting recycled metal material to be reshaped into perforated metal panels that will be applied to building facades under certain patterns or designs.

4. Recycled Metal Material
Modern architecture is using building materials in new and innovative ways. The fascination arrives from both the materials themselves and the way in which they are processed and utilized. The emphasis is not so much on the material to be able to suit with the building, but on the impact given by the particular materials created for the building with its material and visual qualities. As today conventional solutions are giving way to materialized individual concepts which often demand processing techniques and designs that challenge architects.
4.1. Recycling
The metals collected and be sorted to separate metals from the mixed scrap metal. Further process metals are shredded to promote the melting process as small shredded metals have a large surface to volume ratio, scrap metal melted in furnace designed to melt particular metal. And purification process done to ensure the final product material is high quality and free of contaminants, after purification melted metals area carried to cool and solidify.

4.2. Forging
Forging can be carried out manually or by machine using a hammer and ancil or with pressing moulds (forging dies)

4.3. Casting
Casting permits any shape to be formed. However, further processing of steel castings is only possible using machining methods.

4.4. Extrusion
Extrusion of the metal is forced through an opening to form the desired final shape. The process is particularly suitable for nonferrous metals.

4.5. Mechanical Machining
A wide range of metal products in the building industry require mechanical machining. Milling, drilling, filing, sawing and turning are the so-called material removal machining options. It is possible to cut a thread in solid material or mill holes.

5. Perforated Metal Façade

5.1. Environmentally Sustainable
Material used to create the perforated panel can be developed from recycled materials as of metal can be recycled many times, and waste created through perforation is recyclable, so the perforations decrease the amount of metal usage between 10-40%.

5.2. Style and Creativity
Unique and innovative building aesthetic. Variety of perforation patterns to create shadows inside a building. At night, light from interior will shine through the perforations that attracts special attention.

Figure 1: Mountain Dwellings / PLOT = BIG + JDS

5.3. Natural Lighting
Perforated panels allow natural light to pass freely through when used as building facade or as double skin facade. And when used as double skin, the air conditioning load also reduced.
5.4. Flexibility and Durability
Flexible material can be manipulated to various sizes, shapes, and perforation design also lightweight. Depend on the design, perforated metal can be manipulated in various ways as long as the shape and size possibly created/manufactured using current technology.

6. Conclusion
The architectural reuse process can be done more efficient this day thanks to the advance technology invented. The choice to use recycled material once again back to commitment from architect and the client as part of sustainable in architecture design. As of building materials waste end up at landfill, but not all building material waste can be decomposed in short time and might end up adverse environmental impact. The architect must try to engage in sustainable design as of the architect is the one who has the knowledge and information about sustainable design, and the architect must be able to persuade their clients to agree and commit with sustainable design.

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