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CONSTRUCTION MATERIAL USING INDUSTRIAL AND AGRICULTURAL SOLID WASTE

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Abstract: These days, with rapid development all around the world include industrial, agricultural and services sector was help the development of country. This situation can avoid from reality because of the sophisticated and development of technologies. But, the same problem that all countries face it is the waste of that sectors produce and no concrete solution to curb and control it. For example, industrial and agricultural waste was created another problem such as the pollution to environment, not enough space to store it, most of that waste are non–biodegradable form and can't be recycle or reuse as main function of that product. One of the solutions that were implemented is reuse both wastes as material in construction industry. Here, we can see this approach was considered the sustainable development and construction as a green solution in construction project. These are very important to government and construction player need and must consider about sustainable aspect to future development consideration. Lastly, this approach in not only was solve main problem regarding environmental aspect but also gave benefits to other related field especially in construction industry.
Keywords: solid waste, agricultural waste, construction material, green concrete, reuse, recycle

1. INTRODUCTION

Sustainable construction or green construction is one of initiative that was planned and implemented in construction industry in order to consider of natural environment through the boost of massive of development around the world. As we can see from the growth of world population, it was achieved 7 billion people in all around world. So from that growth, it was created new challenges to construction practitioners and government itself. The increasing urbanization, rising standard of living and rapid development in technology was contributed the increasing of amount and variety of solid waste such as industry, agricultural and others activities [1].

Besides that, the function of buildings and structures is to provide shelter to human either in types of residential, commercial and industry. Apart of shelter, building also functioning to meet economics needs for investment and satisfy corporate objectives. Construction industry also one of important sector in Malaysia is regarded as an essential and highly visible contributor to the process of growth of one country. For Malaysia perspective itself, the industry was contributing consistently between 3 – 5 percent of the national gross domestic product [2].

Basically, UK government was highlighted of 10 principles of sustainable development in construction industry in order to achieve initial plan of sustainable or green construction. This principle was covered like the extensive and broad of sustainable area, making it more reliable of foundation. This initiative was gave benefits such as the concept of green building costs lower than conventional method and saves energy. Table 1 shows the 10 principles of sustainable development initiated by UK government.

Table 1. The 10 principles of sustainable development instigated by UK government [3]

The Principles of Sustainable Development	The Interpretation of Sustainability Principles within Construction Industry
Putting people at the center	Show concern for people by ensuring they live in a healthy, safe and productive built environment and in harmony with nature
Taking a long term perspective	Safeguarding the interest of future generations while at the same time, meeting today's needs
Taking account of costs and benefits	Evaluate the benefits and costs of the project to society and environment
Creating an open and supportive economic system	Crating a system which can flourish trades, improve collaboration and resource efficiency
Combating poverty and social exclusion	Improving the quality of building and services, create jobs opportunities and promote social cohesiveness
Respecting environmental limits	Minimizing damage to the environment and its resources
The precautionary principle	Assessing risk and uncertainties before any action and rectify possible damage at source
Using scientific knowledge	Using technology and expert knowledge to seek information and in improving project efficiency and effectiveness
Transparency, information participation and access to justice	Opportunities to improve access to information and encourage ethics and professionalism
Making the polluter pay	Legislation compliance and responsibility

2. CONSTRUCTION MATERIAL AND RELATIONSHIP BETWEEN INDUSTRY AND AGRICULTURAL SOLID WASTE

Materials are one of important element in construction project. Nowadays, the fluctuation price of materials was created problem regarding the costing of project [4]. This because, if we study and look the trend of price such as reinforcement (iron), cement, sand, brick and other related materials show the increasing year by year. If government and construction not work together to ensuring the increasing that price, it will create bigger matter in the future.

By the way, in my opinion the increasing of material is actually can avoid because every year the increasing of demand and scarcity of raw material are several factor that influence the increasing price of materials. Thus, this important that government and industry player came out or brainstorming to create alternative or suggestion in order to curb this matter become worst in future.

One of alternative that relevant and can practice in real situation or by reuse or producing material from solid waste such as industry and agricultural solid waste. This approach was implemented in several countries with selected project. Basically, waste is consider that materials that can't be used in perfect physical or main function of that material. In scientific definition the term of waste known as any substance or object in the categories set out which the holder discard or intends or is required to discard [5]. All industry was produce waste in the end of the uses such as in industry, agricultural and domestic. But in order to make decision to reuse that materials we need to consider the effective or the strengthen suitability, type of project that will be implement and other aspects.

In Agenda 21, most of countries in this world were acknowledge the sustainable development in all premier industry included in construction industry itself. So, the statement of acknowledges are 'environmentally sound waste management must go beyond the mere safe disposal or recovery of wastes that are generated and seek to address the root causes of the problem by attempting to change unsustainable patterns of production and consumption.' Thus, these clear the intention of most countries to reduce the effect of solid waste. The reason why, Agenda 21 proposes are to minimizing wastes, maximizing environmentally sound waste reuse and recycling, promoting environmentally sound waste disposal and treatment and also extending waste service coverage [6]. By the way, these four main aspects need to interrelated and mutually supportive in order to get the effective and comprehensive result that integrated to environmentally responsive framework for managing municipal solid waste.

Other aspect that need to consider are the effective control of the generation, treatment, recycling and reuse, storage, transportation, recovery and disposal of hazardous waste is of paramount importance for proper health, environmental protection and natural resource management and sustainable development. Table 2 shows global dimension of solid waste problem.

Table 2. G global dimension of solid waste problem

Factor	Observation
Population	By 2050 the global population is projected to be 50% larger than today and 95% of that growth is expected to occur in developing countries.
Consumption	Consumers in certain rapidly expanding non–OECD economies are emulating the ecologically challenging consumption patterns of consumers in OECD countries.
Affluence	Some of the highest GDP growth rates in the world are taking place in countries outside the developed world such as China, India and Brazil.
Technology	The World Bank reports that 'massive levels' of industrial investment will occur in developing countries.
Impact	A five–fold increase in global waste generation is possible by 2025.

Basically, industrial process wastes include a very wide range of materials and the actual composition of industrial wastes in a country will depend on the nature of the industrial base. Wastes may occur as relatively pure substances or as complex mixtures of varying composition and in varying physicochemical states. Examples of the materials which may be found under this heading are general factory rubbish, organic waste from food processing, acids, alkalis, metallic sludge and tarry residues. The most important feature of industrial wastes is that a significant proportion is regarded as hazardous or potentially toxic, thus requiring special handling, treatment and disposal.

While, agricultural wastes, which may include horticultural and forestry wastes, comprise crop residues, animal manure, diseased carcasses, unwanted agrochemicals and 'empty' containers. Their composition will depend on the system of agriculture. Estimates of agricultural waste arising are rare, but they are generally thought of as contributing a significant proportion of the total waste matter in the developed world [6]. Since 1960, as a result of huge rises in productivity, there have been corresponding increases in the volumes of crop residues and animal manure requiring disposal. There is likely to be a significant increase in agricultural wastes globally if developing countries continue to intensify farming systems.

Thus, industry and agricultural solid waste is important to do transformation in order to minimize the effect of environment. One of the ways to curb this matter becomes worst is reuse that waste become part of material for construction. Overall, that waste is not hundred percent can't function yet. But, need most research or study about the reuse of solid waste in order to make that 'permanent' material are safety and stable of certain project. Below are several explanation and type of example of making industry and agricultural solid waste part of material in sustainable construction [6].

3. INDUSTRIAL WASTE PRODUCT IN ROAD CONSTRUCTION

Nowadays, the rapid of development in all around the world was created problem to our environmental. For example, many industrial wastes are non–biodegradable form and certain percent of that waste maybe will take a long time to biodegradable. Thus, it is very important to all government and construction industry player to take immediate action to solve or reduce this matter and to avoid it become worst for the future. In India for example, several million metric of tons was produce from industrial and maybe from that waste it can be 'materials' in construction like road construction.

Basically, the use of these materials in road making is based on technical, economic and ecological aspect. The benefits that can get from reuse that solid waste are can reduce the pollution and disposal problem and also will give to higher economic return. Besides that, basic traditional materials such as soil, stone aggregates, sand, bitumen and cement was be burden to government because every year the price was increased and the natural materials (raw materials) being

exhaustible in nature [7]. In generally, the benefits that will be achieve from reuse solid waste become permanent material in highway or road construction are it will help clear valuable land of huge dumps of wastes and preserve the natural reserves aggregates and to protecting environment. Example of industrial waste that maybe can give benefit in road construction are fly–ash from thermal power plants and other coal fired industries, blast furnace slag from steel industries, cement kiln dust from cement related industries, phosphogypsum from phosphatatic fertilizer industries and others related solid waste.

3.1. Fly Ash

Basically, fly–ash was produced from transported combustion chamber, coal fired electric and steam generating plants. Got several scientific procedure need to consider about producing this waste. But, this waster can be used in Portland cement concrete as admixtures to enhance the performance of concrete road and bridges. The percentage of lime in this cement is 65% and the combination of fly–ash with free lime will improve the properties of the concrete. Here are some advantages of fly ash in concrete such as higher ultimate strength, reduced bleeding and permeability and increased durability.

On the other hand, fly–ash can be used in asphalt pavements. Meaning is fly–ash will act as mineral filler to increase the stiffness of the asphalt mortar matrix, improving the resistance of pavement and the durability of the mix [7]. The advantages are can be reduced potential for asphalt stripping due to hydrophobic properties of fly–ash, lime in some fly–ashes may also reduce stripping and may afford a lower cost than other mineral fillers.

3.2. Blast Furnace Slag

While, these waste is generating during the melting process in steel making operation. It is composed of metal oxides, melted refractory, sand from recycled scrap casting, coke ash and other materials. Blast furnace slag can be used as a cementations binder in highway construction. Also known as gravel–slag and the function are to stabilize gravel and sands for sub–base and base construction [8]. The advantages are the development of batter strength, low energy requirement and provides great potential for profitable to produce alternate binder to cement.

Other use is function as a coarse aggregate for asphalt. This waste has been use as a substitute for native coarse aggregate in concrete mixtures and also usually to crushed to achieve the desired particles size. Here are advantages such as can lower the cost than other mineral fillers and suitable for roads near the locality of the steel plants.

3.2 Cement Kiln Dust

In generally, this waste is the finely divided dry alkaline particulate matter carried from a cement kiln by the exhaust gas and captured by the kiln's air pollution control system. The primary value of cement kiln dust is its cementations properties. The use of this waste for soil stabilization in road construction. Meaning is it can improve the properties of soil in situ and as an activator in pozzolanic stabilized base mixtures. The advantages are cement kiln dust effectively improves soil strength and reduces construction time and cost and also can be mixed with soil to modify plastic limits or moisture content to provide the desired stabilized properties [6].

Besides that is use as mineral filler in asphalt pavement. It can be replace a portion of the mineral filler used in hot–mixed asphalt and the advantages are desirable physical properties, the cementations properties of cement kiln dust increased the stability and stiffening of hot–mixed asphalt.

Finally, from the above statement and explanation about the several of industrial waste was gave benefit to construction industry especially in road and highway construction as permanent material that can be use from waste production in industry. Thus, here was shown this approach of reuse waste production can create benefits such as reduce the pollution of waste production and can improve the quality of natural environment in surrounding [8].

4. AGRICULTURAL WASTE AS BUILDING MATERIALS

Some countries in this world were focus on agricultural industries as primary sector in economic aspect. Thus, not only an industry was produced waste but in agricultural also was produced it. Sometimes, the surplus of that waste from agricultural was create same problem with industrial waste such as create pollution to environment and the loose of certain agricultural that can be reuse to benefit product [9]. In order to avoid this matter become continuous problem and become worst, it can be transform to be used as material to construction industry. Even, most of agricultural waste is biodegradable but sometimes that can create more profitable such as be as material in construction industry. For example straw bale from agricultural waste and using soft clay with cement agricultural waste as road construction materials.

4.1. Straw Bale

Basically, straw bale is insulation or as support component in a building is becoming more than just a rare occurrence in agricultural region and in colder climate. So, straw bale waste made and produce from rice, wheat, rye, flax, barley and oats. It is clear that the waste from agricultural can create new material or product in construction industry.

Besides that, the condition of straw bales that have exceptional fire resistance due to the lack of air pollution that penetrates the bales. More space is available for rodents in other building methods and the seed of the straw, which attract rodents, has been removed. However, termites prefer wood and can be deterred by termite shield, sand barrier, vapour barriers, diatomaceous earth and borax [9].

On the other hand, straw bale walls are more effective as load–bearing members if there is lying flat. While the arranged on edge are less effective as load–bearing members but are better insulation and thus preferred for straw bale infill insulation. In fact, it was design to absorbing seismic load to reduce the damage of building caused by earthquake.

Lastly, the benefit of the straw bale is typically it treated as an agricultural waste product as it is slow to decay unlike nitrogen–rich hay.

4.2. Soft Clay with cement

In generally, soft clay usually disposed of and replaced with other suitable backfill material for road construction. But, instead that purpose, the soft clay can be reutilized via stabilization. Meaning is the modified clay road made from agricultural waste such as pineapple leaves, rubber chips and rice husks with smaller quantity of cement can be required for improving the soil. So, it also can enhances the practically of the stabilization technique [9].

Besides that, the agricultural waste were perceived to provide better bonding between soil cement, where the explanation and the proven like the soil particles and wastes materials could be firmly bound by the hydrated cement and the result it become stronger and stiffer soil matrix. This proven was being shown with several scientific experiments and procedure such as:

i. Clay – The bulk, disturbed clay samples were wrapped in layer of cling film and plastic bags to prevent moister loss during transportation and storage.
ii. Ordinary Portland Cement – Used stabilizer whether on its own or admixed with other additives. The cement was first oven–dried at 105 degree Celsius for 24 hours before being stored in airtight containers to maintain the consistency of cement used in the preparation of specimens.
iii. Pineapple leaf fibers – To extract the fibers, surface of the leaves were first scarified to expose the inner layer. Next will boiled and were drained and dried at 105 degree Celsius overnight.
iv. Rubber chips – To retrieved from inner tire tubes for bicycles.
v. Rise husks – Raw rice husks were collected from a rice processing plant and were used as they were without any processing.

The result of this experiment was shown the consistency of cement is perhaps the most effective stabilizer for the clay corresponding with highest strength was achieved and cement is the

dominant component binder in the stabilized soil matrix as shown the marginal change in strength and water content with the 5% of cement specimen [10].

Thus, from both explanation (straw bale and soft clay) was shown the ability of that agricultural waste product was gave benefit to construction industry itself. In addition, besides that benefit, it also was reduce the pollution to environment if that waste not fully utilized to other industries and can generate profit related field in agricultural sector.

5. CONCLUSIONS

As conclusion, sustainable development is important aspect that all of us need to consider to better future about our world. Normally, if we want something we need to scarify something. It same in development, nowadays we can see the rapidly of development was created other problem regarding about the waste. Sometimes industrial and agricultural waste can be recycle to main function of production and most all that wastes is non–biodegradable form. Thus, one of the solutions is reuse that wastes as a sustainable construction material. From the explanation above, industrial waste can be beneficially in road and highway construction. Example of the waste that can be used as material are fly–ash from thermal power plants and other coal fired industries, blast furnace slag from steel industries, cement kiln dust from cement related industries, phosphogypsum from phosphatatic fertilizer industries and others related solid waste. So, the beneficially is not mere to that industry but in same time was gave good impact to related industry. While, agricultural waste also was contribute beneficially to construction industry in term of producing related material such as straw bale as organic and natural building insulation made from rice, wheat, rye, flax, barley and oats. Besides that, soft clay also was used as one of admixture or material in order to improve the strength of cement that made from agricultural waste for construction industry. Thus, we can see the high potential of both wastes in construction industry in order to achieve the sustainable development as green construction solution to solve existing problem from the development of industrial and agricultural itself.

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