Review of rice husk ash effect in sustainability of materials and environment

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Growing process of construction types in the current age in many countries, especially Iran, comes with consumption of building materials increase and after it, the destruction of the environment. On the head of construction materials, there is the most consumed material namely concrete. Approximately per person in the world, annual, One ton of concrete (consisting of sand, water, seed materials and cement) are produced and producing of Portland cement-manufacturer part of concrete-in addition to consuming fossil fuels and coal leads to production of unwanted greenhouse gases and fine-grain materials. On the other hand with the increasing of people needs the amount of agricultural waste is added constantly, while one of the industries that provides the efficiency possibility of these wastage is the construction industry. Thus we want to use a natural material for replacement of cement, such as Rice husk ash, with the aim of reducing fuel consumption in the production of concrete and also its more durability to the non-rebuilding, move toward advancing sustainable materials production and survival of the environment. Hence, with using comparative-analysis method, we study the effects of this valuable material in the concrete. Thus the results show that using Rice husk ash in concrete, addition to improving mechanical properties of concrete could act to reduce fuel consumption and co amount in the production of concrete. Also with using in the Northern indigenous construction of Iran and other rice producer countries help environment health with regard to sustainable transportation.

Key words: Cement, Concrete, Rice husk ash (RHA), Sustainable materials, Sustainable transportation

1. Introduction

Whereas Cement Forms major part of one of the most high consumption Construction materials Namely concrete and this product, addition to Being un Reversible And the need to use nonrenewable resources , consumed Fuel and energy to produce .On the other hand during the construction process, environment Pollution also provides with Production of greenhouse gas. [1]

Hence we intend modifying the ingredients of concrete with Looking for suitable replacement, It is clear that this material should have the Minimal ideal of concrete behavior.

After all, facing wide annual volume of agricultural wastes that are not consumed as animal feed, which always has been considered for farmers as Basic problems, until attempting to burn the waste on their agricultural lands, This not only provides environment pollution also will cause reducing land fertility In the long term. [2]

Only 12 years from 1987 to 1999 the world population has increased 20 percent, From 5 billion to 6 billion people. Along with this growth, increase of resource consumption and we will seek the social and environmental problems. From 1880 to 1996, annual consumption of Portland cement has increased from less than 2 million tons to 1.3 billion tons. This problem is much worse with the occurrence of a population estimated at 9 billion people in 2055. [3]

Overall After the vehicles and pollution caused by factories, Cement production is Greatest generation of co_2 and responsible for 50 percent of industrial co_2. [4]. However, More than 90 percent of carbon released from the concrete industry is attributed to the production of cement clinker in the cement kiln [3]. So that for each ton of cement produced, 1 to 1.25 tons of co_2 are produced [4]. The amount of co_2 released from the cement kiln is about 940 million tons in1990, this amount has reached to 1740 million tons in 2005. [5] Next disaster will be using of approximately 3200lbs of raw materials to produce 2000lbs of cement.[4]One of the available solutions in creating sustainable development, is use of natural pozzolan, Which is associated with less damage and reduce construction pollutions. Some types of this pozzolan are silica soil, volcanic ash and rice husk ash which provide materials with properties of cement used in concrete [1]

The first use of rice husk goes to 1924. M. until 1972 received reports show that ongoing efforts is done to use the ash from uncontrolled combustion. In 1972, Mehta in America published his first article about use of rice husk. [6] Rice husk ash is considered in a few comments, first as the mechanical performance, second, mixing durable of conventional concrete that Is included compressive strength increase, resistance Improve against chloride ion and also permeability reduce. [3] Third, This product can be considered as a promising material Due to availability And effectiveness as a pozzolan and potential to create sustainable building materials with ability of environmental damage Reduce. While ending of natural resources Including Cement raw materials especially near the urban centers increase the need to this important subject. [1]

2- Cement manufacturing process and energy consumption

2-1 Extraction

2-2 Mill to smaller size than 8 cm

2-3 Mixing, milling and baking that its product is clinker

2-4 Making cool the 1300℃ clinker.
2-5 Grinds again for being smaller than 4cm
2-6 Mill for the final stage of cement dust producing
Overall Energy consumption is very high in cement kilns and it is about 20-50 percent of clinker weight and its cooking time is 18-25 hours, depending on the cement plant and used machinery. In other words Thermal energy of about 740-1600 kcal/kg clinker and Consumable electrici-

ty energy in the system is 17-25 kW/h ton of clinker, unfortunately, oil and gas are used for fuel in Cement Factory in our country. While Modern and industrialized countries produce the heat from burning trash.[7] Thus far Cement, addition to Abundant consumption of raw materials and Environmental pollution Requires a lot of energy to produce and these three reasons could be convincing to replace a percentage of it with another material.

3- Cement as generating co_2

3-1 co_2 from cement production

Overall after the vehicles and pollution caused by factories cement is the largest generator of co_2 and responsible for 50 percent of industrial co_2. [4] While Over 90 percent of carbon released from the concrete industry have been attributed to the production of cement clinker in the kiln. [3]So that for each ton of cement production is produced 1 to 1.25 ton of co_2. [4] As we know Productions of this material Provoke to Harmful effects of global warming, minerals Overuse, nonrenewable resources reduction, Regional acid rain, Water contamination and Sedimentation of streams [3]

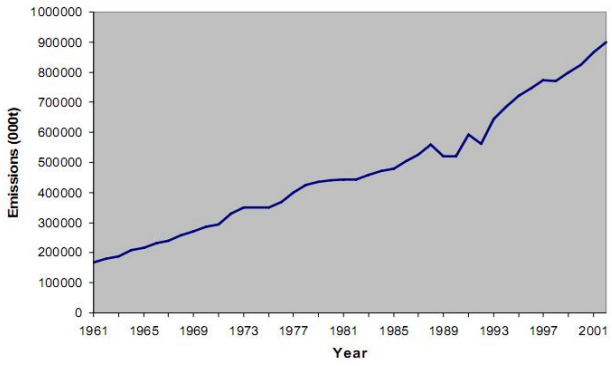

Figure1- World carbon dioxide emissions from hydraulic cement production (1961-2002)

Now Annual growth of cement production is equivalent to 8-10 percent so after that this Diagram Will happen for the future of In air co_2.[5]

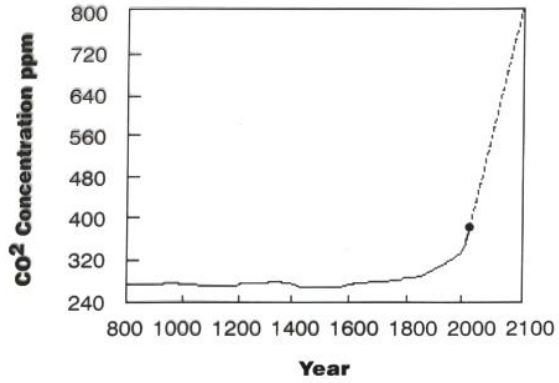

Figure2- Historic and Future Atmospheric co_2 Concentration (IPCC) [5]

3-2 three functions of the ((cement industry sustainability)) three methods has been done for co_2 levels reduction to its rate in 1990 which they are expressed in this Figure

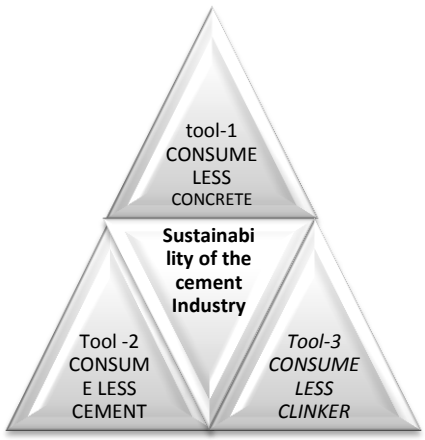

Figure3- tools for cutting the cement industry's carbon emission to the 1990 level in next 20 years. [5]

Thus Application of these 3methods in the construction industry can save huge quantities of cement and clinker, also it reduce the Produced co_2 from cement manufacturing.

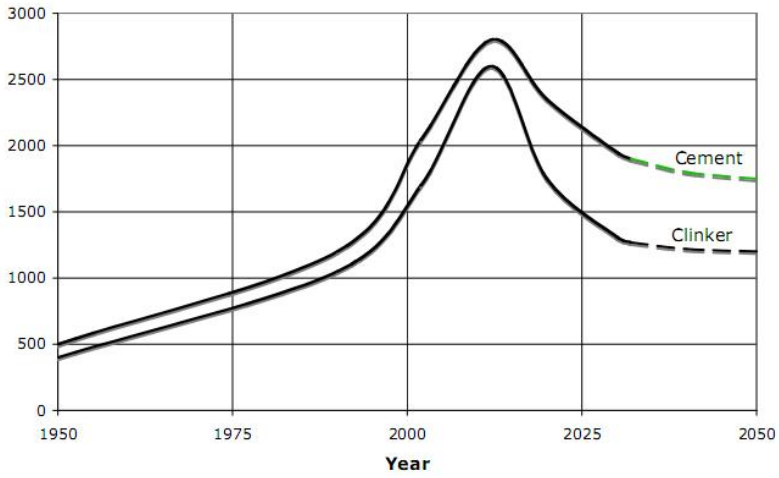

Figure4- Historic and Projected Cement and Clinker Consumption rates [5]

year	2.10	2030
Cement Consumption (million tonnes)	2800	1960
Clinker Factor	0.83	0.60

Clinker Requirement (million tonnes)	2300	1180
co_2 Emission Factor	0.9	0.8
Total co_2 Emission (million tonnes)	2070	940

Chart 1-A Roadmap for Reducing Global Cement Consumption, and co_2 Emissions from clinker production [3]

4- Agricultural waste

In Iran and some countries the major uses of agricultural waste are, animal feed and as fuel in factories like brick plant or rice mill and... In many cases, farmers attempted to burn these additional appearance materials. That this leads to Environmental Pollution and in other hand reduces the fertility of the ground. It also caused soil and water acidification, thus soil pores will be bigger, organic matters Disappears and consequently, it caused crop productions reduction. But in recent years with the rapid progress of human in technical and administrative issues in building Section and with conducted research about building materials and employing natural materials and Strengthening and improving the synthetic building materials, has been done innovations, new and very useful initiatives. One of the Best Approaches is Burn and cinder waste agricultural products such as skins and stems of rice (Annual production of 40,000 tons in the world and finally replacement of approximately thirty to forty percent instead of cement in concrete production. [3]

World production of rice husk ash is Growing and will be available without any charge. Overall Annual harvest of rice is estimated equivalent to 500 million tons and as regards 20 percent of each grain is its husk and 20 percent of this husk is ash weight so annual production of rice ash shell will be 20 million tons. [3]

5- Rice husk as fuel

Rice husk as an alternative to fossil fuels Will have the ability to save 20 percent energy.[3] Burning rice husk in addition to problem solution of husks Destruction Can be introduced as a resource for energy production that Has very high potential energy. This product is one of the most accessible materials and in other hand the most commonly used of them as an ideal fuel for electricity production. [8] Thus generated heat by burning one ton of rice husk is equal to generated heat of 360 kg oil or 480kg coal. [9] On the other hand all these Burned husks, have performance of mixing with cement clinker. [3]

5-1 Rice husk ash content

Silica is forming the main part of rice husk ash. Table… shows an example of rice husk ash Ingredients, so it can be the efficient of economically with such a rich content of ash and its silica, So not only can achieve a combined value but this action can solve huge problem of husks. [3]

٪Amount	Element
Silica (Sio_2)	80-90%
Alumina	1-2.5%
Ferric oxide	0.5%
Titanium dioxide	Nil
Calcium oxide	1-2 %
Magnesium oxide	0.5-2.0%
Sodium oxide	0.2-0.5%
Potash	0.2%

Chart 2-Composition of Rice husk ash on dry basis [3]

5-2 Production Method

According to Professor Ramazan poor Researches, cement quality of rice husk ash is totally depend on its production methods so it be required using special furnaces that can guarantee conditions and burning under control, Special furnace built in Amir Kabir University has the ability of rice husk ash production with different qualities that its optimum temperature combustion for it is 500-650° and its time is 2-4 hours. [6]

It is ideal that rice husk ash and lime be shattered together in crusher, but this mixture has very short life and should be consumed within 15 days. [10]

In optimum conditions, generated heat by burning each ton of rice husk is equal to generated heat of 360 kg oil or 480kg coal and rice husk ash production furnace only has a combustion flame Starter and this act does not require cooking because as we know, the burning operation only needs oxygen to continue.[6]

6- Application of rice husk ash by Features

As mentioned one of the main applications of rice husk ash is cement replacement in concrete as a pozzolan

In the past this system was considered for small scale projects. [3]

But now silica steam could be replaced by rice husk ash in super strong concrete, Steam silica or micro silica is the most common mineral used in concrete mixtures. Replacing 35 percent rice husk ash increases concrete Compressive strength due to the high percentage of silica. Strength

of cement containing rice husk ash against acid attack Increases Compared with conventional cement, Thus it can be used in buildings that are exposed to acid attack. On the other hand replacing10 percent of Portland cement with rice husk ash can increase resistance to chloride ion. [8]

Adding rice husk ash suitable as pozzolan material is effective in enhancing concrete durability against acidic environment and reduces concrete Ruination reinforcement and also has beneficial role in soil stabilization And construction of cement and concrete blocks and even fine brick and concrete insulation.[11]

Other applications of this material are in self-compacting concrete production. Self-compacting concrete as one of the significant advances in concrete technology has been introduced in recent decades. This concrete is produced in the way that require no internal or external vibrator, Compressed under its own weight effect, while it is poured in the mold it flows like honey and only the mold is filling with the help of gravity, covers the Reinforcing and at the same time maintains its uniformity. In concrete to achieve the appropriate admixture with high stability, is required a higher volume of powder material than conventional concrete, powder materials in self-compacting concrete are mainly including the composition of micro silica additives, such as rice husk ash and also using rice husk ash can dramatically increase the compressive strength of self-compacting concrete, Advantages of this method Reduced permeability, More lifetime of molds, shorter construction time the better level of finished work, Vibration using reduction and also remove the noise pollution caused by vibrator. On the other hand today, making fine self-compacting concrete with used significant weight reduction In structural members reduced the force of earthquake.

7- Sustainable Transportation

Considering the massive production of rice in the northern parts of the country and some other areas with attention to the amount of fuel to transport materials can be acknowledged that the use of rice husk ash in rice business areas would be useful in order to apply local materials and to achieve sustainable transport.

Energy for 100 km movement	unit	Construction material
200	m^3	Brick
175	m^3	Sand
100	Tone	Cement
100	Tone	Steel

Chart 3- Energy for 100 km movement [10]

8- Conclusions

Using rice husk ash in urban construction in addition to several positive characteristics is also following with the environmental pollutants factors reduction and helps to environmental sustainability.

1-Rice husk ash a material with no abrasion in nature and like non-beneficial materials that farmer damages the environment by burning it in agricultural land, Now can be effective Pozzolanic take steps to protect the environment .

2- Using this material as a pozzolan in concrete construction can be a 40 percent benefit from nothing .In addition to applying this technique than ordinary concrete production, save a great amount in consumption of fossil fuels and electricity.

3-Production of resistant product against abrasion, acidic and exposure to chlorine ions environments will guide us in order to avoid re-creating for having healthy environment.

4- Applying this material in the northern cities and some areas with rice implant in our country (IRAN) with regard to sustainable transport and fuel consumption reduction for transportations we will work toward achieving sustainability in nature.

5- Using of rice husk ash in self-compacting concrete production has these benefits:

Permeability reduction, more lifetimes of molds, shorter construction time, the more flat level of finished work, reduction of vibration using and removing noise pollution caused by vibrator and also the production of lightweight concrete that will lead to earthquake force reduction on the building.

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