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UTILIZATION OF WASTE OF THERMAL POWER PLANTS INBRICK MANUFACTURING INDUSTRIES APPLYING QUALITYPLANNING

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Abstract: *Generation of flash from thermal power plants(TPPs)is in table. Due to increase in population and urbanization, managing Solid Wastes of TPPs like fly ash are becoming a major challenge in many cities of developing countries. The common way to utilize this industrial waste is to go for construction area. Fly ash is used in many ways, but its use of it in the brick industry is still rarely seen. It may be due to lack of awareness along with the quality features of the fly ash-based brick. This paper proposed a quality improvement planning solution. technological and management framework that will offer a new idea for design and development of fly ash based brick towards proper utilization of solid waste of thermal power plants and also save our environment by reducing Green House gases. Experimental result s confirm the correctness of the proposed model.*
Keywords: Solid Waste, Fly Ash Quality, Quality Planning.

1. Introduction:

The entire development of a country depends on its energy production and consumption. InIndiacoalisthemainsourcesofenergy.Ithasbeenestimatedthat80%ofIndia'stotalinstalledpower is thermal whichconsumed686.34 million tons of coal[1]

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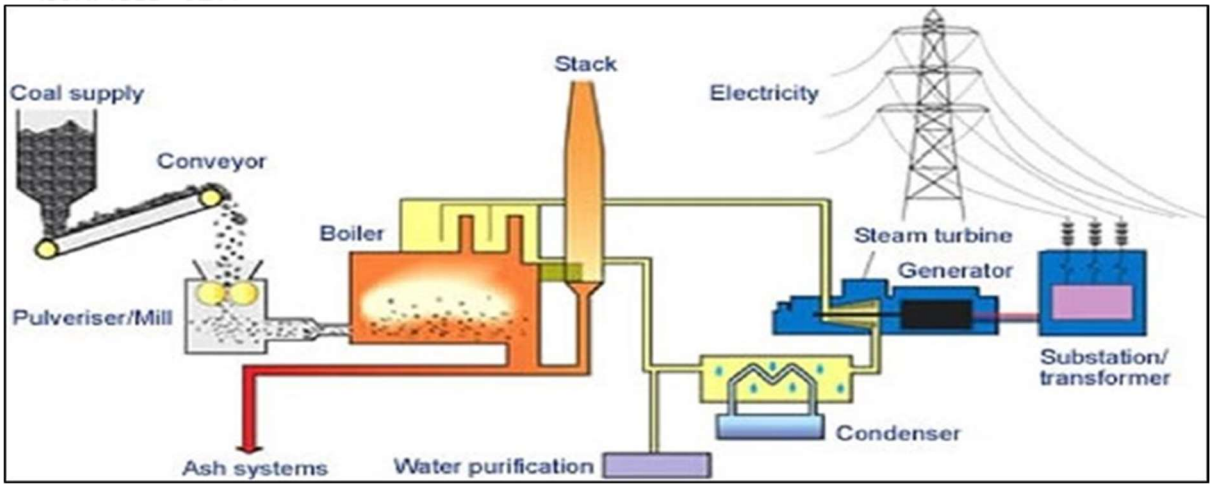

Fig.1 Shows how coal is converted to electricity [2]

Fly ash a coal combustion residue of the thermal power plant has been regarded as a problematic solid waste all over the world. Waste management is now one of the topmost issues to deal with as waste is increasing day by day with population expansion and urbanization. The need for managing this increasing fly ash – solid waste of thermal power plants (TPPs) is very crucial in an environmentally effective, economically, affordable, and socially acceptable manner. The common way to utilize this industrial waste is to go to construction areas. Fly ash is used in many ways, but its use in it in the brick industry is still rarely seen. It may be due to a lack of awareness along with the quality features of the fly ash-based brick.

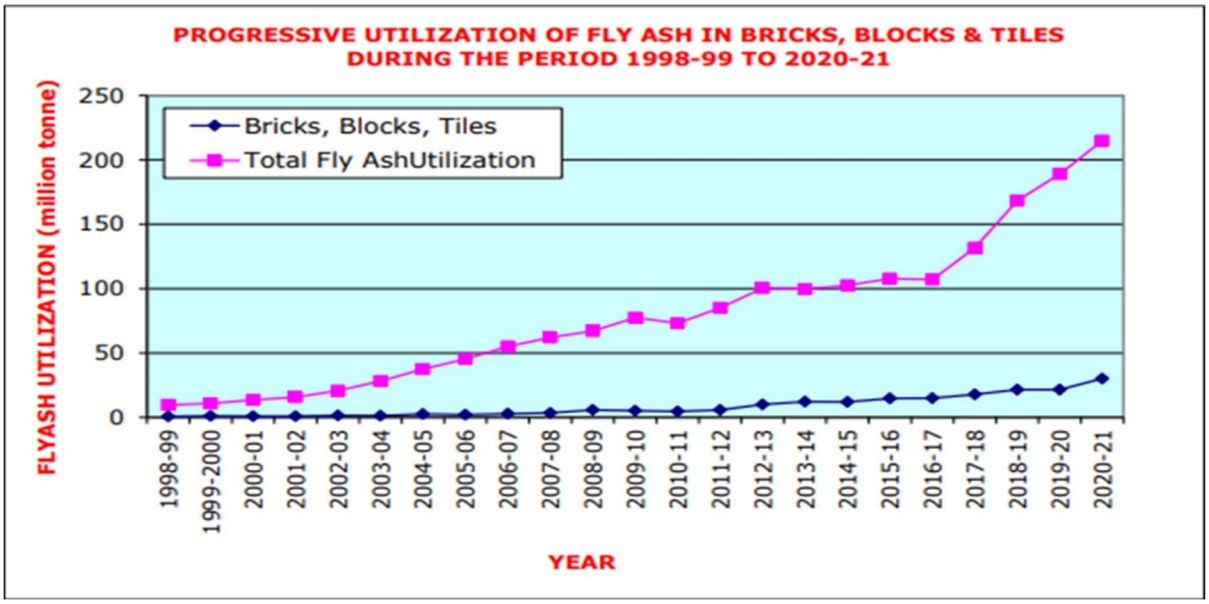

Fig.2 Percentage of fly ash utilization for bricks, blocks, and tiles industries (CEA report Aug,2021) [1]

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2. Motivation and contributions:

Quality planning is a rapidly exploring research area in the field of waste management. Proper quality planning can select the right way to produce quality fly ash-based bricks as well as increase the utilization of fly ash to protect the environment from causing pollution.
The major contributions of this paper are summarized as follows:

i. To explore fly ash-waste of power plant can be utilized in brick manufacturing
i. industry.
ii. To do a detail analysis of the different quality improvement techniques in order to
iii. illuminate quality management process.
iv. To clarify how Waste like fly ash could bring more value to brick industry.
v. Proper utilization of fly ash to protect the environment from causing pollution.

3. literature review:

3.1 solid waste:

Degradation of the environment is among the key problems of today's life. A need to protect our surroundings and the environment has become more important than anything else [3].According to Proc. No. (513/2007), "Solid Waste" means anything that is neither liquid nor gas and is discarded as unwanted. Solid waste management is a challenging task not only in developing countries but also in developed countries. However, the generation of solid waste is one of the important contemporary environmental problems in urban areas [4]. Solid waste is referred to the used and leftover materials comprising domestic solid waste (solid waste generated by households), industrial and commercial solid waste (solid waste produced by shops, hotels, offices, and hospitals), construction and demolition waste, and marine waste (solid waste generated from coastal zonesandsea)[5]. Solid waste management is a huge task and it needs organizational capacity and cooperation between the private and public sectors [3]. The solid waste handling hierarchy is internationally accepted and recommended and the following ascending order of preference are; open-burning, dump, landfill, incinerate, recycle, reuse and prevent. While open burning and dumping are the least preferred and not recommended even though many undeveloped countries are highly used [6]. For Proper handling of solid waste and to reduce the amounts of discards at the source, the "Zero WasteTheory" are essential as far as municipal solid waste management is concerned. Although, "Zero Waste Theory" takes the 3R's (Reduce, Reuse, and Recycle) into consideration for the effective management of solid waste [7]. Proper recycling or reusing would add conservation of species due to unnecessary clearing of forests and vegetation above the mineral resources[8].

3.2 Fly Ash:

In 2007, Sharda Dhadse et all carried out a study on" fly ash characterization, utilization& government initiatives in India- a review," which describes that Fly ash quality depends on

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coal, coal particles fineness, percentage of ash in coal, combustion techniques used, air/fuel ratio, burners used, and type of boiler [9].

ArchanaA., Uparwalet. al. studied the advantages of green building. They reported fly ash as an eco-friendly building material. Fly ash is a pollutant but when used as a building material is eco-friendly. Fly ash can be used for making a variety of building products some using simple low-cost processes and other [10].

OzlemCelik et. Al. (2008) studied the characterization of fly ash and its effects on the compressive strength properties of Portland cement. The author said that granulometry and fineness of fly ashes have an important effect on mortar strength. Fine particles behave as nuclei initiating and accelerating the hydration reactions [11].

A Das (2009) in his studies on the Strength Characterization of fly ash composite material said class C has some self-cementing properties which in the presence of water will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). classic fly ash is pozzolanic and contains less than 10% lime (CaO). Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water to react and produce cementations compounds[12].

Fly ash can fill the gap between different particle sizes, creating a more compacted concrete structure, while the micro aggregate formation can also significantly enhance slurry hardness. Studies indicated that the ash plays an important role in achieving good compressive strength[13].

Quality Management:

The Business Roundtable construction industry cost-effectiveness study concluded that the primary causes for the decline of construction productivity are direct login directly y involved poor management practices [14]. Since quality is part of productivity, the first step for management is to recognize that there is a problem. Jur and e fines quality as "Quality is cust overstays faction" or "Fitness for use". He considers quality management as three basic processes: quality planning, quality control, and quality improvement[15].

Feigenbaum defines quality as the "total composite product and service characteristics of marketing, engineering, manufacture, and maintenance through which the product and service in use will meet the expectations of the customer" [16]. Ishikawa defines quality as the "development, design, production and service of a product that is most economical, most useful, and always satisfactory to the consumer"[17].

4. Scope:

As huge amount of fly ash is generating as an industrial by-product, this research is aimed at finding out the utilization of such industrial products for value-added applications in the

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development of bricks by analysis and developing quality plans and helps to solve the environmental problems.

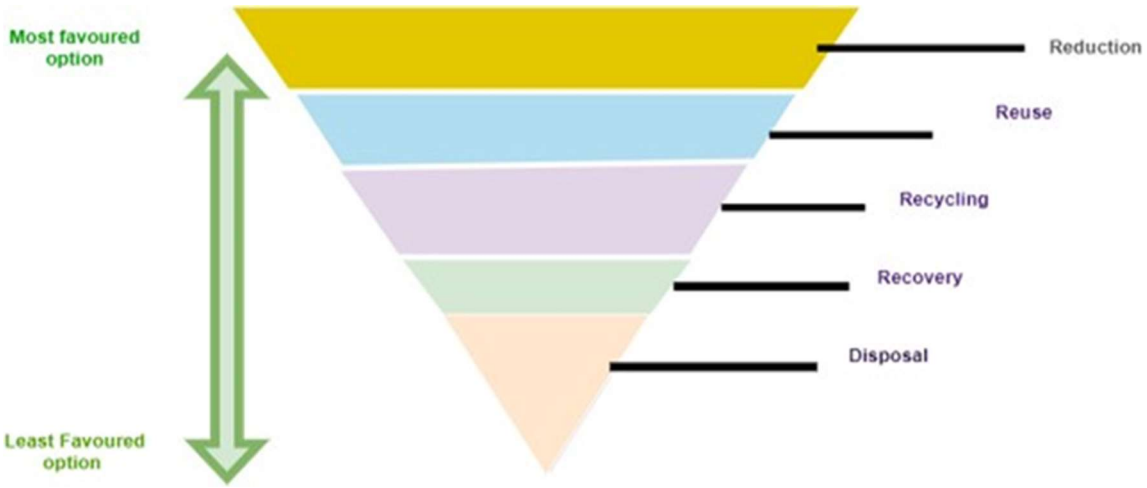

Fig.3Types of Waste management

5. Problem:

Different origin of coal and different plant operating conditions leads to variation in the quality of fly ash. Though fly ash is the main ingredient of the fly ash-based brick industry so it is very important to check the quality of the fly ash once we have received it from supplier/ TPPs. The quality of the brick may be in the creaser decreases in the quality of the fly ash.

6. Fly Ash: Waste to Resource:

Due to rapid population growth, improved living conditions, economic development, and urbanization, the quantity of fly ash from Thermal Power Plants (TPPs) is increasing day by day. Currently, the generation of fly ash is 232.56 million tones. Fly ash contains large amounts of SiO2, A12O3, and CaO, Fly is a pozzolanic material and due to its cementation properties, it can be one raw material of brick production. The physical, mineralogical, and chemical properties of fly ash will strongly affect the performance of brick.

7. Methodology:

Fly ash cannot react with water [19]. But when it mixes with water in presence of lime, it enables it to trigger off its pozzolanic properties. Hydration leads to a long life of the brick. The utilization of fly ash as the main raw material in the manufacturing of bricks will not only create example opportunities for its proper and useful disposal but also help in environmental pollution control to a great ere tent in the ensure rounding areas of power plants[20].

8. Analysis:

The quality of bricks mainly depends on:

i. Quality of the raw materials.

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ii. Proportioning of the raw materials.
iii. Handling & mixing of raw materials.
iv. Handling & pressing of the raw materials.
v. Curing of the finished product.

The carbon content in fly ash depends on the quality of the coal and the nature of the boiler. High carbon content in fly ash will reduce or slow down the chemical bonding with other ingredients of fly ash brick, which after ascertain time decreases the compressive strength of fly ash brick. As per IS 3812 Part 2, max permissible carbon content in fly ash is 5%. The unburned carbon can absorb air entraining admixtures and increase water requirements [21]. High carbon content is believed to interfere with the hydration reactions, as well as reduce the workability and increase the water demand when used in concrete or bricks[22].

On the other side, when fly ash mixes with water in presence of lime, it enables to trigger off its pozzolanic properties. The utilization of fly ash in brick production is gaining immense momentum due several reasons. Particle above 45 microns is considered inert. They behave like sand particles. It has been reported that the particles below 10 microns govern the fly ash activity [23]. The fineness by wet sieving is done according to IS460:1962 and Blaine's air permeability test for knowing the surface area is done according to IS 1727: 1967.

According to IS code 13757:1993, minimum compressive strength required for any brick-

i) 7.5 N/mm2or 75kg /cm2: 2ndclass Brick
ii) 10.5N/mm2or 105.84kg /cm2:1st class Brick.

8.1 Calculation of strength:

Target strength accordingtoIS:10262.2009

$$f'ck=fck+Ks$$

$$=7+1.65x3.5$$

$$=13N/mm2$$

Where,
$f'ck$=target average compressive strong that 28 days
fck=characteristics compressive strength at 28 days,
s = standard deviation [M5– M15 standard deviation is 3.5]K=constant, for 5%defect it is 1.65.

8.2 Statistical analysis:

The fineness of fly ash can be determined by the Residue analysis test and also by the Blaine air permeability test. According to IS 3812 Residue on a 45-micron sieve is 34% maximum and the surface area should be a minimum of 320 m2 /kg. Based on the quality and combustion

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process of coal, the quality of fly ash is varying. To analyze the relationship between fineness through the Sieving and Blaine air permeability apparatus, we use the mathematical correlation procedure. To find out the correlation between two test results of fineness, we go for Rank correlation (R).

Table1Rank Correlation sample data details

Sample	sample. no	Residue(x)	SSA(y)	d= (x-y)	d^2
Fly Ash	1	43	200	-4	16
	2	30	340	1	1
	3	55	230	-4	16
	4	25	380	4	16
	5	27	390	4	16
	6	34	330	-1	1
	Total	**214**	**1870**		**66**

$$\text{RankCorrelation(R)} = 1 - \frac{6\sum d^2}{n^2(n-1)}, \quad [\text{wherethetotalsumvalueofd}^2 = 66, n=6]$$

=-0.88.

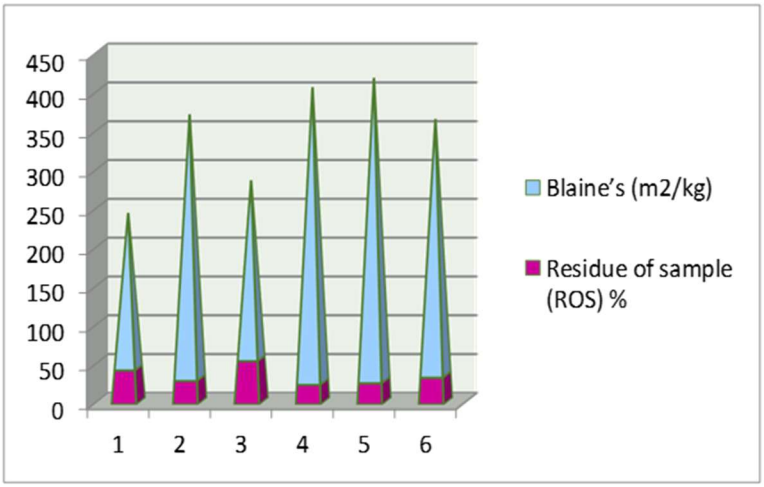

Fig.4 showing the relation between ROS and Blaine's of Fly ash

The correlation value of risk and king between-1<-0.88<1whichmeansROS value and Blaine's value of fly ash have partial negative relation as r are negative (-0.88). Comparative analysis in fig. 2 shows that our proposed method succeeded to analysis the quality of fly ash. It shows that when residue is less it is expected that Blaine surface area will be high and when residues high

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then surface area may be less. Though residue analysis is optional for fly ash tests but it must be do for every sample of fly ash. On the other hand, specific gravity analysis helps to know the physical nature of the fly ash.

9. Performance evaluation:

9.1 quality management:

The aforementioned statistical analysis shows their results are within the desired or expected limits of the quality dimension. It shows a positive impact on the overall aspects of the Fly ash-based brick industry. Accordingly, Quality conformance of Fly ash brick is its standard, specifications, and procedure of production. For every manufacturing industry, quality control is an integral approach. The quality of fly ash brick should be control and maintained at every stage of manufacturing right from the raw material to the finished product.

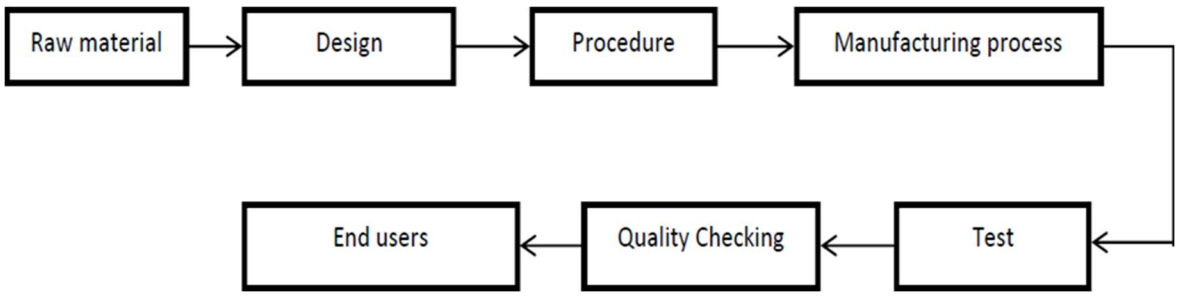

Fig. 5 Regular Quality checking process

9.2 Quality Planning:

Quality plans and policies of fly ash based-brick industry is not only important to improve the quality of the brick but also an important function to keep the plant and machinery operative. To get the targeted compressive strength of FAS-C brick, quality of every raw material is significant, but also crucial to be carried out production uninterruptedly and efficiently. If there are frequent rejection comes out from the users due to quality problems then the Fly ash brick industry will face lots of adverse effects in due course of time.

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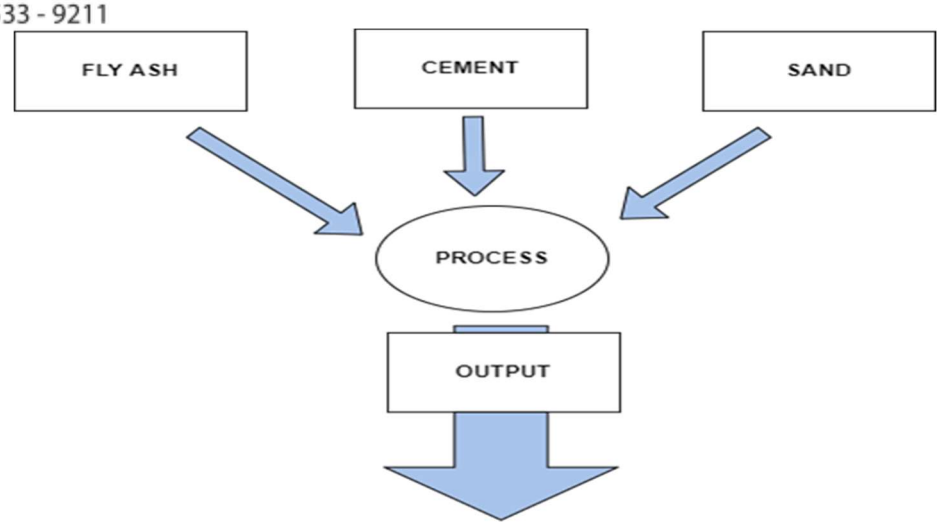

Fig. 6 Input-process-output

The main mechanism of any manufacturing process is to have the right materials in the right quantities available at the right time to run the process uninterruptedly. The production of any factory starts with production planning. But it depends on their source planning i.e., the various raw material required for Fly ash bricks. Production planning is very much dependent on demand management as well as material management. So quality improvement plans and policies for the flash-based-brick industry are important as it provides a means to that industry in respect of every point. Maintenance of quality of fly ash brick and improvement of different policies will help the Fly ash based-brick to gain market growth and also enhances the awareness among the people. There is a huge relationship between Quality control or maintenance of Fly ash based-brick and productivity.

10. Proposed method:

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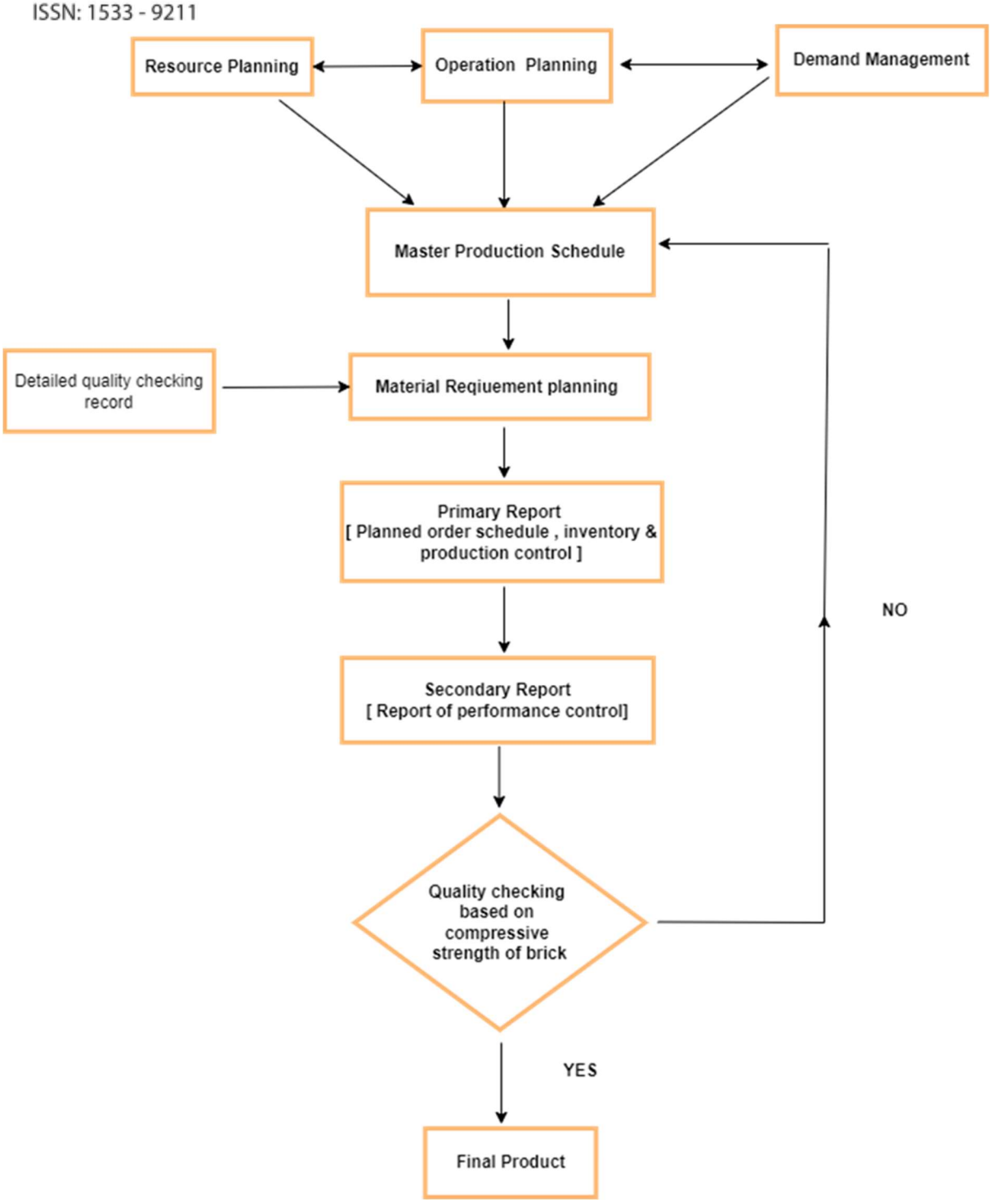

Fig.7ProposedModel

A model has been proposed to improve the Quality aspects of the fly ash bricks manufacturing industry. The Production unit generally starts with operation planning that in turn depends upon the resource planning and demand management. The Production unit totally moves on with the master production schedule proper and effective implementation in a purposeful way.

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The Master Production Schedule (MPS) is the main area of concern for any manufacturing industry. Its success depends on proper and effective production planning. When the concerned Brick manufacturing industry is going for MPS, first primary report i.e., the planned order schedule for inventory and production control is looked into. After the concern report, the secondary report mainly looks into performance control. The further process continues with quality checking of the brick, if it meets the desired standard, it goes for the final stage but if it does not comply with the desired standard of quality, then it is again returned for the initial stage's., primary report for further critical examination.

11. CONCLUSION:

It may be concluded that the thermal power plants are producing huge energy that is being utilized for the growth of our economy. But side by side, these thermal power plants wastes are causing environmental pollution. The proper utilization of those fly ash wastes from the Thermal power plant is going to help the society in minimizing its evil effect due to pollution. This important aspect has been looked into via this research paper at the utilization of the fly ash in a positive aspect for the development of mankind and civilization, In this regard; Quality planning can be used to explore research areas in the field of waste management. Proper planning can select the right way to produce quality fly ash-based bricks as well as increase the utilization of fly ash to protect the environment from causing pollution. It has been observed during the research that the construction industry cost effectiveness study concluded that the primary causes for the decline of construction productivity directly or indirectly involved poor management practices. As a huge amount of fly ash is generating as an industrial by-product, this research is aimed at finding out the utilization of such industrial by-products for value-added applications in the development of bricks by analyzing and developing quality plans and helps to solve the environmental problems. The carbon content in fly ash depends on the quality of the coal and nature of the boiler. High carbon content in fly ash will reduce or slow down the chemical bonding with other ingredients of fly ash brick, which after a certain time decreases the compressive strength of fly ash brick. The fineness of fly ash can be determined by the Residue analysis test and also by the Blaine air permeability test. Based on the quality and combustion process of coal, the quality of fly ash is varying. Quality plans and policies of the fly ash-based-brick industry is not only important to improve the quality of the brick but also an important function to keep the plant and machinery operative.

To get the targeted compressive strength of FAS-C brick, quality of every raw material is significant, but also crucial to be carried out production uninterruptedly and efficiently. The main mechanism of any manufacturing process is to have the right materials in the right quantities available at the right time to run the process uninterruptedly. The production of any factory starts with production planning. Bu tit depends on their source planning i.e., the various material required for Fly ash bricks. Development of bricks by analysis is and developing quality plans and helps to solve the environmental problems.

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