

# A RESEARCH ON THE EVALUATION OF LOW-VOLUME WASTE MATERIALS IN INDIA

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## ABSTRACT

*An overall temperature change and ecological devastation have transformed into the main problem starting late. Outpouring of host of ozone harming substances from modern strategies and its hostile effect on air has changed the attitude of people from the enormous scope fabricating, mass-usage, mass waste society of the past to a zero-release society, use of mechanical squanders and insurance of common assets. Country streets are essentially ease streets; the details for black-top materials in various layers should be as practical as could be normal in light of the current situation, dependable with the development foreseen that would use the street and the climatic condition. In this point, the local materials which are less expensive and incorporate least haulage should be used to most outrageous degree conceivable. In show circumstance safe removal of different squanders made from Industries is an inconceivable issue. These materials cause natural tainting in the locale considering the way that an impressive part of them are non-biodegradable. Starting late, mechanical squanders have been used in street development in making countries. The usage of these materials in street making relies upon specific, monetary, and environmental models. The nonattendance of standard street materials and the protection of the earth make it fundamental to investigate the possible use of these materials intentionally. India has a tremendous arrangement of organizations arranged in different pieces of the country and various more are prepared for the not all that far off future. A couple million metric tons mechanical squanders are conveyed in these establishments. By and large soil, stone totals, sand, bitumen, concrete, etc are used for street development.*

**Keywords:** *Squander Material, Low Volume Roads, Ecological, soil, stone totals, street development.*

## 1. INTRODUCTION

Regular materials being unassuming in nature, its sum is declining continuously. Moreover, cost of isolating extraordinary nature of regular material is growing. Worried about this, the analysts are looking for elective materials for freeway development, and modern squanders thing is one such class. In case these materials can be sensibly used in road development, the pollution and removal issues may be deficiently diminished. Without various outlets, these strong squanders have included a couple of segments of place that is known for land around plants all through the country. Recollecting the necessity for mass use of these strong squanders in India, it was thought useful to test these materials and to make details to improve the use of these modern squanders in street making, in which higher pace of benefits may be possible. The possible usage of these materials should be made for development of low volume streets (Rural streets) in different pieces of our country. The fundamental details should be figured and tries are to be made to amplify the usage of strong squanders in different layers of the street black-top. Post development black-top execution analyzes are to be improved the circumstance these waste materials for development of low volume streets with twofold preferences: (an) It will help away from place that is known for enormous dumps of squanders; (b) It will similarly shield the regular stores of totals, as such guaranteeing the earth.

Materials, for instance, fly-debris from warm force plants and other coal ended endeavors, impact heater slag from steel organizations, concrete broiler dust from concrete related undertakings, phosphogypsum from phosphatatic compost adventures, and various other strong squanders have adequately ended up being useful for street development in various countries. Force stations, using coal like fuel are the world over. Vitality sources and accordingly high measures of fly cinders are these days delivered. Right when pulverized coal is singed, each coal particle encounters reactions self-governingly, assortments in showed consuming conditions to which each coal atom is introduced to and the capability of start that is exposed to make fly debris heterogeneous material. Thus the synthetic arrangement of fly debris depends on the wellspring of coal and similarly on working boundaries of the boilers as such changing from source to source. Only a little bit of these remains are used adequately rest of the debris is dumped as land fill in various spots. The removal of the fly debris which is a certified danger to the earth eats up an enormous number of rupees towards the expense of its removal.

## 2. HIGH STRENGTH CONCRETE:

Concrete is called as "high-quality cement" based on its 28 days compressive quality. High quality cement (HSC) is characterized as a solid with a trademark quality between 60 - 100 MPa, in spite of the fact that qualities higher than 100MPa have just been accomplished and used. Compressive quality degrees of 80MPa and more can be used for both precast and in-situ solid work. According to ACI 363 cement having 28days compressive quality of more than 41 MPa is considered as high-quality cement. For the most part, super plasticizers common pozzolana silica seethe, etc., are used to accomplish high-quality in concrete by keeping water folio proportion at lower level. Shannag have used normal pozzolana and silica smoke to make HSC of 69 MPa to 85 MPa at 28 days with medium usefulness. For creating high quality cement (HSC), use of FD (foundry slag) as trade for normal ordinary total in concrete has likewise been accounted.

In tall structures, HSC has been gainfully used in numerous countries. A tall structure reasonable for use of high-quality cement is taken into thought to be a structure in excess of 30 stories as showed up in figure 1. Not simply, these extraordinary cements have made such undertakings feasible due to stack limit, it has furthermore took into consideration the decline in the proportion of fragments and light emissions parts. Lessening in the proportion of solid people, additionally achieves bringing down dead loads which again achieve diminishing the heaps connected with establishment plan. Moreover, owner's preferred position monetarily from the amount of rentable floor region, commonly on the lower floors, increments as the space required by the segments decreases. HSC is generally used in the development of street extensions and fly-overs. HSC permits the fortified or pre zeroed in on solid braces to traverse a bigger number of lengths than ordinary solid supports having typical quality. Likewise, increment in the individual support limits may have the ability to lessen the amount of braces required. Along these lines, a financial increase is made for solid creators, with the objective that solid is raised to be used in a specific augmentation venture instead of steel.

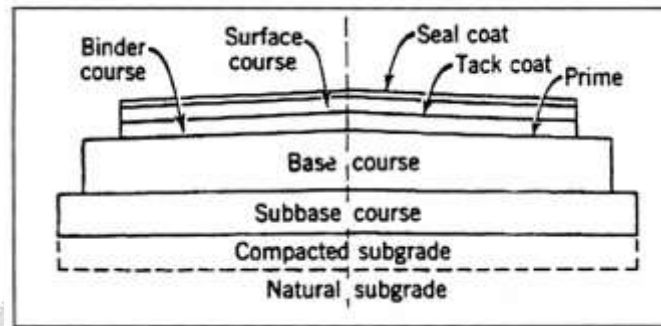


**Figure 1: Applications of High Strength Concrete**

## 3. SOIL SUBGRADE STABILIZATION:

The workableness and life of any street is identified with plan of asphalt structure, which depends upon the quality of the current soil sub-level. Sub-level is lower most fragment of the asphalt zone which frames the establishment of the asphalt structure. Layer thicknesses for different layers of adaptable asphalt are illustrated based on California

Bearing Ratio (CBR) estimation of the dirt sub-grade for most observably terrible dampness condition as per IRC: 37: 2012. Past variations of IRC recommended asphalt setup dependent on multi day drenched CBR estimation of the characteristic sub-grade. Nevertheless, as of late delivered IRC: 37: 2012 recommend to plot the asphalt based on multi day doused CBR estimation of the balanced out and compacted sub-grade or successful CBR of compacted sub-grade comprised of select acquired soil. At any rate the thickness of compacted sub-grade will not be under 500 mm.



**Figure 2: Flexible Pavement Structure Terminology**

### 3.1 Techniques of Soil Sub-grade

Adjustment The sub-level contains unbound earth materials, for instance, rock, sand, buildup, and mud that impact the arrangement and development of streets. The evaluation of properties of soil sub-levels, the extent that thickness, soil solidness, CBR quality is crucial in the blueprint of streets, and their exhibition. Sub-level has a significant influence in giving auxiliary dependability to the asphalt structure as it gets loads constrained upon it by street traffic. Traffic burdens ought to be sent in a way that the sub-grade disfigurement is inside versatile limits, and the weights and strains made are inside safe cutoff focuses under unfriendly climatic and stacking conditions. The dirt sub-grade flops fundamentally due to over the top rutting disappointment if the bearing limit of the sub-grade is powerless. Feeble soil sub-levels having doused CBR esteem under 4 percent are the reason for stress of the asphalt engineers. Doubtlessly the asphalt section can be expected for low CBR esteems anyway the more thickness essential for base and sub base courses request more noteworthy amount of granular and high CBR (more than 30) materials which lead to obtaining and fatigue of characteristic granular stores. Thusly to meet the expanded vehicular traffic and overly substantial pivot load arrangement it has ended up being practically compulsory to improve the CBR quality of the sub level or to build the asphalt thickness. Asphalt engineers have seen the long stretch focal points of expanded quality and toughness of asphalt sub level by settling and fortifying it during the development of another street asphalt or during remaking for broadening of existing street portion. In India there are enormous assortments of soils that occur in the sub level of street asphalts. Soil settling and fortifying innovations have been broadly used during the recent decades to reinforce the dirt. Soil adjustment is the path toward mixing and blending materials in with a dirt to upgrade properties of the dirt. The technique may incorporate the mixing of soils to accomplish a pined for degree or the blending of economically accessible added substances that may modify the degree, surface or versatility, or go about as a folio for cementation of the dirt.

### 3.2 Potential of Fly Ashes Stabilization:

Fly Ash is the waste thing from warm force plants. It is one of the different substances that cause air, water and soil sully. Fly debris can upset the biological cycle and make ecological dangers if it isn't appropriately masterminded off. The start of powdered coal in warm force plants produces fly debris. The high temperature of consuming coal turns the dirt minerals bring in the coal powder into merged fine particles predominantly containing aluminum silicate. Fly debris has both fired and pozzolanic properties. Exactly when pulverized coal is scorched to create heat the development contains 80 percent fly debris and 20 percent base debris. The debris is diverted by pipe gas at electro static precipitator. Clinkers create debris accumulated in the water appropriated container beneath the boilers are named as base debris. Fly debris is characterized by the sort of coal from which the debris is gathered. As per ASTM C-618 fly debris is comprehensively arranged into two significant classifications: Class C and Class F fly debris. Class C fly debris is gotten from consuming of lignite or subs bituminous coal and is frequently implied as high lime debris since it contains a high level of lime commonly more than 10 percent. Class C fly debris is self-

receptive or cementitious within the sight of water, notwithstanding being pozzolanic. Class F fly debris is gotten from the consuming of anthracite or bituminous coal and is additionally implied as low lime fly debris, having lime content under 10 percent. Class F fly debris has pozzolanic properties, and contains shiny silica and alumina. It requires a solidifying specialist, for instance, Portland concrete, quicklime or hydrated lime with the presence of water so as to respond and convey cementitious mixes. Expansion of substance activator, for instance, sodium silicate (water glass) with class F fly debris prompts the development of a geo-polymer.

### 3.3. Fly Ash Mission of India:

The Government of India through the branch of Science and Technology has started the Fly Ash Mission under TIFAC (Technology Information and Assessment Council), The mission proliferates different progressions in the zone of fly debris usage completed by the R and D foundations in India. Fly debris mission was approved in 1994 with Department of Science and Technology (DST) as the nodal office and TIFAC as the actualizing office, in context of by and large concern for nature and the prerequisite for the sheltered removal and compelling use of fly debris. The Ministry of Environment and Forest (MoEF), Ministry of Power, Thermal Power Stations, R&D organizations and industry together have dispatched a Technology Project in Mission Mode (TPMM). Their consideration is on the exhibit of advancements identified with coal debris for mixing conviction and thusly guaranteeing huge scope reception. A reasonable blend of push zones has been taken up for successful use of fly debris. The tasks are embraced in the zones of fly debris portrayal, taking care of and transportation, farming related applications, recovery of debris lakes, underground mine fills and usage in streets and dikes. Hard and fast endeavors are required to utilize this fly debris from natural contemplations, just as to evade land utilization for fly debris dumping. Notwithstanding the way that there has been a consistent development in fly debris use from 1990, we have far to go to arrive at the objective of 100 percent fly debris use. It is represented that the agribusiness increment of grains is around 15 percent, green vegetables 35 percent and root vegetables 50 percent, when fly debris is blended in with soil. Harmfulness tests have exhibited that there is no destructive part as a result of fly debris. Nevertheless, it has higher supplements due to expanded accessibility of iron and calcium. Fly debris can transform into a riches generator by making usage of it for delivering 'green structure' materials, streets, horticulture, etc. Full usage of the producing stock will give work potential to 300,000 individuals and result in a business volume of over Rs.4,000 crore."

### 4. ASH PRODUCTION AND ITS AVAILABILITY:

Any country's monetary and modern development depends upon the availability of force. In India moreover, coal is an essential wellspring of fuel for control age. Around 60% force is made using coal as fuel. Indian coal is having low calorific worth (3000-3500 K cal.) and high debris content (30-45%) achieving huge measure of debris is created in the coal based warm force stations. In the midst of 2005-06 around 112 million ton of debris has been created in 125 such force stations. With the current development in control division, it is ordinary that debris age will reach to 175 million ton for every annum by 2012.

Any coal based warm force station may have the accompanying four kinds of debris:

Such a debris is eliminated from vent gases through Electrostatic Precipitator in dry edge. This debris is fine material and has extraordinary pozzolanic property.

**Fly Ash:** This sort of ash is separated from flue gases through Electrostatic Precipitator in dry shape. This ash is fine material and has great pozzolanic property.

**Bottom Ash:** This sort of ash is gathered in the bottom of evaporator furnace. It is nearly coarse material and contains higher un-consumed carbon. It has zero or little pozzolanic property.

**Pond Ash:** When fly ash and bottom ash or both mixed together in any extent with the huge amount of water to influence it in slurry to shape and saved in ponds wherein water escapes. The stored ash is called as pond ash.

**Hill Ash:** Fly ash and bottom ash or both mixed in any extent and saved in dry frame in the state of a hill is named as hill ash.

Fly debris conveyed in current force stations of India is of acceptable quality as it contains low sulfur and low unburnt carbon for example less incident on start. With a particular ultimate objective to make fly debris available for various applications, most of the new warm force stations have set up dry fly debris takeoff and limit system. In this structure fly debris from Electrostatic Precipitators (ESP) is cleared through pneumatic system and set aside in storage facilities. From storage facilities, it tends to be stacked in open truck/shut big haulers or can be sacked through suitable packing machine. In the ESP, there are 6 to 8 fields (sections) dependent upon the framework of ESP. The field at the pot end is called as first field and counted in this manner 2, 3 onwards. The field at stack end is called as last field. The coarse particles of fly debris are accumulated in first fields of ESP. The fineness of fly debris particles increases in ensuing fields of ESP.

**Fly Ash:** In India coal/lignite based warm force stations represent over 55% of the power presented cutoff and 65% of power age. The proximate and extraordinary investigation of coal mined from India exhibits that the substance of debris in coal is around 40-half. Removal of strong squanders from control plant organizations that usages coal for creation stances amazing ecological issue. As indicated by the assessment of Government of India, control plants will use 1800 million tons of coal that may bring about 600 million tons of fly debris by 2031-2032 (Singh 2011). Joined with this, the decaying quality (extending debris measure) of coal is needed to upset the condition. Roughly 80% of the coal remains and metallurgical slags conveyed today wind up either in low – esteem applications, for instance, landfills and base course for streets, or basically disposed of by ponding and gathering. Removal thusly isn't simply inefficient yet moreover harmful considering the way that it adds to land, air and ground water defilement. Also these mechanical outcomes generally contain little proportions of unsafe metals. The solid development industry should be a supported.

Vehicle for their removal because a huge segment of the damaging metals can be immobilized and securely joined into the hydration aftereffects of concrete. Owing to colossal size, the solid business is reasonably the ideal home for protected and monetary removal of countless tones of open coal debris.

Fly debris, when used in solid, adds to the quality of cement considering its pozzolanic reactivity. In any case, since the pozzolanic response continues gradually, the major quality of fly debris concrete will in general be lower than that of cement without fly debris (Lamond 1950-1967,1983). Because of proceed with pozzolanic reactivity solid makes more perceptible quality at later age, which may outflank that of cement without fly debris. It ought to be seen that pozzolanic response can continue just within the sight of water. Enough dampness ought to be accessible for long time. Along these lines fly debris cement ought to be relieved for longer periods. In this sense, fly debris concrete used in lowered structures, for example, dams will derive full central purposes of accomplishing improved entire arrangement quality and water comfort.

The Indian concrete industry has outpaced the development paces of various noticeable endeavors in the nation on the rear of making request from the housing fragment, extended development in framework headway and entries recovery. Advancing industry updates and government strong strategies are attracting worldwide concrete mammoths and starting off a spate of mergers and acquisitions to drive development. The Indian concrete industry managed its development rate even in the genuine state of cash related log jam. All concrete majors extended their introduced bind in the setting of government upheld development ventures since these tasks have made strong interest for concrete in the nation. Moreover, it is foreseen that industry players will keep extending their yearly concrete yield in coming years and the nation's absolute concrete creation will make at Compound Annual Growth Rate (CAGR) of around 10.5% amidst 2010-11-2013-14. The creation of one tone of concrete requires 1.55 to 1.6 huge amounts of good quality crude materials. These crude materials are commonly unimaginable quality limestone and mud. To make solid more "green" we can make usage of more fly debris in concrete.

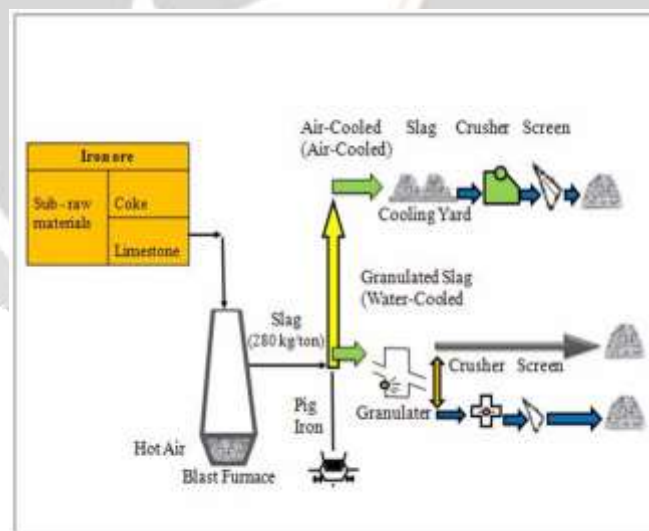
## 5. HIGH STRENGTH CONCRETE:

High Strength cement (HSC) has been a great part of the time used in structural designing structures to decrease the range of auxiliary segments, for example shafts and sections of raised structures. Concrete is called as "high-quality cement" based on its 28 days compressive quality. High quality cement (HSC) is characterized as a solid with a trademark quality between 60 - 100 MPa, despite the fact that qualities higher than 100MPa have just been accomplished and used. Compressive quality degrees of 80MPa and more can be used for both precast and in-situ solid work. According to ACI 363 cement having 28days compressive quality of more than 41 MPa is considered as high-quality cement. By and large, super plasticizers normal pozzolana silica seethes, etc, are used to accomplish high-quality in concrete by keeping water fastener proportion at lower level. Shannag have used characteristic

pozzolana and silica smoke to make HSC of 69 MPa to 85 MPa at 28 days with medium functionality. For creating high quality cement (HSC), usage of FD (foundry slag) as trade for characteristic customary total in concrete has additionally been accounted. The primary applications for high quality cement (HSC) in solid work at site of development are in portions for raised structures, seaward structures, long-range spans and other thruway structures. The primary favorable position of HSC is the abatement in the degree of the weight segments and the amount of longitudinal support required. The water/cover proportions ought to be in the range 0.20–0.35. Alccofine (AF) and waste foundry slag (FD) can be used in mix to improve the quality properties at anomalous states. High-quality cement is required in those structural building ventures which have solid fragments that can contradict high weight loads. High-quality cement is generally used in the erection of tall structures. It tends to be used in solid people, for instance, portions (particularly on lower floors), establishments and shear dividers. High quality cements can likewise be once in a while used in associates structures too.

## 6. GENERATION OF WASTE FOUNDRY SLAG:

Concrete is strong, tough, and prudent and generally a significant part of the time used structural building material in the field of development. As the interest of concrete cement is expanding bit by bit, the interest of its constituent materials, for instance, concrete and total and so on is likewise expanding. The utilization of the normal totals is expanding at a far marvellous rate than the development of the development business. Totals produced falsely are far reaching and continued mining of normal total influencing the earth. This may give the best approach to utilize the mechanical waste outcome as a substitution of total which will deal with the issue of dumping modern waste and help a lot in sparing nature. An enormous amount of result squander material made by the foundry and steel adventures in the midst of the assembling of steel, which stays as unused and requires a huge space for dumping. Squander foundry slag (FD) is one of the reaction take after the other the same volcanic rocks, grayish to dark hued and smooth material which is acquired in the midst of the steel producing measure. In this methodology, in the midst of refining, lime is added to the liquid and degradations coasts at the most noteworthy purpose of the liquid like froth on blend. The outside of corruptions is skimmed from the best and afterward cooled into slag. The schematic viewpoint of age of waste foundry slag (shoot heater) in the midst of steel and iron assembling measure is as showed up in figure 3.



**Figure 3: Schematic View of Generation of Waste Foundry Slag (Blast Furnace) During Steel and Iron Manufacturing Process**

A great many gigantic measures of mechanical waste foundry slag (FD) is produced every year in India and more than 90 % of which stays unused. This unused waste slag is organized in the landfills speaking to a danger to our condition. This may prompt the issue of dumping modern waste slag. Likewise slag got from the refining of scrap steel, for instance, old vehicles may contain toxic substances and dioxins, which ends up unsafe to the earth just as human wellbeing. In spite of the fact that foundry slag has some alluring properties which make it appropriate for

gainful use. The most ideal and greatest use of waste foundry slag influences our economy and condition. Squander foundry slag contains silicates, calcium alumina silicates and alumina silicates which make it a thing that can be used as a total in concrete and can be supplanted as a characteristic ordinary total. Juan Manso had completed an examination on electric curve heater slag in concrete. Zeghichi had reported substitution of regular totals by slag with an advantageous result on quality properties of cement. In 2012, Nadeem and Pofale had deduced that granular slag could be used as elective development material for characteristic sand in workmanship and putting applications either mostly or totally. A stream outline for the correlation of the creation technique of different slags is as showed up in Fig. 4

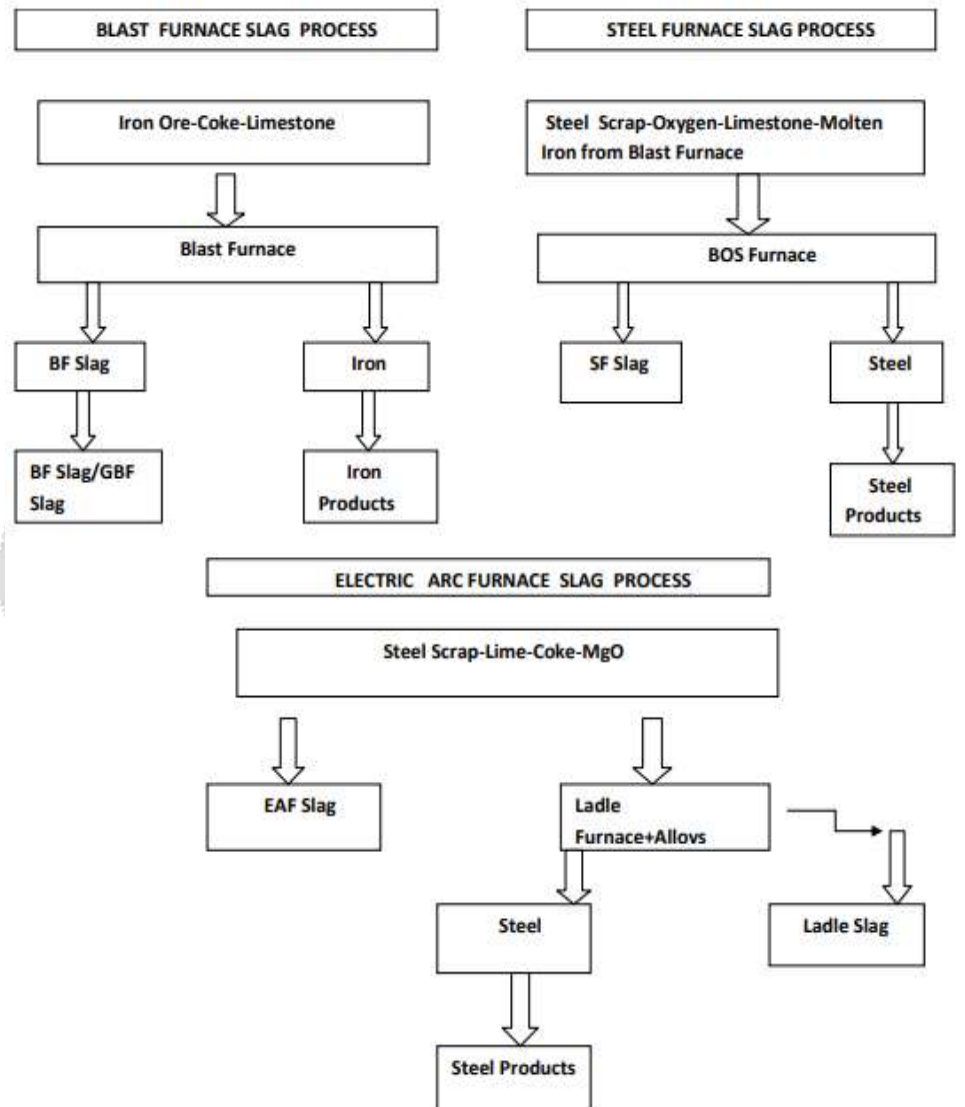


Figure 4: Flow Chart Representing the Production Processes of Different Slags

7. ROAD NETWORK IN INDIA:

Provincial Road network is a key piece of country improvement, since it lifts I admittance to money related and social administrations, thusly creating expanded agrarian productivity, work in industry and organization zones just

as benefit, which thusly extends rustic development openings and genuine pay through which destitution can be diminished. Town streets all in all have low volume of traffic, comprising generally of country transport vehicles. Due to moving of ventures; towards the towns there is an expansion in volume of traffic on town streets. It requires giving the practical course of action of accessibility to the towns.

The National Highways are the spine; of the street framework and the significant streets in India. They convey a huge segment of India's payload and traveler traffic. Public thruways and significant neighborhood streets comprise the optional and interconnecting streets in India. The fundamental streets in India are under enormous weight and in incredible need of modernization so as to deal with the expanded necessities of the Indian economy with minimal effort eco-obliging I materials. Notwithstanding support, the extension of the organization and augmenting of existing streets is getting progressively significant. This would then empower the streets to deal with expanded traffic, and furthermore take into account a relating increment in the normal travel speed on India's streets. Concrete solid streets! welcome an unmistakable favorable position over bituminous streets and are incredibly longer enduring, frequently going for 40 to 50 years, said Shri G Sharan, j Director General (Roads), Ministry of Shipping, Road Transport and Highways, Government of India (2008), and included that; for economical improvement, the modern I society can't oversee without utilizing tip top development material, concrete in streets and thruways.

An average street network has a significant bearing on the money related development of the country. In India streets structure the middle correspondence connect. Street foundation progression is crucial for social reconciliation of the country. Street transport basically includes development of individuals and things by mechanized modes by street. Straightforward entry, adaptability of tasks, approach to gateway organization and dependability have earned street transport an inexorably higher portion of both traveler and load traffic versus various strategies for transport. Transport portion represents 6.4 percent portion of India's Gross Domestic Product (GDP). Street transport has created as the prevailing section in India's transportation zone with a portion of 4.7 for every penny in India's GDP in contrast with railroads that had a 1 percent portion of GDP in 2009-10 as per the information on National Accounts delivered by the Central Statistical Organization (CSO), The development of vehicular traffic has been considerable during the recent years. Vehicular traffic expanded by a compound yearly development rate (CAGR) of almost 10.8 percent from 1951 to 2009. The exacerbating development of vehicular traffic has requested a sheltered and more grounded asphalt section for a wide range of streets. The Current status of Road Network in India is as showed up in Table 1.

**Table 1: Road Network in India**

Road type	Length in km.
National Highways (NH)	58,112
State Highways (SH)	1,37,119
Major District Road (MDR)	4,70,000
Village and Other District Roads (ODR & VR)	26,50,000
Total Road Length	33,15,231

## 8. CONCLUSION:

Usage of fly debris, mechanical waste in blended concrete or in solid yields the higher worth development to such modern wastes diverged from their various applications, for instance, in landfills. By its sheer size, the improvement business gives the ideal home to ensured and affordable exchange of fly debris. It furthermore prompts decline in the hazardous effect on such cements by the intense condition and condition. Fly debris is an important component of current cements. Due to its pozzolanic nature fly debris go about as important component of concrete also. It concrete cement can't be safeguarded in context of overwhelming test results and moreover the productive sensible cases of utility of fly remains in concrete. A highlight on diagram of solid blends to achieve needed properties of cement in fresh and hardened stages and realizing suitable quality control structure including successful easing in the midst of advancement will ensure the affirmation of enormous specific and practical central purposes of using fly debris in essential cement in standard and furthermore in strong condition besides. The examination showed that the quality additions with growing proportion of fly debris up to an ideal worth, past which quality starts to decrease



with encourage development of fly debris. The ideal estimation of fly debris for the four test packs is around 20 % in various stacking spots of parts in strong condition. Fly debris concrete extent is a basic factor choosing the capability of fly debris. As the concrete substance in the solid mix manufactures hydration thing  $\text{Ca}(\text{OH})_2$  will in like manner increase and subsequently the proportion of  $\text{Ca}(\text{OH})_2$  with which the fly debris will go into reaction will extend, by then an extended proportion of C-S-H will result. Consequently, thusly, fly debris will be used even more profitably.

## REFERENCES

1. Ahmaruzzaman M. (2010), "A Review on the Utilization of Fly Ash", Progress in Energy and Combustion Science 36, 327-363, Elsevier Ltd.
2. Alam J. and Akhtar M.N. (2011), "Fly Ash Utilization in Different Sectors in Indian Scenario", International journal of emerging trends in Engineering and Development, Issue 1, Vol 1 August, RS Publication, pp-1-14.
3. Albinas Gailius a & Zivile Laurikietyte (2003), "Waste Paper Sludge Ash and Ground Granulated Blast Furnace Slag as Binder in Concrete", Journal of Civil Engineering and Management, 9:3,198-202.
4. Antonio Eduardo B. Cabral, Vieira Mylene M., Maria Viviane A. dos Santos (2013), "Performance Assessment of Concrete with Partial Replacement of Portland Cement by Coal Ash", World of Coal Ash (WOCA), April 11-15, Lexington, Kentucky, USA, PP-1-9
5. Avinash G, Ibrahim QS, Mehmood SQu, Syed Md AA, Syed SH (2012), "Strength Aspects of Glass Fibre Reinforced Concrete." Int. J. Sci.Eng. Res. 3(7): 1-5.
6. Bagui Swapan Kumar, (2012), "Pavement Design for Rural Low Volume Roads Using Cement and Lime Treatment Base", Jordan Journal of Civil Engineering, Volume 6, No. 3,
7. Bai J., Chaipanich A., Kinuthia J.M., O'Farrell M., Sabir B.B., Wild S., Lewis M.H. (2003), "Compressive strength and hydration of wastepaper sludge ash-ground granulated blastfurnace slag blended pastes", Cement and Concrete Research 33,1189-1202.
8. Balwaik Sumit A, Raut S P (2010), "Utilization of Waste Paper Pulp by Partial Replacement of Cement in Concrete", International Journal of Engineering Research and Applications (HERA) ISSN: 2248-9622, Vol. 1, Issue 2, pp.300-309.
9. Basak Sudip, Bhattacharya Amartya Kumar, Paira L. K. (2004), "Utilization of Fly Ash in Rural Road Construction in India and its Cost Effectiveness", ejge
10. Bhalchandra S. A., Bhosle A. Y. (2013), "Properties of Glass Fibre Reinforced Geopolymer Concrete", International Journal of Modern Engineering Research (DMER) ww.ijmer.com Vol. 3, Issue. 4, Jul - Aug. pp-2007-2010 ISSN: 2249-6645.
11. Bhanumathidas N. and Kalidas N. (2003), "Fly ash: The resource for construction industry", April, The Indian Concrete Journal, pp-997-1004.
12. Bhatti JI., J Gajda PE., Botha, F. and Bryant MM, PG. (2006), "Utilization of Discarded Fly Ash as a Raw Material in the Production of Portland cement.", Journal of ASTM International, Vol. 3, No. 10.