# STRENGHT EVALUATION OF RIGID PAVEMENTS BY ADDITION FLY ASH


***Presented by***

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# overview

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- *Applications Fly*
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# ABSTRACT

The present paper deals with the effect on the strength properties of cement concrete by using fly-ash.The utilization of fly-ash in concrete as partial replacement of cement is gaining immerse importance today,mainly on account of the improvement in the in the long term durabilityof concrete combined with ecological benefits.

- Technological improvements in the thermal power plant operations and fly-ash collection systems have resulted in improving the consistency of fly- ash.
- To study the effect of partail replacemementof cement mixes with300 to 500 Kg/cum cementious materials at 20% ,30% ,4 0% replacement levels.

- *In this paper the effect of fly-ash on setting time, density, air content, compressive strength are studied Based on this study compressive strength v/s W/C curves have been plotted so that concrete mix of grades M 20 with difference percentage of fly-ash can be directly designed*

# INTRODUCTION

- *Fly ash is a fine residue of coal combination in the Thermal Power Plants.*

*The thermal grade Indian coal contains 35 to 45% of ash resulting in generation of huge quantity of fly ash. Coal being the main raw material for thermal power generation, ash is the essential by product.*

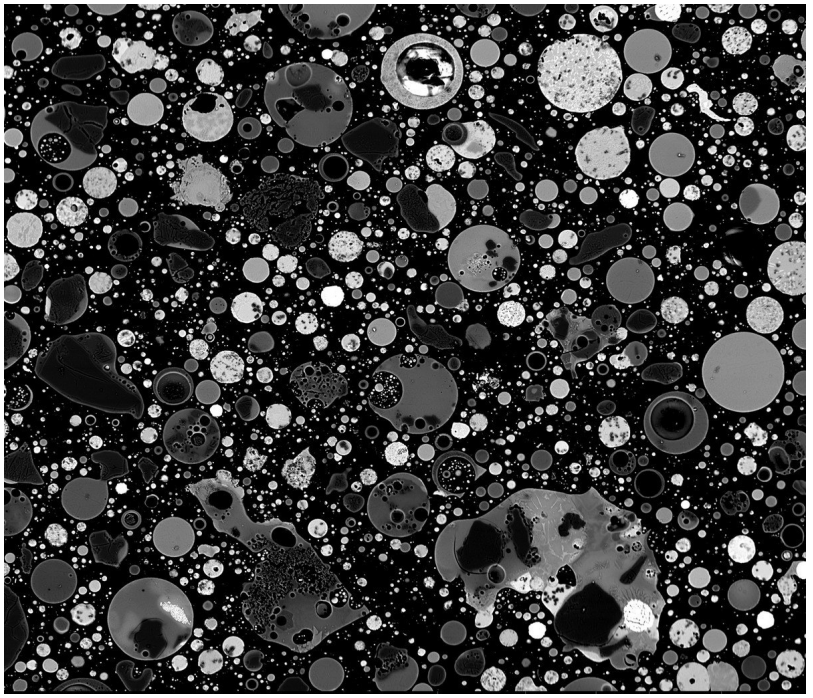

FIG-1

- *Huge quantity of bottom ash & fly ash are generated from boilers of coal fird Thermal Power Plants . Internationlly fly ash is considered as a by product which can be used for many applications.*

- *Power plants fuelled by coal produce a significant quantity of the electricity we consume in the world today.*
- *In addition to electricity , these plants produce a material that is fast becoming a vital ingredient for improving the performance of a wide range of concrete products.*

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- *The materials are also produced as a by product from industrial plants using pulverized coal or lignite as fuel for the boilers*

- *Depending upon the source and makeup of the coal being burned , the components of fly ash  vary considerbly, but all fly ash includes substantial amounts of*
    - *1 . Silicon dioxide (SiO2)*

  *(  both amorphous and crystalline),*
    - *Aluminium oxide (Al2O3) and*
    - *Calcium oxide (CaO),.*

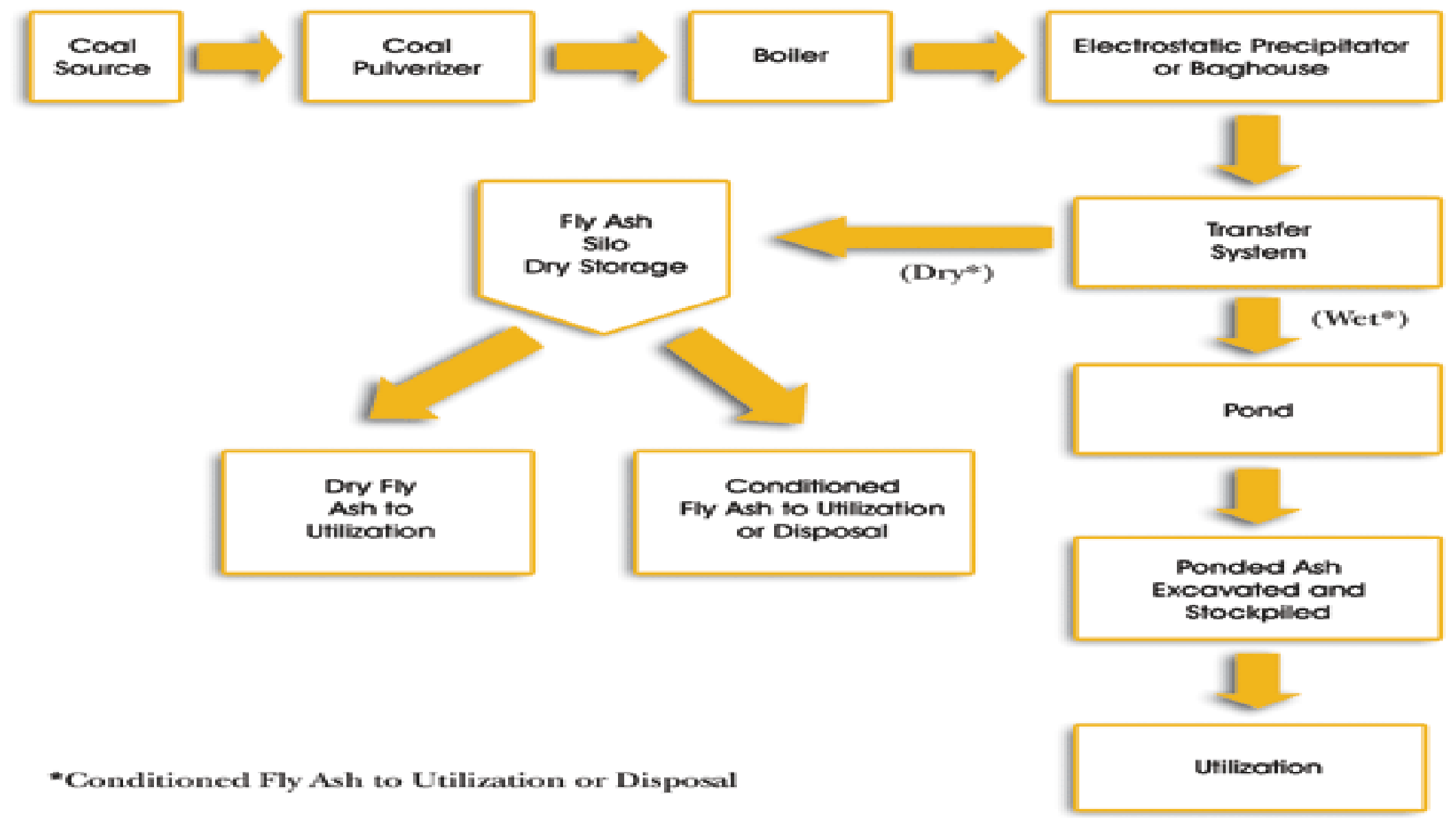
Coal Source
Coal Pulverizer
Boiler
Electrostatic Precipitator or Baghouse
Transfer System
(Dry*)
Fly Ash Silo Dry Storage
(Wet*)
Pond
Dry Fly Ash to Utilization
Conditioned Fly Ash to Utilization or Disposal
Ponded Ash Excavated and Stockpiled
Utilization
*Conditioned Fly Ash to Utilization or Disposal

FIG-2

# Classification

## Class ‘ F ’ fly ash :

- *The* burning *of harder, older anthracite and bituminous coal typically produces Class F fly ash .*
- *This fly ash is pozzolanic in nature, and contains less*

*than 7% lime (CaO).*


fig-3

- *Possessing pozzolanic properties , the glassy silica and alumina of Class F fly ash requires a cementing agent, such as portland cement,quicklime,or hydratedlime-mixed with water to react and produce cementitious compounds.*
- *Alternatively,adding a chemical activator such as sodium silicate(water glass)*

# Class C fly Ash :

- *Another type of fly ash – class C produced from*

*burning sub-bituminous coal. It has self*

*– cementing & pozzolanic properties.*

*When class C fly ash contacts with*

*water, it will harden & gain strength*

*over time.*


fig-4

- *Generally, it contains more than 20% lime(CaO).*

*Alike, class F fly ash, the self-cementing class C*

*does not require any activator. The higher contents in class C*

# Physical properties of flyash

| | |
|---|---|
| *Parameters* | : **Fly Ash** |
| *Bulk Density (gm/cc)* | : **0.9 – 1.3** |
| *Specific Gravity* | : **1.6 – 2.6** |
| *Plasticity* | : **Lower or non – plastic** |
| *Shrinkage Limit (ol stability)* | : **Higher** |
| *Grain size* | : **Major fine sand/ silt and small % of clay size particles** |
| *Clay (percent)* | : **Negligible** |
| *Free swell Index* | : **very slow** |
| *Classification (Texture)* | : **Sandy silt to silty loam** |
| *Water Holding Capacity (WHC) (%)* | : **40 - 60** |
| *Surface Area (m2 / Kg)* | : **30 - 65** |
| | : **500 - 5000** |

# Chemical properties

## Chemical composition of fly ash and ponds ash :

| Compounds (%) | Fly Ash | Ponds Ash |
|---|---|---|
| *SiO2* | *38 – 63* | *37 – 75* |
| *Al2 O3* | *27 – 44* | *11 – 53* |
| *TiO2* | *0.4 – 1.8* | *0 – 1* |
| *Fe2 O3* | *3.3 – 6.4* | *3 – 34* |
| *MnO* | *b.d - 0.5* | *b.d – 0.6* |
| *MgO* | *0.01 – 0.5* | *0.1 – 0.8* |
| *CaO* | *0.2 – 0.8* | *0.2 – 0.6* |
| *K2 O* | *0.04 – 0.9* | *0.1 – 0.7* |
| *Na2 O* | *0.07 – 0.43* | *0.05 – 0.31* |

# Fly Ash Applications

- *Fly ash can be used as prime material in blocks, paving or blocks ; however , one the most important applictions is PCC pavement.*
- *PCC pavements use a large amount of concrete and substituting fly ash provides significant economic benifits.*
- *Fly ash has also ben used for paving roads and as embankment and mine fills , and it's gaining acceptance by the government.*


fig-5

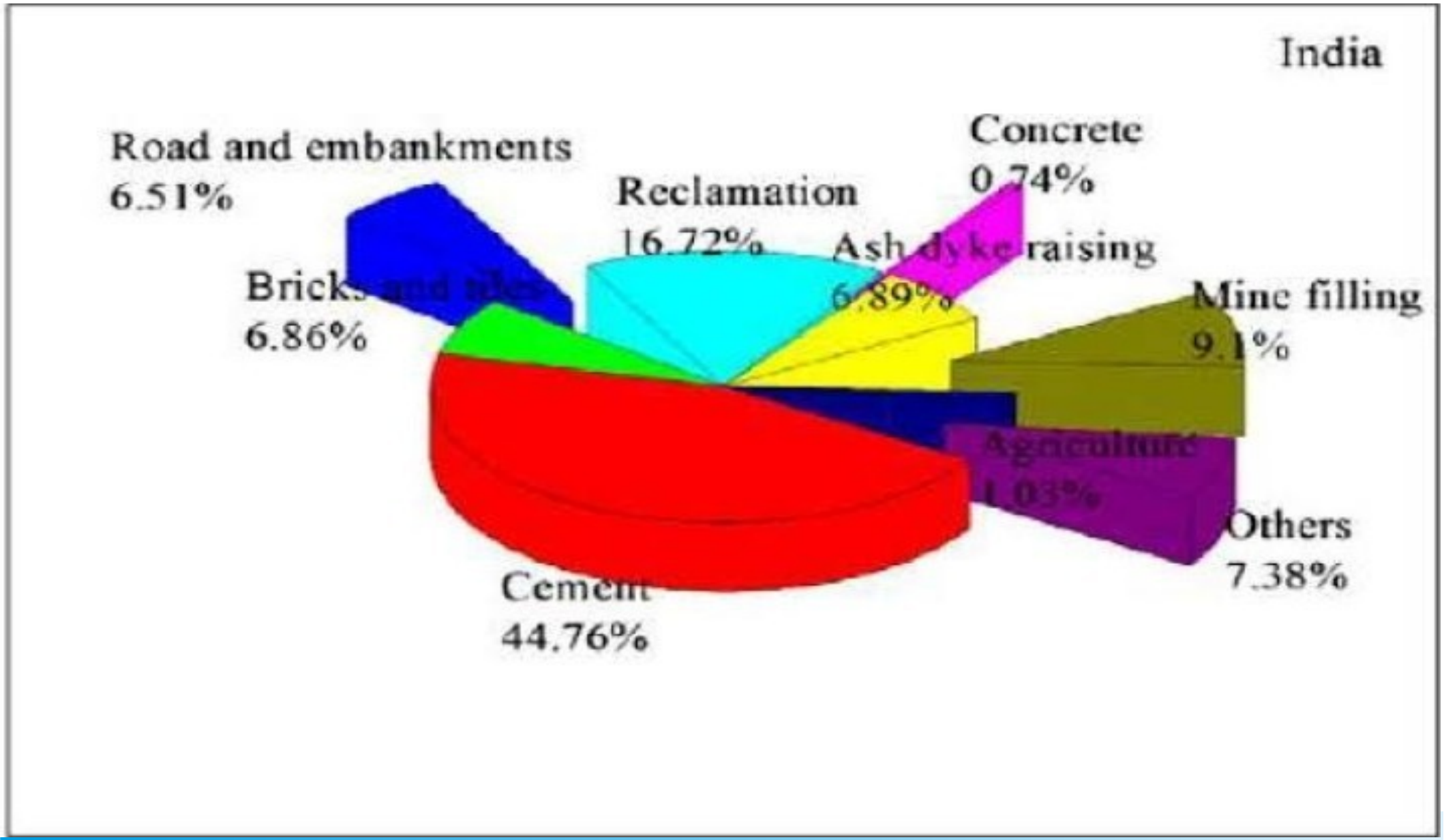
India
Road and embankments
6.51%
Concrete
0.74%
Reclamation
16.72%
Ash dyke raising
6.89%
Mine filling
9.1%
Bricks
6.86%
Agriculture
1.03%
Others
7.38%
Cement
44.76%

fig-6

# Fly ash Benifits

➔ *Fly ash can be a cost-effective substitute for portland cement in some markets.*

*In additon, fly ash could be reecognized as an*

➔ *environmentally friendly product because it is*

*a by product and has low embodied energy.*

➔ *In addition , fly ash also requires less water*

fig-7

*fly ash also requires less water than Portland cement and it is easier to use in cold weather.*

# Other benefits include :

- *Produces various set times.*
- *Cold weather resistance.*
- *Higher strength gains, depending on its use.*
- *Can be used as an admixture.*
- *Can substitute for Portland cement.*
- *Considered as non – shrink material.*
- *Produces denser concrete and a smoother surface with sharper detail.*
- *Great workability.*
- *Reduces crack problems , permeability and bleeding*
- *Reduces heat of hydration.*
- *Produces lower water/cement ratio for similar slumps when compare to no fly ash mixes.*

# Environmental benefits of fly ash use in concrete

- *Use of fly ash in concrete imparts several environmental benefits and thus it is ecofriendly.*
- *It saves the cement requirment for the same strength thus saving of raw materials such as limestone , coal etc required for manufacture of cement is high – energy intensive industry.*

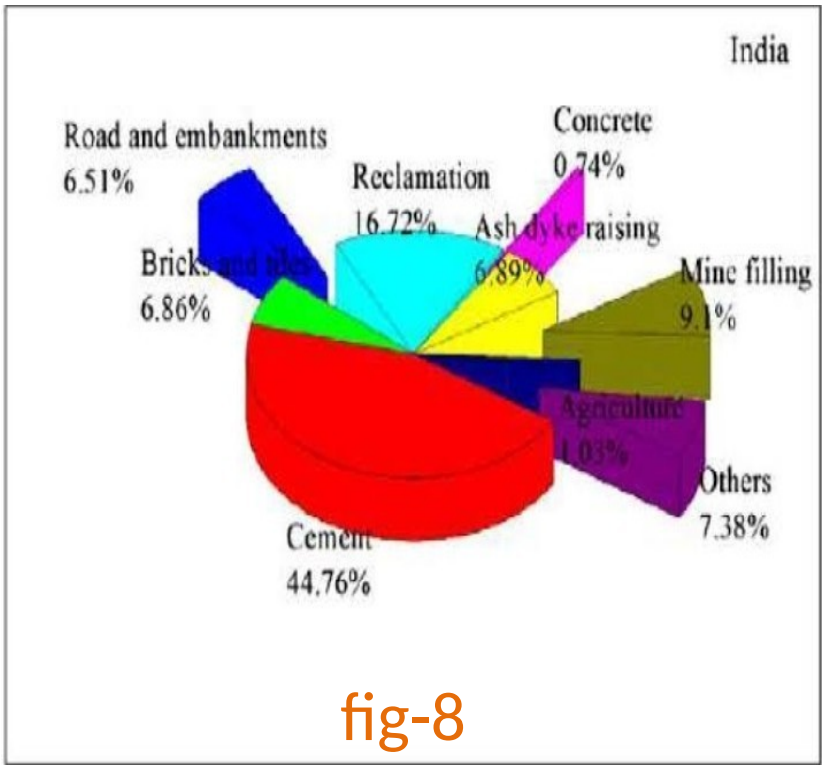

fig-8

- *Manufacturing of one tonne of cement , about*

  *1 tonne of CO2 is emitted and goes to atmosphere.*
- Less requirement of cement means less emission of CO2 results in reduction of green house gas emission

# Fly Ash Drawbacks

- *Smaller builders and housing contractors are not that familiar with fly ash products which could have different properties depending on where and how it was obtained.*

- *For this reason,fly ash applications are encountering resistance from traditional builders due to its tendency to effloresce along with major concerns about freeze/thaw performance.*

*Other major concerns about using fly ash concrete include:*

*1.Slower strength gain.*

*2.Seasonal limitation.*

*3.Increase in air entraining admixtures.*

*4.An increase of salt scaling produced by higher fly ash.*

# USES:

- *The most common use of fly ash is as a partial replacement for portland cement used in producing concrete.Replacement rates normally run between 20% to 30%,but can be higher.*
- *Fly ash reacts as a pozzolan with the lime in cement as it hydrates,creating more of the durable binder that holds concrete together.*

## VARIOUS USES OF FLY ASH

i. *Fly Ash Bricks / Block*

ii. *Cement Concrete*

iii. *High Volume Fly Ash Concrete(HVFAC)*

iv. *Road Construction*

v. *Embankment/Back fills / Land development*

# Highway Applications

## Fly Ash in Structural Fills/Embankments:

### Overview:

1. *Fly ash can be used as a borrow material to construct fills and embankments.*
2. *When fly ash is compacted in lifts,a structural fill is constructed that is capable of supporting highway buildings or other structures.*
3. *Fly ash has been used in the construction of structural fills/embankments that range from small fills for road shoulders to large fills for interstate highway embankments.*

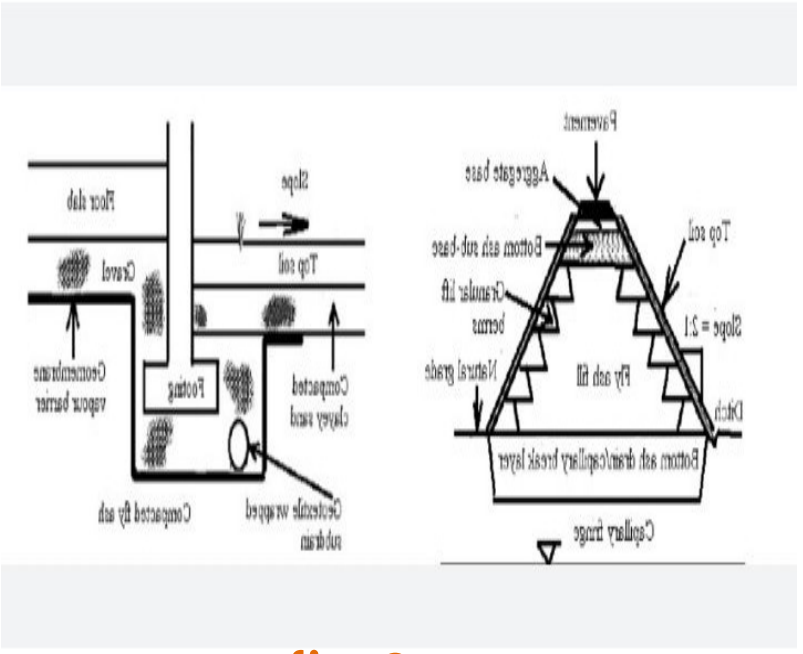

fig-9

# Benefits:

*When used in structural fills and embankments,fly ash offers several advantages over soil and rock:*

- *Cost-effective where available in bulk quantities.*
- *Eliminates the need to purchase,permit,and operate a borrow pit. Can be placed over low bearing strength soils.*
- *Ease of handling and compaction reduce construction time and equipment costs.*

**Cautions:** *Be aware that*

- *State or local environmental regulations may require consideration of the potential impacts to ground water at adjoining properties.*
- *Requires dust control and erosion prevention measures.*

# Fly Ash in Soil Improvement

**Overview:**

- *Fly ash is an effective agent for chemical and/or mechanical stabilization of soils.*

fig-10

- *Soil density,water content,plasticity,and strength performance of soils.*
- *Typical applications include: Soil stabilization, soil drying,and control of shrink-swell.*

**Benefits:** *Fly ash provides the following benefits when used to improve soil conditions*

- *Eliminates need for expensive borrow materials.*
- *By improving subgrade conditions,promotes cost savings through reduction in the required pavement thickness.*

**Cautions:** *The most important considerations for soil improvement projects are*

- *Soil moisture content at the time of compaction.*
- *Fly ash with a sulphate content greater than 10% may cause soils to expand more than desired.*

# Fly Ash in Asphalt Pavements

**Overview:**

- *Fly ash can be used as mineral filler in HMA paving applications.*
- *Mineral fillers increase the stiffness of the asphalt mortar matrix,improving the rutting resistance of pavements,and the durability of the mix.*

fig-11

**Benefits:** *Fly ash will typically meet mineral filler specifications for gradation,organic impurities,and plasticity.*

**The benefits of fly ash include:**

- *Reduced potential for asphalt stripping due to hydrophobic properties of flyash.*
- *Lime in some fly ashes may also reduce stripping. May afford a lower cost than other mineral fillers.*

# Fly Ash in Grouts for Pavement Sub Sealing

## Overview:

- *Grouts are proportioned mixtures of fly ash,water,and other materials used to fill voids under a pavement system without raising the slabs(subsealing),or to raise and support concrete pavements at specified grade tolerances by drilling and injecting the grout under specified areas of the pavement.*

fig-12

# **Benefits:** *Fly ash grouts*

- *Can Be used to correct undermining without removing overlying pavememt.*
- *Be accomplished quickly with minimum disturbance to traffic. Develop high ultimate strength.*
- **Cautions:** *Fly ash grouts :*
- *Require curing period before extremely heavy loading because of low early strength.*

  *Require confinement of the grout mixture under pavement.*

# Fly Ash in Portland Cement Concrete

- *The use of fly ash in portland cement concrete(pcc) has many benefits and improves concrete performance in both fresh and hardened state.*
- *Fly ash use in concrete improves the workability of plastic concrete,and the strength and durability of hardened concrete.*
- *Fly ash use is also cost effective.*
- *When fly ash is added to concrete,the amount of portland cement may be reduced. Ordinary portland cement(OPC) is a product of four principal mineralogical phases.*
- *The phases are tricalcium silicate- C3S(3Cao.Sio2),dicalcium silicate- C2S(2caO.Sio2),*
- *Tricalcium aluminate-C3A and tetracalcium alumino-ferrite- C4AF(4CaO.Al2O3.Fe2O3)*

*2C3S+6H-------->C3S2H3+3 CH*

# RESULTS

- *The experiment conducted with replacing the cement with 30% flyash at water cement (w/c) ratio of 0.55 is found to be suitable.*
- *The experimental results will be compared with both with (w/c) ratio 0.55 along with 0.6.*

# Conclusion

- *Use of high volume fly ash concrete in construction is one big step in **natural resource conservation** and it needs to be promoted all over the world.*
- *In fact we can call high volume fly ash concrete as a **green concrete**,since it can protect the environment from **global warming** and at the same time from **pollution**.*
- *There may be some negativity attached to it like slower construction rates as it **gains strength slowly** and **gives lower early strengths**.*
- *But,the same can be ignored as the **later strengths**(90 days or more) and **durability**of high volume fly ash concrete is much **better than the plain concrete.***
- *<u>The inclusion of high volume fly ash in the mixture causes:</u>*

*Reduced the heat of hydration,bleeding,segregation,density,but increased workability and setting time.*

*Increased durability of concrete.*

# Thank you