STUDY ON FLY ASH AS A PARTIAL REPLACEMENT MATERIAL IN HIGHWAY EMBANKMENT

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Abstract. Fly debris (FA) is a side-effect failure extracted from coal terminated force plants by electrical / electrostatic clarifier. India does have the planet's very largest coal reserves. In the current scenario, about 160 million tonnes of fly-debris have been produced, almost double in the last decade. A significant proportion of warm-force plants in India use bitumen and subbituminous coal and generate huge volumes of fly debris. High debris material (30 percent-hal) of fossil fuels adds to these enormous fly debris volumes. Fly-debris is used in various sections such as block making, construction of streets and banks, concrete processing, agricultural uses, low-lying areas recovery, mines filling. Dust Dyke Raising the wasted enormous volume of fly debris has attracted analysts' attention to explore new wide use techniques. Fly debris bank is one of the drive regions to mass disperse fly dust. As in India, the actual condition of street and dike fly debris use is just 6 percent. The present study refers to the potential uses as a dike material for fly debris. Fly debris does have the larger part of the important and good geophysical patent for its use as bank fill.

1. Introduction

"Squander changes " is the amazing term utilized in compelling strong waste administration strategy. India's hot-power plants expend over 300 million tonnes of coal and produce nearly 100,000 MW of power. This generates around 163.56 million tonnes of fly debris, even though only 61.37 percent is used. In spite of the fact that fly debris has wide assortment of uses in structural designing businesses however mass usage of fly debris is conceivable just in the event that it is utilized as a dike material. Direct utilization of fly debris in parkway bank ventures devours enormous volumes of fly debris and gives a promising answer for the removal issue, yet in addition a financial option In relation to the use of usual materials. As these materials are designed to be used as bank construction materials, focus is put on ensuring certain physical and mechanical properties, like compression, permeability, consistency, firmness and conductivity..

2. HIGHWAY EMBANKMENT

Walkway is a dense barrier of soil which is created to cross on a low ground zone on a road or railroad, or to stop water from entering the area from a stream or sea. A obstacle means a quantity of earthen materials set and compressed to lift the elevation of a road (or railroad) above the present level, including the ground surface. A fill insinuates a volume of earthen material that is set and
compacted to fill in an opening or despairing. Banks or fills are created of materials that typically contain soil, anyway may in like manner fuse aggregate, rock, or crushed clearing material

3. FLY ASH

Fly debris is the product of the consumption of pummelling coal in plants producing electricity. During combustion, coal mineral debasements mix with the gases of the fumes in suspension and buoy out of the burning chamber. It cools and hardens into round polished particles called fly debris as the intertwined material ascends. Electrostatic precipitators or pack channels capture fly debris from the gases of the fumes.

3.1. FLY ASH IN HIGHWAY EMBACKMENTS

Determinations for fly debris basic fills and banks are like details for built soil fills. To achieve the ideal consistency and compressibility characteristics needed for the plan, valid arrangement and compaction of fly debris fillings is necessary.

4. Design and Specification Requirements

- Ash sources.
- Site conditions.
- The ash's physical, technical, and chemical properties.
- Design issues.
- Environmental impacts.
- Erosion and dust control.
- Specifications/quality control.
- Performance specifications

5. Construction Practices

5.1. General

Suggested development methods have been created as the aftereffect of experience picked up with preliminary banks and development ventures. Acclimations to these standard techniques might be essential, contingent upon genuine field conditions.

5.2. Site preparation

Setting up the fly debris location site is like ground filled products criteria. It is necessary to clear and scrub the site. For conclusive propagation, dirt should be held. The depletion of the area and the removal of spills, ponds or streams from hitting the fly debris should be given careful attention.

5.3. Delivery and on-site handling

In safe dump trucks or pneumatic large hauler vehicles, fly debris is typically pulled to the location. To avoid tidying, change the water substance of the debris. Reduce the water by transitory amassing and mixing with drier storehouse debris due to tidal pond debris to forestall street spillage during transport and to allow suitable arrangement. It is placed dry in warehouses or motorised large hauler
trucks as a consequence of the solidifying properties of high calcium debris. Unless the debris is kept moist and even if the debris is secured to avoid tidying and disintegration, low calcium debris may be amassed nearby.

5.4. Spreading

Typically, fly debris is distributed and levelled in free lifts of 150 to 300 mm thick with a dozer, grader, or other hardware. Then the lift is followed by the dozer or other introductory compaction gear.

6. Compaction

6.1. Equipment

Start compaction as soon as the material has been dispersed and is at the correct moisture content. The most promising compaction results have been obtained with self-propelled, pneumatic-tired roller sand self propelled or towed vibratory rollers. Vibratory rollers operated at the fly ash resonant frequency will compact the ash more effectively than non-vibratory rollers and in fewer passes. Table 6 lists the types of compaction equipment that have been tested for use with fly ash.

6.2. Moisture control

In the compaction method, control of the required range of dampness is an important consideration. To achieve the optimal dampness content, fly debris can be adjusted with liquid at the crop storehouse. Make sure to look at the options for pulling fly debris soaked in the plant to the ideal water content, or including water at the site. Pulling wet fly debris to the site means better transport costs, despite the quality of water field penances in ground place.

6.3. Weather restrictions

During extreme conditions, fly debris may also be assessed. Ice usually infiltrates only the upper layer of the compacted debris in the colder months, and can be re-compact after defrosting. If the water freezes too quickly throughout compression, the operation can be stopped until the temperature increases. Production will also continue in rainy conditions, regardless of whether the moisture content of the debris is overly high. The gear will stall, however, and it may be difficult to achieve sufficient compaction.

6.4. Insensitivity to moisture variations

Since water is flowing throughout emptying of capacity stores to low calcium travel debris, fly debris may be acquired at any required rainfall water. About the fact that the optimal dampness content is more predominant than either silty soils, when set dry from optimal, the adhesion behaviour of copper slag fly debris is typically harsh against varieties of rainfall water. However, when water is added and becomes difficult to deal with if not placed in an efficient place, higher cement fly debris will self-solidate.

7. LITERATURE REVIEW

Several experiments have been performed in which the technical characteristics and physical and chemical properties of fly ash have been determined in the laboratory. In England and the United States, fly ash has long been used as an embankment filling. Some of the case storeys (Fiber and
Digioia, 1976) reveal that fly ash embankment will provide stable light weight filling that, due to age hardening characteristics, will be stronger than most natural soils of the material. The expressway connecting Waukegan, Illinois, USA between Grand and Greenwood Avenues was constructed over a fill embankment on the outsides of fly ash slopes with 2.4 m of earth fill. In India, a 1 km long fly ash embankment was built in Raichur district of Karnataka during the early 70s. Currently, the second Nizamuddin Bridge approach embankment along NH 24 in New Delhi was built using pond ash.

1. Rafat Siddique (2003): Completed test exam handling concrete joining high quantities of fly debris of Class F. Portland concrete with class F fly 12 debris was supplanted by 40, 45 and 50 percent respectively. For both fresh and solidified solid properties, experiments were conducted. He concluded that at 28 years old days, the supplanting of concrete with these rates of fly debris material lowered the compressive consistency, parting rigidity, flexural quality and cement flexibility modulus, but there was a non-stop and tremendous increase in quality properties over the past 28 days. Cement consistency is appropriate for use in reinforced concrete solid production with 40 percent, 45 percent and half fly debris material, even at 28 days. Scraped area obstruction of cement was firmly impacted by its compressive quality, independent of fly debris content. Scraped spot obstruction was found to increment with the expansion in age for every solid blend.

2. Singh (2007): The output of concrete with fly ash substitutions above 30-35% was recorded. His analysis reveals the characteristics of HVFAC at 50 percent. Two demonstration schemes in New Delhi, India, using fly ash. These demonstration projects were aimed at making Indian professionals familiar with local materials and Indian site conditions with this type of concrete. On samples obtained at the time of casting, as well as field cores from the site, many engineering parameters were tracked for almost a year. The findings demonstrate that HVFAC is also an exceptional substance with higher than conventional concrete later-age properties, including compressive power, flexural strength.

3. Phanikumar and Sharma (2004): A comparative report was completed by Phanikumar and Sharma what’s more, the impact of fly debris on designing properties of far reaching soil through an exploratory program. The effect of far-reaching soil on parameters such as free swell record (FSI), swell capacity, growing weight, mobility, compaction, efficiency and water-driven conductivity is considered. On a dry weight premise, the debris blended far-reaching soil with fly ash material of 0.5, 10.15 and 20 percent and caused expansion in fly ash content to decrease plasticity characteristics and the FSI was decreased by about half by the expansion of 20 percent fly debris. Owing to the rise in most intense dry unit weight with an expansion of fly ash content, the pressure based conductivity of far-reaching soils blended in with fly ash declines with an expansion of fly ash content. There is a drop in the optimal dampness content as the fly ash content builds and the highest dry unit weight increases.

4. Latifi et al. (2015) examined the physico-concoction and quality attributes of fly ash-base debris blend at multi day and 28 days of restoring. Base debris and fly ash sieved through 2.00mm work was taken up for study. The outcomes affirmed the development of new cementations item calcium silicate hydrate when water was added to the blend. Additionally modulus of versatility diminished with no noteworthy impact on shear quality with expanding base debris content.

5. S. Bhuveneshwari and S.R. Gandhi: An examination was done by S. Bhuveneshwari and S.R. Gandhi on the impact of designing properties of far reaching soil through a test program. Foundation ventures, for example, roadways, railroads, water repositories, recovery and so on requires earth material in exceptionally enormous amount. In metropolitan settings, it is not efficiently usable to get earth that must be pulled from a long separation. Regularly, with highly plastic and substantial soil, vast regions are covered, which is not fair for that reason. Different scientists have carried out large laboratory / field preliminaries and suggested encouraging results for the use of such extensive soil after modification with added substances, such as sand, sediment, lime, fly ash, and so on. Since Fly Ash is unreservedly available, it can be used for adapting far-reaching soils for numerous jobs for projects in the area of a thermal power plant. The present paper presents a analysis conducted to verify the changes in Fly Ash’s comprehensive soil properties at changing speeds. Preliminary and field
evaluations at both testing facilities have been carried out and the findings are provided for in this article. Intensive mixing of the two materials (sweeping soil and fly ash) to the necessary degree to form a homogeneous mass is one of the major problems in field application. "The paper outlines a procedure followed for setting these substances in layers of the appropriate thickness and running a Circle Harrow. A tentative bank of 30 m length by 6 m width by 0.6 m height was established successfully and the completed in-situ tests demonstrated its reasonableness for dike construction, sediment dykes, lesser-laying territory filling, etc.

6. Edil et al. [1] The feasibility of self-establishing fly remains has been tested for the adaptation of fragile fine-grained soils. Blends were tested for California bearing proportion (CBR) and flexible module (MMrr) tests. Diverse delicate fine grained soils, for example, inorganic soils and natural soil what’s more, extraordinary fly remains were utilized. Two of the fly cinders are great Class C remains and the different remains are off-detail cinders. Tests were conducted on soils and mixtures of soil-fly debris arranged at optimal quality and diverse wet optimal moisture content. The outcomes indicated that expansion of fly debris altogether, expanded the CBR and MMrr of the inorganic soils. On the other hand, CBR of soil–fly debris blends commonly expanded with fly debris content and diminished with expanding compaction water content. Moreover, In order to extend the asphalt blockage, fly debris can be hardened over time. Native soil typically had a lot of lower inorganic soil CBR and MMrr values. However, the solid module increased more for wetter or increasingly plastic fine grained soils.

7. Cokca [2] Used from high-calcium and low-calcium class C fly cinders for far-reaching soil modification and evaluation of substantial soil-lime, soil-concrete sweeping, and large soil-fly debris frameworks. Lime, concrete and fly debris were added to the far reaching soil at various rates. The examples were exposed to synthetic piece, grain size appropriation, consistency cut-off points, and free swell tests. Likewise, the Specimens with fly debris were restored and after that they were exposed to oedometer free swell tests. It very well may be inferred that the sweeping soil can be effectively balanced out by fly remains. In addition, the examples' pliancy list, acceleration, and increasing capacity decreased with the stabiliser level and time relief.

8. Research Studies Sponsored by FHWA
In 1974, after numerous failures of existing shale embankments, the Federal Highway Administration Initiated and sponsored a three-phase Analysis to create recommendations for the design and construction of remedial measures for current failures and for the design and construction of new shale embankments. The report was carried out by the U.S. Experimental Station of Army Engineers Rivers, Vicksburg, Mississippi.

As part of the preliminary work carried out for Phase 1 (12), the researchers made a very interesting discovery that provided the basis for their, as well as other, research: "... With time after development, the underlying cause of excessive settlement and slope collapses in highway shale embankments seems to be erosion or softening of some shales."

7.1. causes of shale embankment problems

Step 1 of the study centred on existing knowledge on classification and material properties, physical and chemical tests, design criteria and procedures for construction supervision, and in situ and compacted shale sampling and testing procedures. As part of Step 1, the researchers summarised existing building practises used by some of the state highway departments at the time and found that the conditions for approval or denial differed greatly between states[6]. They also found that most of the causes of failures cited could be attributed to the absence of testing to predict the output of shale over time. "The researchers have determined that" ... the main consideration is the degree of resilience shown by the shale content and how it can be predicted that this resilience would adjust with time.

The second phase (t3) of the research deaH mainly who the evaluation and remedial treatment of shale embankments that were exhibiting distress. Resuns of this part of the research provided a process by which a highway geotechnical engineer could assess the current overall stability of an existing
embankment and also provided recommendations for correcting shale embankment problems. Perhaps the most important part of their results was the statement that surface and subsurface drainage is a critical part of most remedial measures. Therefore, considerations of surface and subsurface drainage are extremely important in design of new embankments.

Phase 3 (14) was designed to fill gaps identified in the first two phases of the study and to provide a comprehensive manual for design and construction of shale embankments. As part of this phase, information and interviews supplied by 15 state highway departments regarding shale embankment performance was correlated with the slake durability index to provide a guideline for placing shale in embankments. Slake durability indices were generally correlated with lift thickness and embankment performance. Also as part of Phase 3, the researchers provided conclusions and recommendations regarding the use of shale in highway embankments. Based on those findings, the primary causes of large settlements and slope stability problems are inadequate compaction, saturation, and shale deterioration. Another conclusion was that classification of shales according to long-term durability was absolutely essential in development of design measures. Recommendations included classifying shales as either soil-like or rock-like and then placing the material in lift thicknesses.

8. TEST METHODS

8.1. Density Testing

8.1.1. Moisture Density Relationships

Every soil does have a moisture content that can be condensed to the most extreme thickness, known as perfect dampness. To achieve adequate compaction, it is important to compress the dirt at the optimum dampness and to regulate the dampness content. In order to get the ideal thickness, too little dampness will require unnecessary compact effort. In the unlikely possibility that there is a lot of dampness, before the excess water is delivered, the most intense thickness will not be done, paying no attention to how much the soil is rolled. The effect of dampness increases with the dirt's decreasing molecular size. That is, the calculation of moisture phase considerably affects muds and sediments (little molecule size) rather than sands and rock. Hold the importance of dampness in mind.

8.1.2. Proctor Test

In the testing lab, the multipoint delegate test is run as per VTM-1. According to VTM-12, a one-point delegate evaluation is performed on the site of the undertaking. A good guide for the field control of dampness is the dampness/thickness bends created using the Proctor test. If surprising or unexpected soil is encountered, additional testing may be needed.

8.1.3. Field Density Testing

In compliance with VTM-10 / AASHTO T310, or by other permitted methods, field density determinations will be conducted with a portable nuclear field density testing unit. The most commonly used method is nuclear testing. To assess the approximate real density of the tested substance in units of pounds per cubic foot (pcf) and humidity in percentage of dry weight (percent), it entails the use of low level ionising radiation. Density determinations for embankment material would be consistent with the density of the same material evaluated in compliance with the VTM-1 or VTM-12 criteria where a nuclear device is used, and a control strip will not be required. A later section will discuss details of the test methods.

8.1.4. Density Specifications for Embankment Material
As calculated by VTM-1 or VTM-12, a minimum of 95 percent of maximal theoretical density. The overall potential density does not exceed 102 percent.

8.2. Moisture Tests

Broiler / Pan Drying This is the "old" dampness checking technique, but it is effective. It utilises a lot of scales, a dish, and a means of heating (broiler, gas oven, or electric hotplate) to "heat" the moisture out of the soil. The simple dampness is when the heaviness of the skillet has been deducted from the all-out weight.

Speedy Tester for Humidity

This is the most commonly applied dampness testing method, rather than possibly the atomic measure. As the name infers, the intrigue is identical. It is easy to execute and snappy. Connections with dry dampness tests from broilers make the "expedient" completely reliable. The "expedient" is used for Proctor tests and normal thickness tests to attain the dampness information. But "rapid" can also assist the auditor in various ways because of its simplicity and snappiness.

In order to make sure that the soil has the proper dampness quality, the Inspector can conduct visit dampness inspections. It is proposed to use the "Quick" Moisture Tester to perform these tests for convenience.

The "Fast" test could be driven by using the half-example strategy when determining the dampness content for overwhelming muds, or the field oven technique could be used. In order to make sure that the soil has the proper dampness quality, the Inspector can conduct visit dampness inspections. The "Rapid" Moisture Tester is recommended to be included in the instruction of these measures for expediency. The "Expedient" test could be led by the half-example methodology when determining the dampness content for significant muds, or the field oven strategy could be used.

8.2.1. Moisture Specifications

The determinations demand that of lift be compacted at the ideal dampness for both the subgrade and bank, with a resilience of ± 20 percent of the ideal dampness content. In the event that dampness isn’t inside these predefined resiliences, at that point the lift must be circulated air through or water included by and large. The dampness content for total is ± 2 rate purposes of the ideal dampness content.

Moisture Specifications:
- Soils + 20% of optimum moisture
- Aggregates + 2 percentage points of optimum moisture
- Cement Treated Aggregate optimum moisture + 2 percentage points of optimum moisture

Moisture Limits Example – Soils:
1) Given: OMC = 15%
2) Find Range (± 20%): 15% x 0.20 = 3%
3) Upper Limit: 15% + 3% = 18%
4) Lower Limit: 15% - 3% = 12%
5) Acceptable Moisture Range: 12% to 18%

Moisture Limits Example – Aggregates:
1) Given: OMC = 8%
2) Find Range (± 2 percentage points)
3) Upper Limit: 8% + 2% = 10%
4) Lower Limit: 8% - 2% = 6%
5) Acceptable Moisture Range: 6% to 10%

Moisture Limits Example – Cement Treated Aggregates:

1) Given: OMC = 5%
2) Find Range (+ 2 percentage points)
3) Upper Limit: 5% + 2.0% = 7%
4) Acceptable Moisture Range: 5% to 7%

8.3. Controlling Moisture

The dispersion of soil particles is not only important, but the conveyance of moisture within the dirt often influences its compactability. Dampness is essential for filling all soil pockets and for greasing the particles of dirt. On the chance that the dampness isn’t equitably scattered, despite the fact that the compactive exertion and normal dampness might be worthy, the thickness results won’t be acceptable. At the point when extra dampness is required, better dampness control is by and large got when included at the unearthing. The contracted worker’s duty to choose when and how dampness will be used is.

To ensure proper moisture:
➢ Monitor material behavior
➢ Watch equipment
➢ Take plenty of tests

Siphoning may occur on the chance that the moisture content of the dirt is excessively high. The material bends as piled, and the material bounces back to its unique location as the heap is eliminated. The con-structure gear seems to be sitting on a wave as it goes over the fill. The quality of the dirt is substantially reduced in this situation. Basically, one scheme is to let it dry out. If the area for syphoning is located in an undercut, extra seepage arrangements might be required. On the chance that the water content isn’t diminished by certain methods, and the chance of waste issues repeating isn’t wiped out, rehashed loadings will make interior shear disappointment in the bank. When siphoning happens, development ought not proceed until a perpetual answer for the seepage issues is found.

If moisture is too high:
➢ Wait
➢ Scarify
➢ Remove and replace
➢ Chemical treatment
➢ Geosynthetic bridging

If moisture is too low:
➢ Add water
➢ Thoroughly mix.

8.3.1. Factors governs fly ash as an embankment material

It is light weight material when contrasted with common soils consequently reasonable as bank fill over delicate compressible ground. An all around compacted fly debris bank would apply 60% of the weight on establishment contrasted with normal soils.

The fly debris compaction bent is moderately level, meaning that the level of compaction is less touchy to the water content and fly debris can be used as a dike material even in wet environments.

Fly debris has a high shear resistance point, as compared to normal soils, better durability of slants could be obtained.
Fly debris compaction should be achievable with accelerated thickness changes within the usage of either static or vibratory roller within five to six targets, thereby making the development.

Over the entirety of its calculates its accessibility bountiful could be used viably evading consumption of normal geo material and counterbalancing issues like removal and natural contamination.

9. RESULTS

| S.NO | EXPERIMENTAL TEST                  | RESULT           |
|------|-----------------------------------|------------------|
| 01   | SPECIFIC GRAVITY                  | 2.70%            |
| 02   | SEIVE ANALYSIS                    | 0.04%            |
| 03   | MOISTURE CONTENT                  | 11.11%           |
| 04   | DIRECT SHEAR STRENGTH             | 0.694 Kg/cm²     |

10. CONCLUSION

As fly ash is abundantly available and there are many problems associated with disposing of fly ash and heavy metal toxicity leached to the ground water table. On the other hand, fly ash has substantial geotechnical, chemical and physical properties that replace fly ash on soil and prevent natural geo material from being degraded and concerns such as disposal and environmental degradation can be used as an embankment material, this paper has been attempted to encourage the use of fly ash as a causeway material in Highway Engineering.

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