# The Combined Potential usage of Fly Ash (FA) and Recycled Coarse Aggregates (RCA) in Highway Embankment Construction

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***Abstract:*** **In now a day's cement and aggregates made a major role in construction, at the same time an aggregates depletes in nature, cost of cement and aggregates also high due to large consumption. So this case we are studied under partial replacement of cement and coarse aggregates. In this experimental study we are partially replaced cement with fly ash (FA) and fresh (new) coarse aggregates with recycled coarse aggregates. The cement is replaced with fly ash at the interval of 5% weight of cement, to the range of 0% to 25%. And coarse aggregates are partially replaced with RCA at the interval of 10% weight of CA, to the range of 0% to 50%. Also determine their mechanical property at 7, 14 and 28 days of curing. To ensure the optimum percentage of strength in replaced fly ash and RCA in concrete.**

***Key words: Fly ash (FA), Recycled coarse aggregates (RCA), Optimum, Mechanical property etc,***

## I. INTRODUCTION

Highway embankment made of heavy material to obtain the load from the pavement. We are selected highway embankment to replace the optimum percentage of fly ash and recycled coarse aggregates in the replacement of cement and coarse aggregates the highway embankment can lead to reduce the earth pressure on the structure of pavement and allows the retaining wall to use for an opening supports.

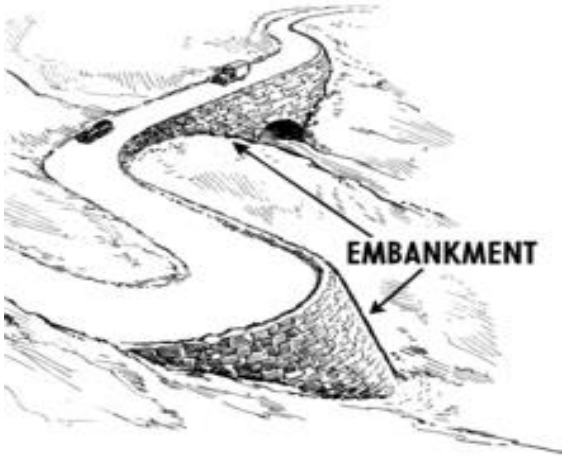


Fig 1: Embankment

### 1.1 Cement

In this paper we have used cement OPC 43 Grade (Ultratech cement).

### 1.2 Fine aggregates

Fine aggregate is used 4.75 mm Indian standers sieve passed M-sand is used in the preparation of specimen.

### 1.3 Fly ash

Locally available fly ash is used for the partial replacement in concrete mix.

Fig 2: Fly ash

### 1.4 Coarse aggregates

Coarse aggregates is the another main component in construction these are extracted from ground surface deposits.

### 1.5 Recycled coarse aggregates (RCA)

RCA are the new technique to avoid the demand of new aggregates for the construction, after demolition of old roads and buildings, the concrete removed aggregates are considered recycled coarse aggregates.

Fig 3: Recycled coarse aggregates

## II. MATERIALS AND METHODOLOGY

### 2.1 MATERIALS

The M-25 Grade concrete is proffered in this project, mixing proportion is based on mix design of M-25 Grade. The listed materials are used in this experimental study.

2.1.1 Binding material
- (1). Cement
- (2). Fly ash

2.1.2 Fine aggregates

2.1.3 Coarse aggregates
- (1). Natural aggregates
- (2). Recycled coarse aggregates

2.1.4 Water

### 2.2 METHODOLOGY

2.2.1 The following procedure is adopted in construction procedure,

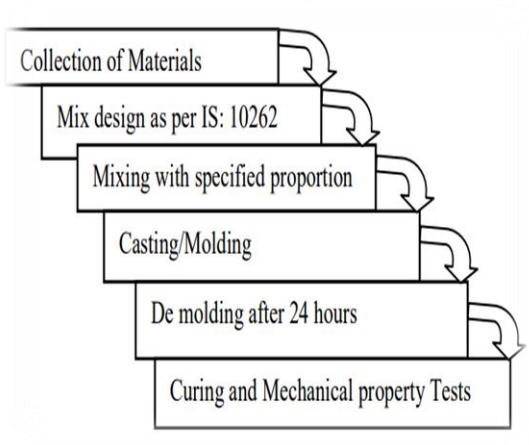


Fig 4. Flow chart

### 2.3 EXPERIMENTAL STUDIES

#### 2.3.1 Mix design

In this test we used M-25 Grade of concrete. The blend layout becomes accomplished as consistent. With IS 10262-2009, the blend % 1:1.52:2.86 is the mix proportion and W/C atio is 0.5

Table 1: mix proportion as per IS 20262-2009

| Materials | Qty/$m^3$ | Proportion |
|---|---|---|
| Cement | 394.32 kg | 1 |
| FA | 598.6 kg | 1.52 |
| CA | 1128.22 kg | 2.86 |
| water | 197.6 lit | 0.5 |

Fig 5. Mixing of Concrete

#### 2.3.2 Casting of Specimens

Cement, M-sand, Coarse combination, Fly ash had been weighed in a dry circumstance and that they combined collectively in a mix for you to keep away from cement, combination and water loss. Has the order of M-25 concrete composed with fly ash and RCA substitution The fly ash and RCA substitution charge become various among 0% to 25% and 0% to 50% respectively.

Fig 6. Sample of cube casting

### 2.3.3 Curing of specimens

In casted specimens are kept in a room temperature for 24 hours after harden the concrete the moulds are separate from mould apparatus. After the de mould transfer to the curing tank. After the specified days of curing 7, 14 and 28 days.

Fig 7. Curing tank

2.3.4 Testing of Specimens

After final touch of certain time of curing cubes are exanimate in well-known checking out machine (UTM).

Fig 8. Testing machine

## III. RESULTS AND DISCUTION

### 3.1 TESTS ON FRESH CONCRETE

3.1.1 Slump cone test
3.1.2 Compaction factor test
3.1.3 Vee-Bee test

### 3.1.1 Slump cone test:

Table 2: Slump cone test reading

| SL NO.. | W/C ratio | Slump value |
|---|---|---|
| 1 | 0.45 | 185 |
| 2 | 0.5 | 170 |
| 3 | 0.55 | 150 |

### 3.1.2 Compaction Factor Test

Table 3: Compaction test reading

| SL NO | W/C ratio | Compaction factor |
|---|---|---|
| 1 | 0.45 | 0.857 |
| 2 | 0.5 | 0.948 |
| 3 | 0.55 | 0.982 |

### 3.1.3 Vee-Bee test

Table 4: Vee-Bee test reading

| SL NO | W/C ratio | Vee-Bee in sec |
|---|---|---|
| 1 | 0.45 | 4.1 |
| 2 | 0.5 | 3.7 |
| 3 | 0.55 | 3.2 |

3.2 TO FIND OPTIMUM DOSAGE

*(A) Partially replacement of fly ash to find optimum dosage.*

Table.5: Partial replacement of fly ash in 7 days

| SL NO | % of replacement | Avg compressive strength KN/m$^2$ |
|---|---|---|
| 1 | 0% | 20.77 |
| 2 | 5% | 23.37 |
| 3 | 10% | 18.77 |
| 4 | 15% | 15.83 |
| 5 | 20% | 13.88 |
| 6 | 25% | 12.34 |

Table 6: partial replacement of fly ash in 14 days

| SL NO | % of replacement | Avg compressive strength KN/m$^2$ |
|---|---|---|
| 1 | 0% | 29.72 |
| 2 | 5% | 31.16 |
| 3 | 10% | 28.72 |
| 4 | 15% | 27.54 |
| 5 | 20% | 25.08 |
| 6 | 25% | 24.18 |

Table7: partial replacement of fly ash in 28 days

| SL NO | % of replacement | Avg compressive strength KN/m$^2$ |
|---|---|---|
| 1 | 0% | 31.57 |
| 2 | 5% | 33.16 |
| 3 | 10% | 30.19 |
| 4 | 15% | 28.67 |
| 5 | 20% | 27.25 |
| 6 | 25% | 26.05 |

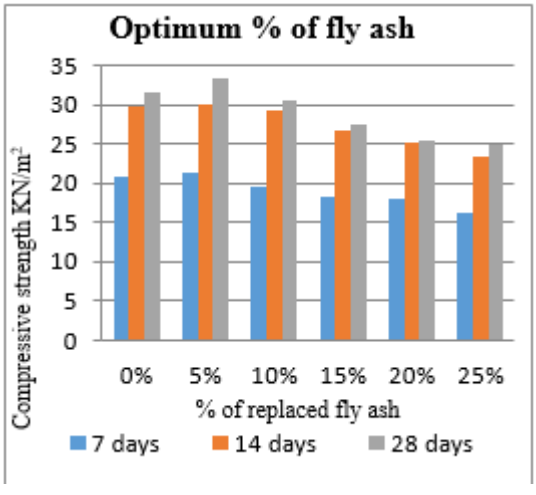


Fig 9: graphical representation of fly ash

*(B) Partial replacement of RCA to find optimum dosage.*

Table 8: Partial replacement of RCA in 7 days

| SL NO | % of replacement | Avg compressive strength KN/m$^2$ |
|---|---|---|
| 1 | 0% | 20.77 |
| 2 | 10% | 21.48 |
| 3 | 20% | 19.46 |
| 4 | 30% | 18.21 |
| 5 | 40% | 18.02 |
| 6 | 50% | 16.27 |

Table 9: Partial replacement of RCA in 14 days

| SL NO | % of replacement | Avg compressive strength KN/m$^2$ |
|---|---|---|
| 1 | 0% | 29.72 |
| 2 | 10% | 30.16 |
| 3 | 20% | 29.42 |
| 4 | 30% | 26.81 |
| 5 | 40% | 25.14 |
| 6 | 50% | 23.42 |

Table 10: Partial replacement of RCA in 28 days

| SL NO | % of replacement | Avg compressive strength KN/m$^2$ |
|---|---|---|
| 1 | 0% | 31.57 |
| 2 | 10% | 33.3 |
| 3 | 20% | 30.47 |
| 4 | 30% | 27.49 |
| 5 | 40% | 25.42 |
| 6 | 50% | 24.92 |

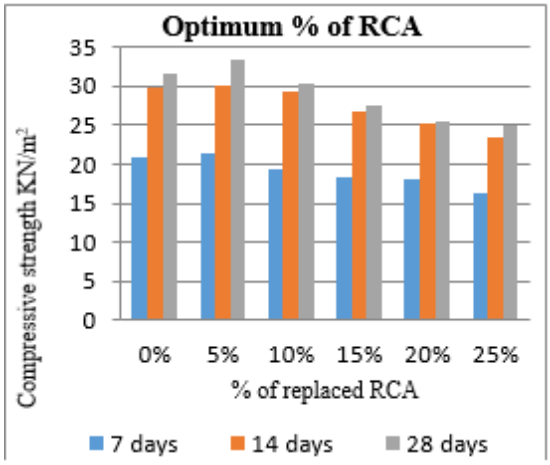


Fig 10: graphical representation of RCA

## Inference

From the above graphical representation we know the optimum % of dosage of replacement materiel in part alternative of fly ash 0%, 5%, 10%, 20% & 25% by weight of cement we get optimum of 5% as same in RCA replaced alternatively 0%,10% ,20%,30%,40% & 50% by weight of coarse aggregate we get optimum of 10%.

3.3 TESTS ON HARDEN CONCRETE
3.3.1 Compressive strength test
3.3.2 Split tensile test
3 3.3 Flexural strength test
3 3.4 Shear test

### 3.3.1 Compressive strength test

Table 11: Optimum % of fly ash & RCA in 7 days

| SL NO | Replacement material | Avg compressive strength |
|---|---|---|
| 1 | Conventional | 20.77 |
| 2 | Fly ash + RCA | 23…37 |

Table 12: Optimum % of fly ash & RCA in 14 days

| SL NO | Replacement material | Avg compressive strength |
|---|---|---|
| 1 | Conventional | 28.54 |
| 2 | Fly ash + RCA | 31.16 |

Table 13: Optimum % of fly ash & RCA in 28 days

| SL NO | Replacement material | Avg compressive strength |
|---|---|---|
| 1 | Conventional | 31.28 |
| 2 | Fly ash + RCA | 33.16 |

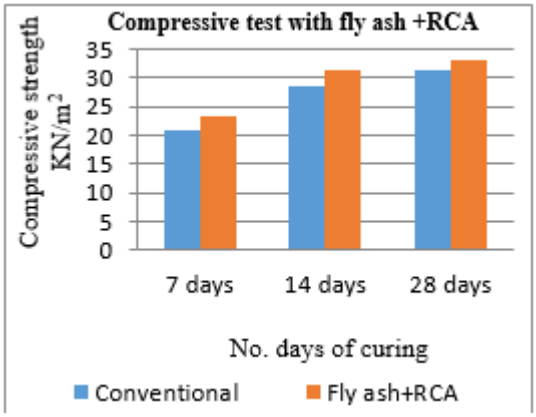


Fig 11. Graphical representation of compressive strength

### 3.3.2 Split tensile strength test

Table 14: Optimum % of fly ash & RCA in 7 days

| SL NO | Replacement material | Avg split tensile strength |
|---|---|---|
| 1 | Conventional | 2.17 |
| 2 | Fly ash + RCA | 2.56 |

Table 15: Optimum % of fly ash & RCA in 14 days

| SL NO | Replacement material | Avg split tensile strength |
|---|---|---|
| 1 | Conventional | 2.82 |
| 2 | Fly ash + RCA | 3.14 |

Table 16: Optimum % of fly ash & RCA in 28 days

| SL NO | Replacement material | Avg split tensile strength |
|---|---|---|
| 1 | Conventional | 2.97 |
| 2 | Fly ash + RCA | 3.62 |

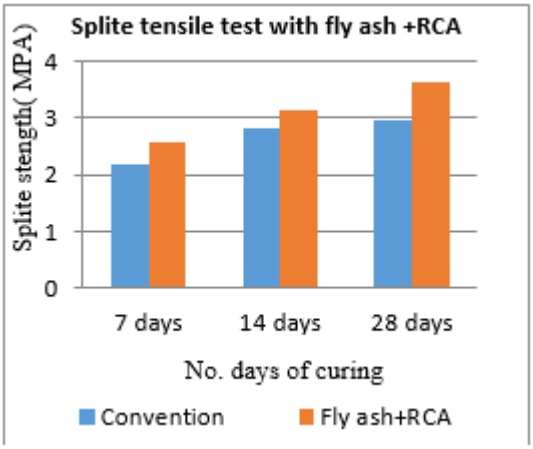


Fig 12: Graphical representation of split tensile strength

3.3.3 Flexural tensile strength test

Table 17: Optimum % of fly ash & RCA in 7 days

| SL NO | Replacement material | Avg flexural strength |
|---|---|---|
| 1 | Conventional | 2.82 |
| 2 | Fly ash+ RCA | 3.10 |

Table 18: Optimum % of fly ash & RCA in 14 days

| SL NO | Replacement material | Avg flexural strength |
|---|---|---|
| 1 | Conventional | 3.21 |
| 2 | Fly ash+ RCA | 3.54 |

Table 19: Optimum % of fly ash & RCA in 28 days

| SL NO | Replacement material | Avg flexural strength |
|---|---|---|
| 1 | Conventional | 3.29 |
| 2 | Fly ash + RCA | 4.10 |

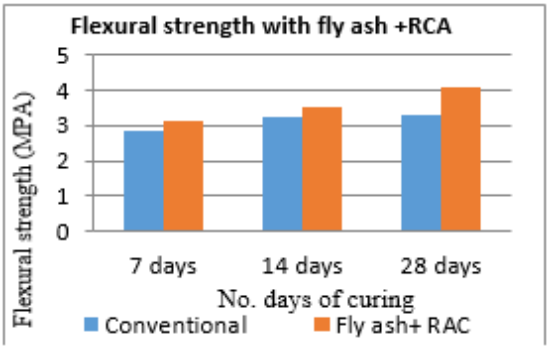


Fig 13: Graphical representation of flexural strength

3.3.4 Shear test

Table 20: Optimum % of fly ash & RCA in 7 days

| SL NO | Replacement material | Avg shear strength |
|---|---|---|
| 1 | Conventional | 5.92 |
| 2 | Fly ash + RCA | 7.12 |

Table 21: Optimum % of fly ash & RCA in 14 days

| SL NO | Replacement material | Avg shear strength |
|---|---|---|
| 1 | Conventional | 8.54 |
| 2 | Fly ash + RCA | 10.02 |

Table 22: Optimum % of fly ash & RCA in 28 days

| SL NO | Replacement material | Avg shear strength |
|---|---|---|
| 1 | Conventional | 9.62 |
| 2 | Fly ash + RCA | 12.45 |

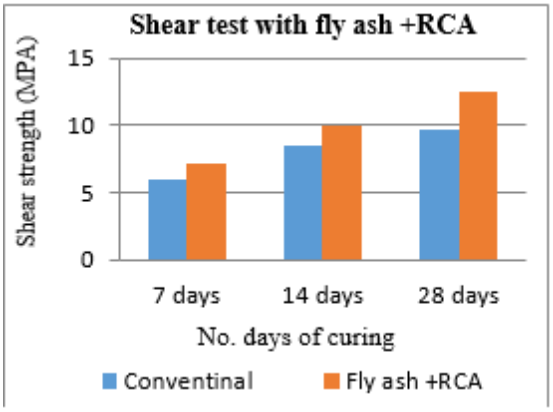


Fig 14: Graphical representation of shear test

## IV. CONCLUSION

In the study, we discovered suggest of M-25 grade concrete is executed blended the use of fly ash and RCA as partial alternative with cement and coarse aggregates respectively. We discovered from above experimental checks and consequences the received top-rated alternative of concrete made with 5% of fly ash and 10% of RCA.

- ❖ Compressive strength of conventional concrete is 31.02 KN/m2 @28 days of curing. The partially replaced combined fly ash and RCA is obtained 33.16 KN/m2. Also found that the strength is 5.66% increased.
- ❖ Split tensile strength of conventional concrete is 3.62 Mpa @ 28 days of curing.
  The partial replaced combined fly ash and RCA is obtained 3.26 Mpa. Also found that the strength is 17% increased.
- ❖ Flexural strength of conventional concrete is 3.29 Mpa @ 28 days of curing. The partially replaced combined fly ash and RCA is obtained 4.10Mpa. also found the strength is 19.75% increased.
- ❖ Shear strength of conventional concrete is 9.62 Mpa @ 28 days of curing. The partial replaced combined fly ash and RCA is obtained 12.45 Mpa. Also found that the strength is 22.73% increased.

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