Data Article

Data on the engineering properties of aluminum dross as a filler in asphalt

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\textbf{A B S T R A C T}

Pavement is the backbone of an effective and efficient transportation system. Data on the use of aluminium dross as filler material in the modification of asphalt for a sustainable pavement was espoused. Aluminium dross which is a solid waste from steel production industry was utilized. Data on the engineering and stability properties of the material in enhancing the strength of the asphalt mix design was espoused. This was achieved by adding the solid waste at 0\%, 2.5\%, 5\%, 7.5\%, 10\% and 12.5\% of aluminium dross to the asphalt concrete sample. Marshall Test was used to determine the stability of aluminium dross in flexible pavement and this was used for the selection of asphalt binder content with a suitable density which satisfies minimum stability and range of flow values using AASHTO specification. The data obtained will be of help to researchers, engineers, road construction workers and environmentalist on the use of this solid waste in the construction of sustainable long-lasting roads for national growth and solid waste reduction.

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### Value of data

- The data obtained here will contribute to the re-use of aluminium dross waste from steel production industry.
- The data will be of help to researchers, engineers, road construction workers and environmentalist on the use of this solid waste in road construction.
- The data could be used by highway engineers and road construction workers in the effective design of this modified asphalt.
- The data will aid policymakers on the proper use of this in pavement technology in the construction of sustainable roads.

There is a great information potential in the application of this waste in the road construction industry. This will help to reduce the negative effect of the improper disposal of the waste \[1,2\] and its re-use in transportation which is an integral component of national growth \[3-5\].

### 1. Data

Aluminium dross (Plate 1) is in abundance, and proper utilization of this waste product will be economical \[5-11\]. The research of \[5-7\] revealed common filler materials other than aluminium dross that has been used in the past and are still being used up till date in concrete and asphalt. Based on the findings of \[2\], it was discovered that aluminium industries create almost five million tons of this waste every year. Aluminium dross has several re-uses as avowed by \[2\]. This data set assessed the use of the waste in asphalt modification as a filler material.

Ductilometer was used in assessing the ductility of the bitumen before the addition of aluminium dross. Additionally, ball and ring test and penetration test was also carried out on the modified asphalt. This is because the wearing course expands under sunlight and retracts at night. Asphalt compacting machine is used to compact the Marshall Specimen manually for sample preparation. After selecting particle sizes of aggregates with the sieve analysis machine, the optimum bitumen content mix was added thoroughly, and the heated sample was placed inside the mould and the sample was thereafter placed under the compacting machine and the marshall stability equipment.
Table 1
Data on the Analyte Concentration.

| ELEMENT   | CONCENTRATION (Wt%) |
|-----------|---------------------|
| Na₂O      | 0.000               |
| MgO       | 0.931               |
| Al₂O₃     | 77.172              |
| SiO₂      | 13.482              |
| P₂O₅      | 0.000               |
| SO₂       | 0.700               |
| Cl        | 0.276               |
| K₂O       | 0.161               |
| CaO       | 1.129               |
| ClO₂      | 1.439               |
| Cr₂O₃     | 0.071               |
| Mn₂O₃     | 0.202               |
| Fe₂O₃     | 4.186               |
| ZnO       | 0.237               |
| SrO       | 0.015               |

Table 1 shows the data on the chemical composition of the solid waste after pulverization. Table 2 and 3 contain data on the sieve analysis of the aluminium dross and the aggregates respectively. Fig. 1 showed the data on the Ductility of the samples assessed. Table 4 contains values on the Marshall and Volumetric Properties of Bitumen Content Mix. Fig. 2, Fig. 3 shows Marshall Stability Vs Bitumen Content and Marshall Stability versus Bitumen Content. Fig. 4 shows the results of Bulk density versus Bitumen Content. Table 5 shows the Optimum Bitumen Content. Table 6 shows the data on Comparison of Marshall and Volumetric Properties of Bitumen.

The Bitumen Content samples were prepared at Optimum Bitumen Content with Aluminium dross as a filler it was used at 2.5%, 5%, 7.5% and 10% by weight of aggregates. The volumetric and Marshall properties of these samples were determined and compared.

2. Experimental design and methods

2.1. Materials

Aluminium dross was obtained from an open dumped site in Ado-Odo Ota local government in Ogun State, Nigeria. This material was collected in an airtight container. Bitumen of
Table 2  
Data on the sieve analysis of the aggregates.

| Wt of aggregate Retained | % of the total wt retained | Cumulative% of total wt retained | % passing |
|--------------------------|---------------------------|-------------------------------|-----------|
| I                        | II                        | AV                           |           |
| 19.0mm                   | 69                        | 80                           | 75        | 92.515 |
| 13.2mm                   | 74                        | 68                           | 71        | 92.915 |
| 12.5mm                   | 11                       | 22                           | 17        | 98.304 |
| 9.5mm                    | 64                        | 54                           | 59        | 94.112 |
| 6.3mm                    | 127                       | 128                          | 128       | 87.226 |
| 4.75mm                   | 74                        | 70                           | 72        | 87.815 |
| 2.36mm                   | 180                       | 180                          | 180       | 82.036 |
| 1.00mm                   | 170                       | 180                          | 175       | 82.535 |
| 0.60mm                   | 108                       | 90                           | 99        | 90.12  |
| 0.30mm                   | 69                        | 75                           | 72        | 92.815 |
| 0.15mm                   | 39                        | 37                           | 38        | 96.208 |
| 0.075mm                  | 12                        | 12                           | 12        | 98.803 |
| Receiver                 | 3                         | 4                            | 4         | 99.601 |

Table 3  
Determination of particle size distribution of coarse aggregate.

| LS Sieve sizes | Weight of Aggregate retained (g) | % of total weight retained | Cumulative% of total weight retained | Cumulative% Passing |
|----------------|----------------------------------|----------------------------|-------------------------------------|---------------------|
| I             | 2                               | Average (g)                |                                     |                     |
| 19.0mm        | 31                              | 23                         | 27                                  | 2.7                 | 2.7                | 97.3               |
| 13.2mm        | 252                             | 307                        | 279.5                               | 27.95               | 30.65              | 69.35              |
| 12.5mm        | 21                              | 11                         | 16                                  | 1.6                 | 32.25              | 67.75              |
| 9.5mm         | 116                             | 98                         | 107                                 | 10.7               | 42.95              | 57.05              |
| 6.3mm         | 156                             | 146                        | 151                                 | 15.1               | 58.05              | 41.95              |
| 4.75mm        | 144                             | 138                        | 141                                 | 14.1               | 72.15              | 27.85              |
| 2.36mm        | 98                              | 97                         | 97.5                                | 9.75               | 81.9               | 18.1               |
| 1.00mm        | 40                              | 40                         | 40                                  | 4.0                | 85.9               | 14.1               |
| 0.60mm        | 28                              | 27                         | 27.5                                | 2.75               | 88.65              | 11.35              |
| 0.30mm        | 74                              | 74                         | 74                                  | 7.4                | 96.05              | 3.95               |
| 0.15mm        | 34                              | 33                         | 33.5                                | 3.35               | 99.4               | 0.6                |
| 0.075mm       | 5                               | 3                          | 4                                   | 0.4                | 99.8               | 0.2                |
| Receiver      | 2                               | 2                          | 2                                   | 0.2                | 100.0              | 0.00               |

Table 4  
Data on the Marshall and Volumetric Properties of Bitumen Content Mix.

| Bitumen Content (%) | Marshall Stability (KN) | Flow (mm) | Density (g/cm³) | Vv (%) | VFB (%) | VMA (%) |
|---------------------|-------------------------|-----------|-----------------|--------|---------|---------|
| 2.5                 | 14.07                   | 3.15      | 2.35            | 4.52   | 67.02   | 13.70   |
| 5.0                 | 14.97                   | 3.24      | 2.35            | 4.05   | 69.40   | 13.20   |
| 7.5                 | 13.96                   | 4.18      | 2.33            | 3.87   | 70.20   | 12.97   |
| 10.0                | 13.70                   | 4.16      | 2.12            | 3.56   | 70.55   | 12.45   |
| 12.5                | 13.22                   | 4.06      | 2.04            | 3.44   | 70.89   | 12.13   |

Table 5  
Optimum Bitumen Content.

| Bitumen Content (%) | Max Stability | Max Density | 4.5% Air Voids | Optimum Bitumen Content (OBC) |
|---------------------|---------------|-------------|----------------|-----------------------------|
|                     | 5.5           | 5.5         | 5              | 5                           |


Fig. 1. Data on the Ductility of the samples assessed.

Table 6
Comparison of Marshall and Volumetric Properties of Bitumen.

| Aluminium Dross | Marshall stability (KN) | Flow(mm) | Density (g/cc) | Vv (%) | VFB (%) |
|----------------|-------------------------|----------|----------------|--------|---------|
| 0              | 14.07                   | 2.74     | 1.245          | 3.6    | 62.11   |
| 2.5            | 14.55                   | 2.61     | 1.150          | 3.8    | 63.41   |
| 5              | 14.86                   | 2.82     | 1.130          | 4.01   | 68.40   |
| 7.5            | 14.97                   | 2.45     | 1.160          | 3.85   | 67.22   |
| 10.0           | 14.84                   | 2.36     | 1.236          | 3.68   | 60.42   |

Penetration Grade 60/70 was purchased in Lagos, Nigeria. The Penetration test was carried out to re-affirm the penetration grade. Fine aggregates (river sand) and coarse aggregate were purchased in a quarry in Ogun State.

2.2. Sample preparation

The aluminium dross was obtained in the raw form and sealed in an airtight bag and air-dried for forty-eight hours (48) before pulverization. Fine aggregate is soil particles that pass through a 4.25 mm sieve and coarse aggregates of size 4.75 mm were used.

2.3. Test and methods

Wavelength-dispersion X-ray fluorescence spectrometer and atomic absorption spectrometer was used to determine the chemical composition of the waste. Mechanical sieve shaker was used to assess the grain size analysis of both aluminium dross and the aggregates used. This test procedure was used in designing and evaluating bituminous Paving mixes using ASTM standard procedures.

Tests were carried out on the bitumen to determine the rheology. The viscosity test was done according to [12], and the penetration test was also done conferring to the specification of [13].
Fig. 2. Marshall Stability Vs Bitumen Content.
Fig. 3. Bulk density Vs Bitumen Content.

Fig. 4. Percentage Air Void Vs Bitumen Content.

The bitumen was modified with aluminium dross at 0, 2.5, 5, 7.5 and 10% of the bitumen waste. The rheology was then repeated at the percentage additions. Marshall stability was done on the asphalt mixture with the naturally occurring bitumen and the polymer modified bitumen according to [14].

Declaration of Competing Interest

Authors declare no conflict of interest

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2020.105934.

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