**Fig 1. (a)Relative mineral content**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Quartz（%）** | **Illite (%)** | **Kaolinite (%)** | **Chlorite (%)** | **Montmorillonite (%)** | **Anorthite (%)** | **Hematite (%)** |
| 66.32 | 10.47 | 13.36 | 4.27 | 0.38 | 0.50 | 4.69 |

**Fig 1. (b)Relative mineral content**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Particle size（mm）** | <5.000 | 2.000-5.000 | 1.000-2.000 | 0.500-1.000 | 0.250-0.500 | 0.100-0.250 | 0.075-0.100 | <0.075 |
| **Grain size distribution** | 16.000 | 26.300 | 51.500 | 112.900 | 105.500 | 54.000 | 100.200 | 34.000 |

**Fig 4. (a) Plant growths.**

|  |  |  |
| --- | --- | --- |
| **Group number** | **Germination rate (%)** | **Plant height on the 25th day (mm)** |
| 1 | 67.00 | 61.00 |
| 2 | 79.00 | 75.00 |
| 3 | 72.00 | 50.00 |
| 4 | 68.00 | 60.00 |
| 5 | 72.00 | 52.00 |
| 6 | 63.00 | 40.00 |
| 7 | 65.00 | 50.00 |
| 8 | 65.00 | 61.00 |
| 9 | 58.00 | 43.00 |
| 10 | 57.00 | 40.00 |

**Fig 4. (b)** **Soil parameters.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Soil parameters** | **Water-absorbing content / Adhesive content (g/m2)** | | | |
| **0.00/0.00** | **15.00/5.00** | **30.00/5.00** | **60.00/10.00** |
| **Shrinkage rate (%)** | 31.03 | 31.29 | 30.23 | 28.48 |
| **Internal friction angle (°)** | 14.8 | 17.3 | 26.7 | 22.7 |
| **Cohesion (kPa)** | 11.04 | 27.02 | 17.91 | 10.72 |
| **Erosion rate (%)** | 3.47 | 14.44 | 16.35 | 17.3 |
| **Water content (%)** | 13.32 | 13.45 | 11.98 | 10.47 |
| **Swelling rate (%)** | 10.58 | 9.72 | 8.45 | 7.26 |
| **pH** | 5.6 | 6.5 | 6.8 | 6.8 |
| **Permeability coefficient (cm/s)** | 0.78 | 0.66 | 0.38 | 0.31 |
| **Electrical conductivity (mS/cm)** | 0.54 | 0.72 | 0.44 | 0.24 |

**Fig 5. Comparison of erosion rate (%)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00** **(%)** | 3.47 | 14.44 | 14.13 | 16.35 | 11.03 | 17.30 |
| **1.00 (%)** | 3.94 | 9.63 | 4.48 | 13.25 | 4.57 | 6.86 |
| **2.50 (%)** | 2.44 | 4.04 | 5.65 | 8.91 | 3.05 | 12.56 |
| **5.00 (%)** | 2.26 | 4.64 | 6.18 | 10.14 | 6.74 | 6.37 |
| **10.00 (%)** | 1.97 | 1.92 | 3.85 | 7.92 | 3.43 | 5.87 |

**Fig 6. Comparison of the cohesive forces of each sample (%)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 8.38 | 18.75 | 17.07 | 16.62 | 27.78 | 11.04 |
| **1.00 (%)** | 10.72 | 24.03 | 17.91 | 19.57 | 26.15 | 21.80 |
| **2.50 (%)** | 17.16 | 26.73 | 19.56 | 24.03 | 27.02 | 22.00 |
| **5.00 (%)** | 18.48 | 27.19 | 23.46 | 24.96 | 32.98 | 23.51 |
| **10.00 (%)** | 18.48 | 40.26 | 23.98 | 27.00 | 34.84 | 36.70 |

**Fig 7. Comparison of the internal friction angles of each sample (°)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 22.70 | 20.30 | 26.70 | 23.90 | 17.30 | 14.80 |
| **1.00 (%)** | 20.10 | 14.70 | 14.70 | 16.40 | 14.30 | 24.40 |
| **2.50 (%)** | 6.10 | 8.20 | 10.50 | 15.40 | 22.80 | 20.60 |
| **5.00 (%)** | 14.90 | 16.60 | 20.60 | 13.70 | 25.10 | 28.10 |
| **10.00 (%)** | 15.60 | 17.70 | 23.40 | 27.50 | 18.60 | 16.60 |

**Fig 9. Moisture content of each sample with different amounts of additional weathered red-bed soil over 120 h (%)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 10.41 | 11.95 | 12.32 | 12.34 | 13.20 | 13.09 |
| **1.00 (%)** | 10.55 | 11.45 | 13.02 | 13.31 | 13.86 | 14.55 |
| **2.50 (%)** | 12.94 | 13.17 | 13.85 | 14.24 | 15.64 | 16.04 |
| **5.00 (%)** | 14.71 | 14.98 | 15.92 | 16.27 | 16.72 | 17.73 |
| **10.00 (%)** | 15.17 | 16.40 | 16.92 | 18.83 | 18.12 | 19.64 |

**Fig 10. Comparison of shrinkage rate (%)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 28.48 | 29.83 | 30.23 | 30.36 | 31.29 | 31.03 |
| **1.00 (%)** | 28.56 | 29.65 | 29.98 | 29.35 | 30.56 | 30.13 |
| **2.50 (%)** | 28.60 | 28.20 | 28.22 | 28.32 | 28.86 | 29.67 |
| **5.00 (%)** | 27.71 | 27.48 | 28.57 | 28.14 | 26.78 | 29.38 |
| **10.00 (%)** | 26.63 | 27.32 | 26.25 | 28.17 | 26.63 | 25.61 |

**Fig 11. pH change at different amounts of added weathered red-bed soil**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 6.80 | 5.80 | 6.80 | 5.80 | 6.50 | 5.60 |
| **1.00 (%)** | 6.10 | 6.90 | 6.00 | 5.40 | 4.80 | 5.09 |
| **2.50 (%)** | 6.90 | 6.80 | 6.10 | 5.60 | 4.90 | 5.31 |
| **5.00 (%)** | 6.50 | 7.00 | 6.80 | 5.60 | 4.80 | 5.01 |
| **10.00 (%)** | 6.20 | 6.90 | 5.70 | 5.30 | 4.80 | 4.15 |

**Fig 12. Change in electrical conductivity at different amounts of added weathered red-bed soil (mS/cm)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 0.024 | 0.044 | 0.044 | 0.066 | 0.072 | 0.054 |
| **1.00 (%)** | 0.036 | 0.054 | 0.051 | 0.076 | 0.078 | 0.066 |
| **2.50 (%)** | 0.030 | 0.066 | 0.066 | 0.066 | 0.078 | 0.096 |
| **5.00 (%)** | 0.042 | 0.054 | 0.072 | 0.084 | 0.084 | 0.086 |
| **10.00 (%)** | 0.064 | 0.074 | 0.084 | 0.096 | 0.09 | 0.096 |

**Fig 13. Comparison of the expansion rate at different levels of added weathered red-bed soil (%)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 7.26 | 7.76 | 8.45 | 9.23 | 9.72 | 10.58 |
| **1.00 (%)** | 6.80 | 8.45 | 8.28 | 9.38 | 9.81 | 10.70 |
| **2.50 (%)** | 7.39 | 8.68 | 8.77 | 9.82 | 10.71 | 10.86 |
| **5.00 (%)** | 7.93 | 7.33 | 9.67 | 9.55 | 10.79 | 11.38 |
| **10.00 (%)** | 8.39 | 10.18 | 10.61 | 10.68 | 10.17 | 11.34 |

**Fig 14. (a) Upper and lower limitations applied (cm/s)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 0.43 | 0.46 | 0.56 | 0.43 | 1.21 | 2.16 |
| **1.00 (%)** | 0.12 | 0.67 | 0.45 | 0.23 | 1.20 | 1.83 |
| **2.50 (%)** | 0.27 | 0.57 | 0.61 | 0.43 | 0.38 | 1.36 |
| **5.00 (%)** | 0.27 | 0.34 | 0.41 | 0.43 | 0.58 | 0.66 |
| **10.00 (%)** | 0.15 | 0.33 | 0.13 | 0.52 | 0.34 | 0.59 |

**Fig 14. (b) Upper and lower limitations not applied.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **materials** | **0.00/0.00 (g/m2)** | **15.00/2.50 (g/m2)** | **15.00/5.00 (g/m2)** | **30.00/2.50 (g/m2)** | **30.00/5.00 (g/m2)** | **60.00/10.00 (g/m2)** |
| **0.00 (%)** | 0.31 | 0.28 | 0.38 | 0.40 | 0.66 | 0.78 |
| **1.00 (%)** | 0.43 | 0.34 | 0.41 | 0.47 | 0.78 | 1.18 |
| **2.50 (%)** | 0.43 | 0.43 | 0.50 | 0.71 | 0.63 | 1.14 |
| **5.00 (%)** | 0.56 | 0.60 | 0.55 | 0.34 | 0.87 | 1.19 |
| **10.00 (%)** | 0.67 | 0.62 | 0.87 | 1.01 | 0.92 | 1.72 |

**Fig 16. Temporal change in plant growth in ester materials coupled with weathered red-bed soil**

|  |  |  |
| --- | --- | --- |
| **Group number** | **Germination rate (%)** | **Plant height on the 25th day (mm)** |
| 1 | 50.00 | 105.00 |
| 2 | 80.00 | 125.00 |
| 3 | 75.00 | 127.00 |
| 4 | 75.00 | 124.00 |
| 5 | 90.00 | 135.00 |
| 6 | 65.00 | 112.00 |
| 7 | 65.00 | 118.00 |
| 8 | 70.00 | 126.00 |
| 9 | 80.00 | 126.00 |
| 10 | 45.00 | 101.00 |
| 11 | 35.00 | 98.00 |