Appendix A

Unconfined Compressive Strength Test Results

In the present study, the following assumptions have been taken to determine the volumetric lime content and Porosity of stabilized red mud.

a. The amount of lime for each mixture was calculated based on the mass of dry red mud.

b. The dry density of the specimens was calculated as the dry mass of the bauxite residue and lime divided by the total volume of the sample.

Volumetric lime content (L_v): It is defined as volume of lime with respect to total volume/volume of specimen and expressed in percentage.
Suppose, We take 100 gm of bauxite residue and L gm of lime.
Then, total mass (m_T) = (100+L) gm.

TABLE A.1: Data sets of UCS results based on conventional designed approach

Molding moisture (w) %	Curing time (t) days	Dry density (γ_d) kN/m^3	Unconfined compressive strength (UCS) (kPa)				
			Lime content (L) %				
			3	5	7	9	11
26	7	13	465.418	684.073	779.215	899.12	975.497
		14	629.217	905.087	1069.397	1264.91	1258.683
		15	828.04	1218.337	1344.193	1693.497	1753.247
		15.5	1018.222	1571.063	1764.923	1891.687	1996.012
	28	13	703.216	733.601	813.716	994.106	1185.664
		14	807.51	997.01	1318.9	1608.2	1660.495
		15	1166.257	1436.086	1823.707	2078.392	2293.764
		15.5	1525.137	1774.88	2168.977	2776.945	3100.12
	60	13	1092.953	1330.863	1546.84	1716.273	1854.623
		14	1542.237	1788.387	2059.573	2285.457	2199.273
		15	1716.407	2377.5	2626.547	2835.45	3194.367
		15.5	1779.93	2815.718	3374.56	3680.877	3989.257
28	7	13	467.686	702.13	779.67	907.323	1011.363
		14	630.84	914.21	1089.78	1305.513	1298.367
		15	838.74	1232.903	1376.393	1726.282	1811.227
		15.5	1067.466	1580.157	1770.27	1927.173	2123.69
	28	13	662.004	764.31	939.743	1102.508	1238.986
		14	977.453	1101.156	1421.623	1807.464	2029.083
		15	1153.247	1526.165	2012.713	2290.519	2671.047
		15.5	1685.573	1987.139	2357.185	2877.823	3512.85
	60	13	1207.08	1356.943	1553.253	1747.11	1904.47
		14	1482.3	2007.613	2088.443	2234.333	2460.557
		15	1773.5	2336.085	2684.29	2916.023	3438.62
		15.5	2156.377	2878.97	3470.22	3607.15	4350.593

Table **A.1 Continued.....**

Molding moisture (w) %	Curing time (t) days	Dry density (γ_d) kN/m^3	Unconfined compressive strength (UCS) (kPa)				
			Lime content (L) %				
			3	5	7	9	11
30	7	13	502.686	752.13	829.67	957.323	1061.363
		14	665.84	964.21	1139.78	1355.513	1348.367
		15	888.74	1282.903	1426.393	1776.282	1861.227
		15.5	1217.466	1630.157	1820.27	1977.173	2173.69
	28	13	690.87	820.499	1034.992	1175.352	1314.87
		14	999.103	1223.177	1594.178	1897.813	2207.861
		15	1283.238	1677.116	2098.332	2591.74	2841.07
		15.5	1750.3	2157.828	2538.008	2977.703	3609.515
	60	13	925.795	1310.583	1643.909	1753.038	1921.272
		14	1310.317	1989.559	2193.261	2342.121	2613.494
		15	1711.83	2432.063	2770.543	2990.948	4092.105
		15.5	2171.588	3050.891	3573.553	3853.804	4611.447

So,

$L_v = \frac{Volume\ of\ lime}{Total\ volume} = \frac{\frac{Mass\ of\ lime\ (m_L)}{(Densuty\ of\ lime\ (\gamma_L)}}{\frac{Total\ mass\ (m_T)}{Density\ of\ specimen\ (\gamma_d)}} = \frac{\gamma_d \times m_L}{G_L \times \gamma_w \times m_t} = \frac{\gamma_d \times L}{G_L \times \gamma_w \times (100+L)}$

$= \frac{\gamma_d \times (\frac{L}{100})}{G_L \times \gamma_w \times (1+\frac{L}{100})}$

Finally,

$$L_v(\%) = \left[\frac{\frac{\gamma_d}{\left(1+\frac{L}{100}\right)} \times \left(\frac{L}{100}\right)}{G_L \times \gamma_w}\right] \times 100 \qquad \text{(A.1)}$$

Where:

γ_w = Density of the specimen (Defined as the weight of the water per its unit volume).

γ_d = Dry density of the specimen (Defined as the weight of solid in a given volume).

L = Lime content (Defined as the mass of lime with respect to total mass).

G_L = Specific gravity of lime (Defined as the ratio of the density of lime solids to the density of water).

G_{RM} = Specific gravity of bauxite residue (Defined as the ratio of the density of bauxite residue solids to the density of water).

Porosity (η): It is defined as volume of voids with respect to total volume/volume of specimen and expressed in percentage.

So,

$$\eta = \frac{Volume\,of\,voids}{Total\,volume} = \frac{Total\,Volume - Volume\,of\,voids}{Total\,volume} = 1\text{-}\frac{Volume\,of\,Solids}{Total\,volume}$$

$$= 1\text{-}\frac{Volume\,of\,RedMud}{Total\,volume} + \frac{Volume\,of\,lime}{Total\,volume}$$

$$= 1\text{-}\ Volumetric\,red\,mud\,content + Volumetric\,lime\,content$$

$$= 1\text{-}\ \left[\left[\frac{\frac{\gamma_d}{\left(1+\frac{L}{100}\right)})}{G_{RM}\times\gamma_w}\right] + \left[\frac{\frac{\gamma_d}{\left(1+\frac{L}{100}\right)}\times(\frac{L}{100})}{G_L\times\gamma_w}\right]\right]$$

Finally,

$$\eta(\%) = 100 - 100\left[\left\{\frac{\gamma_d}{1+(\frac{L}{100})}\right\}\left\{\frac{1}{G_R\gamma_w} + \frac{(\frac{L}{100})}{G_L\gamma_w}\right\}\right] \qquad (A.2)$$