

EXPERIMENTATION OF RAPID CHLORIDE PERMEABILITY TEST ON READY MIX CONCRETE PLANT WASTE AGGREGATE CONCRETE. (R.M.C.A.C)

AbhayShelar¹, Dr. D. Neeraja², Dr. Amit B. Mahindrakar³
VELLORE INSTITUTE OF TECHNOLOGY VELLORE

Abstract- This paper presents an experimental program on rapid chloride permeability test on Ready mix concrete plant waste aggregate concrete Utilising oil concrete production not only solves the problem of disposing this solid waste but also help to conserve natural resources. The parameter of investigation included rapid chloride permeability test for a period of 7 days, 28 days and 90 days. Ready mix concrete plant waste aggregate specimens of 100×50 mm cylinders were cast and tested. The chloride permeability values were compared to ASTM C1202 criteria

Keywords-, Rapid chloride permeability test, Ready mix concrete plant waste aggregate chloride permeability test

1. INTRODUCTION

Increase of population has made large demand on construction material and it leads to a chronic shortage of building materials and thereby increasing the construction cost due to the shortage. To solve this problem, engineers are not only challenged for the future home building in term of construction cost control but also need to convert the plant wastes to useful construction and building materials. Once of the way was introduced plant waste material in concrete to reduce the use of aggregate. Such wastes material like fly ash, wood chipping, paper mill, crumb rubber, silica fume and palm oil clinker etc [1-7]. Extensive research work has been carried out by Mohammed and Mohammed et al. to produce concrete utilizing to fine and coarse aggregate [8,9]. The physical and mechanical properties of the oil palm clinker concrete have been established. The developed ready mix concrete plant waste aggregate concrete easily attains strength of more than 18 MPa, which is a requirement for structural lightweight concrete as per ASTM C330 [10]. Lightweight

concrete using ready mix concrete plant waste aggregate as replacement aggregate is still a relatively new construction material and the structural performance of the concrete has not yet been investigated. Therefore, the ability of chloride ions to penetrate the concrete must then be known for design as well as quality control purposes. Reinforced concrete structures are exposed to harsh environments yet is often expected to last with little or no repair or maintenance for long periods of time (often 100 years or more). To do this, a durable structure needs to be produced. For reinforced concrete bridges, one of the major forms of environmental attack is chloride ingress, which leads to corrosion of the reinforcing steel and a subsequent reduction in the strength, serviceability, and aesthetics of the structure. This may lead to early repair or premature replacement of the structure. A common method of preventing such deterioration is to prevent chlorides from penetrating the structure to the level of the reinforcing steel bar by using relatively impenetrable concrete. The ability of chloride ions to penetrate the concrete must then be known for design as well as quality control purposes. The resistance of concrete to penetration by chlorides is an important factor in protecting reinforced concrete structures from premature deterioration. The penetration of the concrete by chloride ions, however, is a slow process. It cannot be determined directly in a time frame that would be useful as a quality control measure. Therefore, in order to assess chloride penetration, a test method that accelerates the process is needed, to allow the

determination of diffusion values in a reasonable time. The Rapid Chloride Permeability Test (RCPT), as it is commonly called, has been in existence for over 20 years and was standardized by ASTM over 20 years ago. The test is used extensively in the concrete industry for assessing concrete quality.

2. READY MIX CONCRETE PLANT WASTE AGGREGATE AGGREGATE PROPERTIES

The ready mix concrete plant waste aggregate was sieved to 2 categories which is fine aggregate (< 5mm) and coarse aggregate (5mm-14mm). Table 1 below shows the aggregate properties for both fine and coarse aggregate

Table1: Properties of ready mix concrete plant waste aggregate

Properties	Fine	Coarse
Aggregate size (mm)	<4.75	4.75 - 20
Bulk Density(kg/m ³)	1580.82	1684.42
Specific gravity(SSD)	2.72	2.74
Moisture content	0.15	0.08
Water absorption (24 hours)	16.5	18.5
Fineness modulus	2.36	2.74
Los Angeles abrasion value, %	-	26.22
Aggregate impact value (AIV), %	-	26.34
Aggregate crushing value (ACV), %	-	19.42

Totals having dry unit weights (of under) 1600 kg/m³ [11]. Because of the permeable idea of ready mix concrete plant waste aggregate total, low mass thickness and high water ingestion were normal. Ready mix concrete plant waste aggregate fine and coarse total has a unit weight of 1580.82 kg/m³ and 1684.42 kg/m³. This lessens the general dead load in a structure, which accompanies a lot of sparing in the aggregate development cost. When all is said in done, most ready mix concrete plant waste aggregate total have higher water ingestion esteems contrasted with regular total. Despite the fact that ready mix concrete plant waste aggregate has high

water assimilation, significantly higher water retention were accounted for pumice total which have an estimation of around 18 % [14]. However the high water retention of ready mix concrete plant waste aggregate total can be gainful to the subsequent solidified cement. It has been accounted for that ready mix concrete plant waste aggregate cements with permeable total (high water assimilation) are less touchy to poor curing when contrasted with typical weight concrete particularly in the early ages because of the inner water supply put away in the permeable ready mix concrete plant waste aggregate total. [15] From Table 1, it can be watched that the total effect esteem (AIV) and total smashing worth (ACV) of ready mix concrete plant waste aggregate aggregates were higher compared to the ordinary squashed stone totals [12]. All the more particularly the AIV and ACV were roughly 35% and 30% higher individually contrasted with the stone total. The higher ACV esteem for the ready mix concrete plant waste aggregate total may be caused by the molecule state of ready mix concrete plant waste aggregate utilized as a part of this examination which is permeable and precise. The total with such shape and condition have the likelihood to be squashed when stack is connected on them.

3. EXPLORATORY PROGRAM

3.1. MATERIAL

The materials utilized as a part of this work are water, Ordinary Portland Cement and ready mix concrete plant waste aggregate total. The water utilized is a consumable drinking water from tap which appropriate for solid work [16]. Business bond meeting the ASTM C150 [17] for Type I Portland concrete was utilized in this examination. The total utilized is ready mix concrete plant waste aggregate acquired from locally palm oil maker in Malaysia. The clinkers are smashed and were isolated into wanted size; fine total (particles less than 5mm) and coarse total (molecule between 5-14mm).

Charge passing in Coulombs	Chloride permeability rating
Greater than 4000	High
2001 to 4000	Moderate
1001 to 2000	low
100 to 1000	Very low
Less than 100	Negligible

3.2. MIX PROPORTIONS

The Proportions proportioning was done in as per the necessities of ACI Committee 211.2-98 [18]. A focal composite outline (CCD) was utilized for the factor setting after a broad trail blends were done in the research facility. The elements utilized as a part of this work are water-bond proportion (x1) and concrete substance (x2). Each factor has settled the farthest point in agreement to the necessities of ACI Committee 211.2-98 [18] which water-bond proportion and concrete substance have extend 0.36-0.50 and 480-520 kg/m³ individually. The elements esteem is appeared in Table 2.

Table2: Factor setting using central composite design

Factor	Axial point	minimum	centre	Maximum	Axial point
x ₁	0.36	0.42	0.44	0.46	0.50
x ₂	465.00	485.00	550.00	525.00	545.00

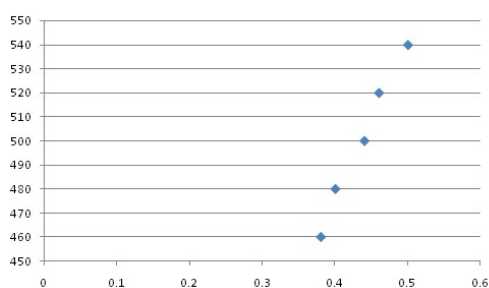


Figure1: Mix proportion water-cement ration over cement content

Figure 1 has demonstrated the water-bond proportion versus concrete substance in the range water-concrete proportion (0.4-0.46) and bond content (480-520 kg/m³). 5 blends extents configuration were gotten the solid properties and the five blends extent were signified as A1, A2, A3, A4 and A5 separately.

Table3: RCPT ratings as per ASTM C1202

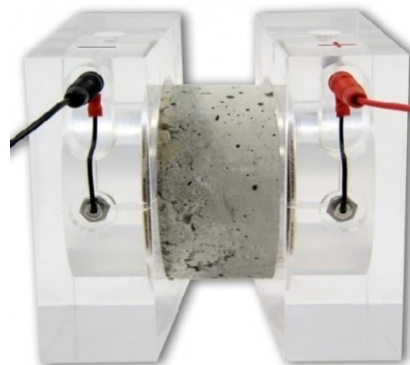


Figure2: Schematic diagram of RCPT (ASTM C1202-94)

4. RESULTS AND DISCUSSIONS

4.1 PROPERTIES OF RMCPW CONCRETE

The properties of the solidified ready mix concrete plant waste aggregate concrete for the 5 mix extents tried at an age of 28 days are introduced in Table 4.

Table4: Properties of ready mix concrete plant waste aggregate concrete for 5 chosen mix proportion

Mixture	Air dry density (kg/m ³)	Compressive strength, MPa	Splitting tensile strength, MPa	Modulus of rupture, MPa	Elastic modulus, Gpa
A1	2435	25.62	2.50	2.63	36.94
A2	2456	25.78	2.31	2.87	39.35
A3	2462	26.15	2.30	2.97	41.76
A4	2478	26.52	2.32	3.04	44.17
A5	2482	26.84	2.31	3.12	46.58

Figure 3 demonstrate the test result for compressive quality ranges between 25.62 to 26.8 N/mm². It is around 50% higher than the base required quality of 17 N/mm² for auxiliary ready mix concrete plant waste aggregate cement prescribed by ASTM C330 [10].

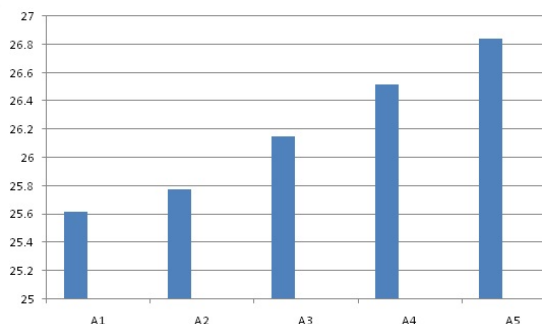


Fig 3 Compressive Strength for RMCPW Concrete
 AirDryDensityforRMCPW
 Normal Concrete Density (2500 kg /m3)

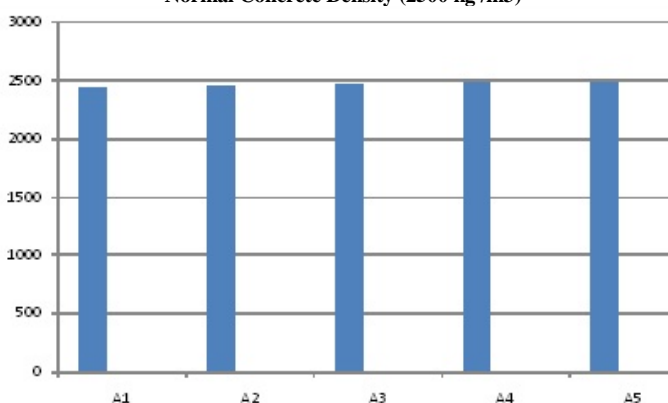


Figure 4: The Density of RMCPW concrete

The test outcomes demonstrated that the ready mix concrete plant waste aggregate solid modulus of flexibility ranges 9.73 to 26.94 GPa. The part elasticity and modulus of crack outcome ranges 1.85 to 2.72 N/mm² and 3.46 to 4.64 N/mm² separately. The outcomes demonstrate that part rigidity and modulus of burst have an expanding an incentive by increment the bond content and a diminishing an incentive by increment the water-concrete proportion.

4.2 RAPID CHLORIDE PERMEABILITY TEST

The centralize mix proportion(A3) which compressive quality ran inside 25-30 N/mm² was been use in the further investigation of RCPT with ready mix concrete plant waste aggregate concrete. The satisfactory blend involved 500 kg/m³ concrete, 473 kg/m³ fine ready mix concrete plant waste aggregate total, 155 kg/m³ coarse ready mix concrete plant waste aggregate total and with a free

water/bond proportion of 0.44. The solid properties are introduced in Table 5.

Table 5: Properties of ready mix concrete plant waste aggregate concrete

Concrete Properties	Average of 3 sample
Air dry density (kg/m ³)	2463
Compressive strength, 28days (MPa)	26.18
Splitting tensile strength (MPa)	2.35
Modulus of rupture (MPa)	2.95
Elastic modulus (GPa)	41.76

The question of the test was to assess the execution of RMCPW concrete and contrasted the chloride penetrability esteem and ASTM rating as Table 3. Chloride particle vulnerability test were directed on chamber examples for each solid blend at 7, 28 and 90 days for RMCPW concrete. The aftereffects of chloride penetrability in coulombs for various age are given in Table 6.

Table6: Chloride permeability for RMCPW concrete with age

Sample	7 days Chloride Permeability		28 days Chloride Permeability		90 days Chloride Permeability	
	Coulombs	Remark	Coulombs	Remark	Coulombs	Remark
C1	5226	H	4486	H	3844	M
C2	5480	H	4296	H	3976	M
C3	5274	H	4674	H	3976	M
Average	5327	H	4485	H	3932	M

The seven-day add up to charged go for RMCPW concrete are gone from 5226 to 5274 coulombs and the normal charge passed was 5327 coulombs. The twenty-eight day add up to charged go for RMCPW concrete are extended from 4486 to 46485 coulombs and the normal charge passed was 4485 coulombs. The ninety day add up to charged go for RMCPW concrete are gone from 3844 to 3932 coulombs and the normal charge passed was 3932 coulombs. As indicated by ASTM rating standard, RMCPW solid show high chloride-particle vulnerability at age 7 days and 28 days. This high estimation of chloride-particle

vulnerability of RMCPW concrete was normal as a result of the permeable idea of RMCPW. The chloride protection of cement is along these lines profoundly reliant on the porosity of cement as far as pore measure, pore appropriation and interconnectivity of the pore framework [26]. At age 90 days, RMCPW solid show direct chloride-particle vulnerability. From past examines [27-30], solid will show a general descending pattern in the measure of electrical accuse go of an expansion in time. The outcome is appear in Figure 5. With the age expanding, the concrete glue hydrates the pores turn out to be less all around associated and thusly more impervious to the section of electrical current are recorded. In preview research[28], moderate chloride-particle vulnerability esteem was recorded for normal solid which shape by stream sand. The RCPT result for RMCPW concrete at age 90 days are practically identical to common cement.

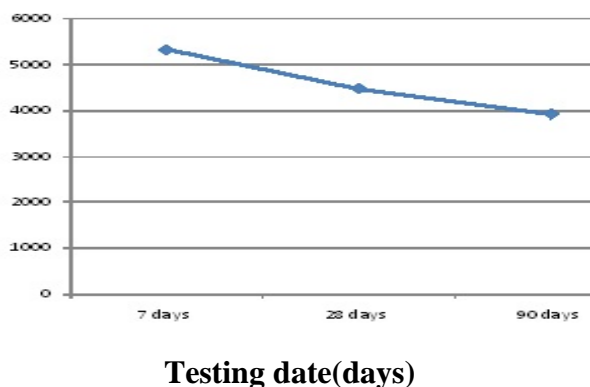


Figure 5: RCPT value for different testing date

5. CONCLUSIONS

The result from this study shown that the chloride permeability value of ready mix concrete plant waste aggregate concrete is comparable to ordinary concrete and give encouragement for ready mix concrete plant waste aggregate to be used as aggregate in production of durable structural ready mix concrete plant waste aggregate concrete. The following conclusions can be made on the basis of the current experimental results.

[1] The compressive strength of RMCPW

concrete at age of 28 days ranges between 25.62 N/mm² to 26.84 N/mm². It is approximately 50% higher than the minimum required strength of 17 N/mm² for structural RMCW concrete recommended by ASTM C330.

- [2] The density of RMCPW concrete ranges between 2435 kg/m³ to 2482 kg/m³ are fall within the limit of lightweight and it is approximately 16% lighter than normal concrete (2200 kg/m³)
- [3] The ready mix concrete plant waste aggregate concrete modulus of elasticity ranges 36.94GPa to 46.58GPa. The splitting tensile strength and modulus of rupture result ranges 2.63 N/mm² to 3.12 N/mm² and 2.5 N/mm² to 3.12 N/mm² respectively. The splitting tensile strength and modulus of rupture have an increasing value by increase the cement content and a decreasing value by increase the water-cement ratio.
- [4] RMCPW concrete show high value of chloride-ion penetrability at age of 7 days and 28 days due to the porous nature of RMCPW.
- [5] Moderate value of chloride-ion penetrability was recorded for RMCPW concrete in age 90 days resulted by the cement paste hydrates the pores become less well connected.
- [6] The results show that RMCPW concrete are comparable to ordinary concrete. Therefore RMCPW concrete are suitable to be use as durable structural lightweight concrete.

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