ASHCOR™

RAM™

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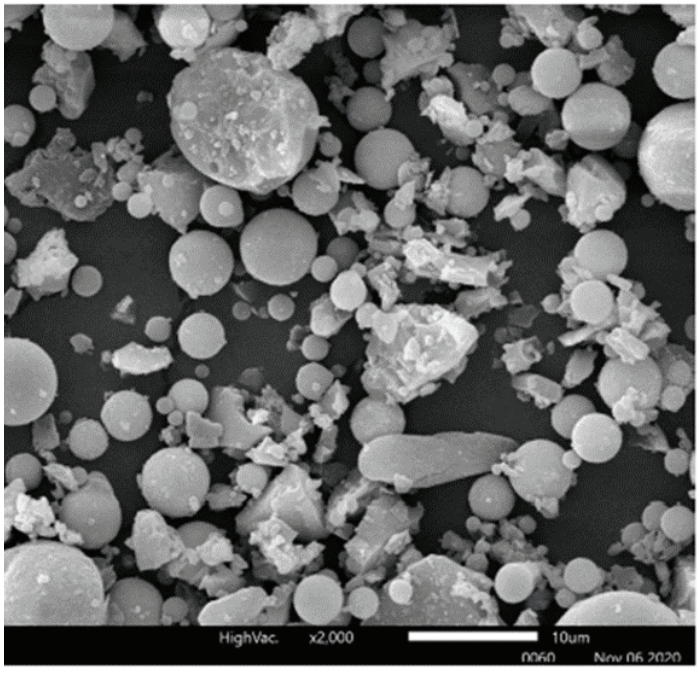
BATTLE RIVER RAM ASH – TECHNICAL DATA SHEET

Ashcor's Battle River (BR) RAM ash is a unique product manufactured in Alberta, Canada. It stands out as the first of its kind – a CSA A3001 and ASTM C618 compliant supplementary cementitious material (SCM) that is produced from harvested coal ash.

The technology behind RAM™ (Reclaimed Ash Management) is a patented innovation developed by Ashcor Technologies Ltd. Its primary purpose is to process harvested coal ash impoundments and transform them into high-quality pozzolans suitable for construction applications.

RAM™ utilizes a thermo-mechanical process to transform impounded coal ash, often a mixture of fly ash and bottom ash, into a marketable SCM without the need to separate the bottom ash. This is especially significant given the increasing number of coal-fired power plant closures and regional shortages of fly ash. Ashcor's solution not only adds a supply of a high-quality SCMs but also offers significant environmental benefits.



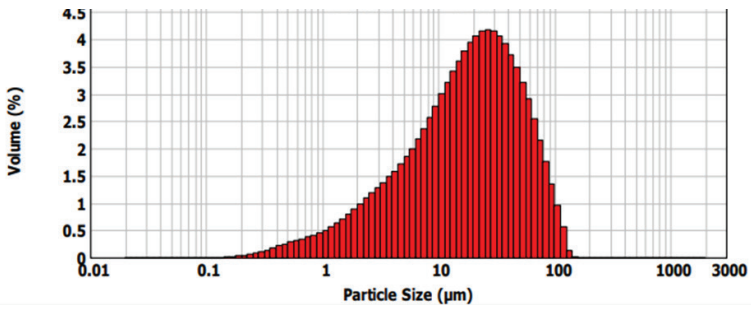
Scanning Electron Micrograph - BR RAM Ash

HOW IT WORKS

Unlike traditional fly ash, which is generated at coal-fired power plants with limited control over product characteristics, RAM ash is a methodically manufactured product. It undergoes a series of quality assurance and quality control (QA/QC) processes to improve the consistency and reliability of the product.

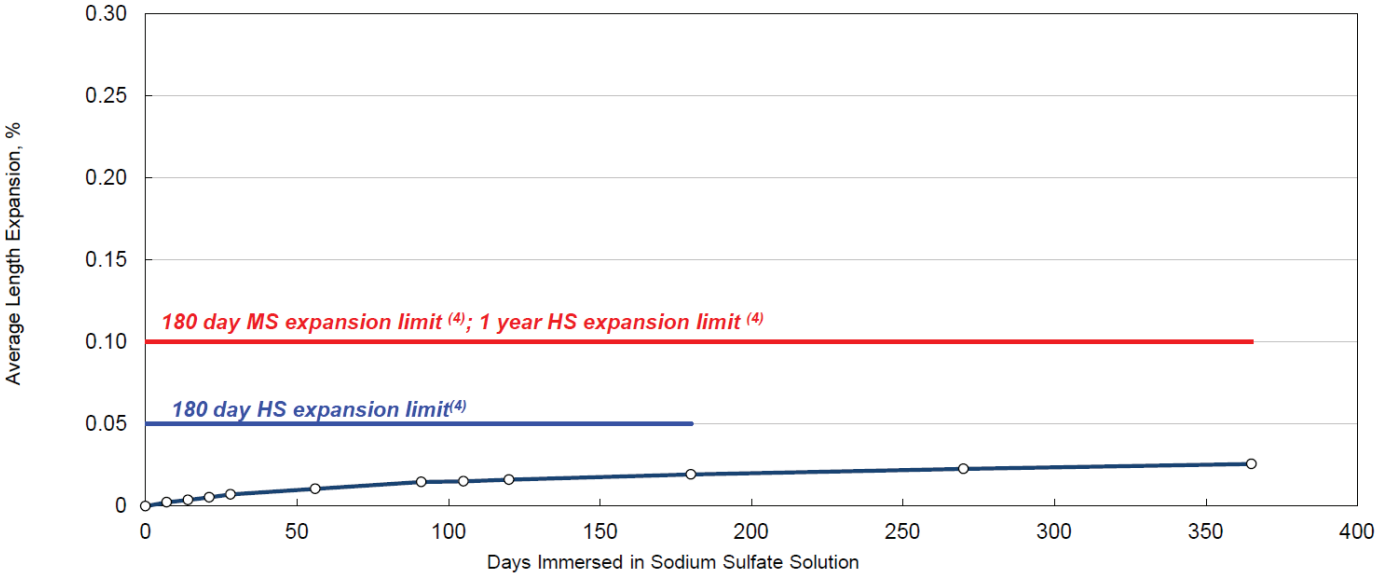
The RAM ash production process includes grinding and classification steps to maintain a uniform particle size distribution. Specifically, it targets the grinding of coarser bottom ash particles to achieve the required pozzolanic activity while preserving the water demand and flowability properties of the fly ash particles.

Current customers of BR RAM ash include ready-mix concrete suppliers and oil-well cementing companies.

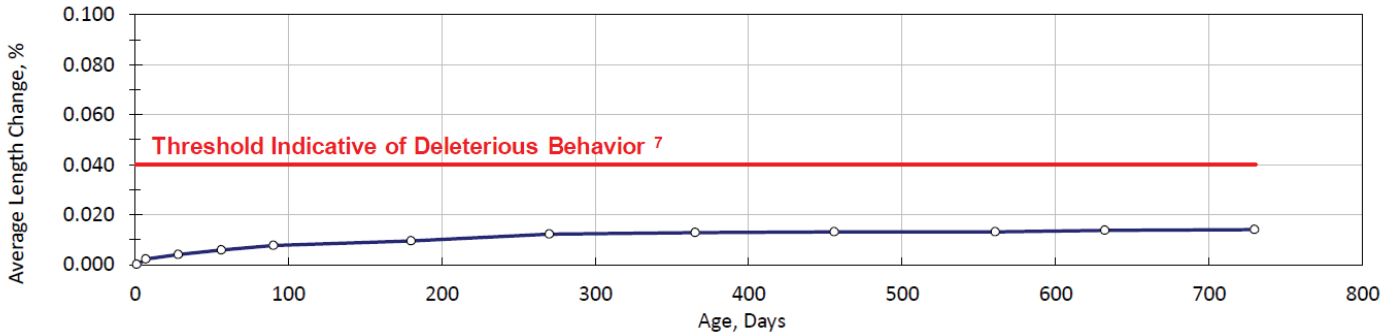


Particle Size Distribution - BR RAM Ash

BR RAM ash provides exceptional performance in mitigating alkali silica reaction and in resisting sulfate expansions in concrete.



ASTM C1012 - Resistance to Sulfate expansion in concrete with 20% BR RAM Ash



ASTM C1293 – Mitigated concrete expansion due to Alkali Silica Reaction with 20% BR RAM Ash

BR RAM ash meets the CSA A3001 Classification of Type F, and meets or exceeds other specifications, including ASTM C618 and AASHTO M295.

Chemical and Physical Properties of BR RAM Ash

CHEMICAL ANALYSIS	Avg. of Annual Composites			CSA A3001		
	2022	2023	2024	Type F	Type CI	Type CH
Sum of Major Oxides (SiO_2+Al_2O_3+F_2O_3) (%)	86	86	84			
SO_3 (%)	0.2	0.2	0.3	5 max		
CaO (%)	6	6	7	≤ 15	> 15 - ≤ 20	> 20
Moisture (%)	0.3	0.3	0.3	3 max		
LOI (%)	2.3	2.4	2.4	8 max	6 max	6 max
PHYSICAL ANALYSIS						
Fineness - Retained on 45µm (%)	14	18	20	34 max		
Density (g/cm^3)	2.3	2.3	2.3			
Water Requirement (% Control)	98	99	100			
Strength Activity Index (% Control) - 7 Days	78	74	77			
Strength Activity Index (% Control) - 28 Days	85	81	84	75 min		
Soundness, Autoclave Expansion (%)	0.1	0.1	0.1	0.8 max		
Control of Alkali (silica) Aggregate Reactivity Mortar Bar Expansion at 14 days (%)	0.1	0.1	0.1	0.1 max		

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Cement Used →	GUL 1			GUL 2			GUL 3		
% Replacement →	100% Cement	10% FA	25% FA	100% Cement	10% FA	25% FA	100% Cement	10% FA	25% FA
Slump (mm)	105	120	125	75	60	65	105	85	110
Air (%)	6.8	7.0	7.2	5.0	5.2	5.2	7.8	7.4	7.8
Hardened Air Void (ASTM C457) (%)	9	11	12	5	7	7	6	8	8
Compressive Strength - 7d (ASTM C39) MPa	30	29	24	45	39	31	34	29	26
Compressive Strength - 28d (ASTM C39) MPa	43	38	36	57	51	45	44	41	34
Compressive Strength - 56d (ASTM C39) MPa	46	42	41	62	57	51	48	45	38
Compressive Strength – 90d (ASTM C39) MPa	50	46	46	67	60	57	51	48	43
Compressive Strength – 120d (ASTM C39) MPa	52	48	46	69	61	59	53	50	45
Compressive Strength – 365d (ASTM C39) MPa	55	51	55	71	68	63	58	55	50
Alkali Silica Reactivity - Accelerated Mortar Bar (ASTM C1260/ASTM C1567) (%)	0.4	0.3	0.1	0.4	0.4	0.1	0.4	0.3	0.1
Rapid Chloride Permeability Test - 56d (ASTM C1202) - Coulombs	2862	2572	1508	1953	1473	999	2318	1985	1193
Bulk Resistivity 56d (CSA A23.2-26C) Ω*m	82	91	173	108	145	210	127	142	256
Linear Shrinkage 1yr (CSA A23.2-21C) (%)	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.07
Sulphate Resistance (6 months) (ASTM C1012) (%)	0.12	0.11	0.04	0.20	0.09	0.04	0.07	0.04	0.04
Sulphate Resistance (12 months) (ASTM C1012) (%)	0.68	0.33	0.07	0.85	0.30	0.05	0.22	0.10	0.05
Scaling Resistance (LS-412-R35) (Avg. Mass loss % - 50 Cyl.)	0.03	0.04	0.04	0.09	0.03	0.36	0.02	0.03	0.03
Scaling Resistance (LS-412-R35) (Visual Rating - 50 Cyl.)	1	1	1	2	1	2	1	1	1

1. *Three separate general use limestone (GUL) cements were used*
2. *Target concrete mix was Ontario Provisional Standards and Specification (OPSS) 30 MTO*
3. *Concrete mixes were designed to meet slump of 80 ± 30 mm and air content of 6 ± 2%*
4. *FA in the matrix refers to Ashcor's Battle River (BR) RAM Ash*
5. *All replacement levels met targeted strength of 30 Mpa at 28 days and continued to gain strengths*
6. *Higher levels of cement replacements with BR RAM Ash showed enhanced resistance to ASR, chlorides, and sulphate attack*
7. *Linear shrinkage and scaling resistance were within the expected ranges*
8. *Extended Alkali Silica Reactivity test (ASTM C1293) and Freeze-Thaw test (ASTM C666) are currently underway*

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