BMT Marine Painting Forum

Project Summary:

Comparative Performance of Paint Specifications Applied onto Substrates Prepared Using Recycled Glass Abrasive Media

Executive Summary:

In Early 2006, BMT Marine Painting Forum was approached by W.R.A.P. (Waste Resource Action Programme); a government appointed body set up to investigate the potential uses of recycled materials for industrial processes. One particular area of interest was the use of recycled glass, which could be ground into an appropriate particle size and utilized as an abrasive blasting medium for preparation of steel substrates prior to painting.

Some concerns were expressed by various members of the forum that, due to the nature of the feedstock of waste glass (i.e. domestic and commercial waste from jars and bottles which could contain significant amounts of water soluble or greasy contaminants). Should the contaminants become embedded into the substrate during the blast process, this could have potential ramifications on the performance of the subsequent paint system.

The forum undertook to perform a project investigating the effectiveness of recycled glass as an abrasive medium, by preparing test plates using a commercially available glass abrasive in comparison to plates prepared using two commonly used standard blast media (Chilled iron grit and aluminium oxide).

Project Outline:

The project plan was split up as follows:

- Phase 1 – Blasting efficiency, comparing a 0.5– 1.0 mm mesh graded glass abrasive against G17 grade (0.4 – 0.8 mm) chilled iron grit, and a comparative particle size aluminium oxide abrasive.
- Phase 2 – Adhesion / mechanical properties
- Phase 3 – Performance Testing
- Concurrent surface analysis @ CAPCIS (Reported separately).

Phase 1 – Blasting Efficacy

3mm gauge hot rolled mild steel panels with millscale intact were used for the test programme. The panels were pre-prepared as follows:

- All Steel thoroughly degreased
  - Solvent wash (MEK)
  - Scrub with proprietary degreaser / water rinse
  - Isopropanol rinse

The abrasives were loaded into a Hodge Clemco Enviroclean 1250 blast cabinet, and test panels were prepared to a target standard of Sa2½ (BS EN ISO 8501-1)

The cabinet was thoroughly stripped down and cleaned of all residual abrasive between each abrasive.

In terms of perceived time taken to achieve near white metal Sa2½ standard, aluminium oxide was rated to be the most efficient abrasive, with the chilled iron and recycled glass being subjectively equal. One negative comment regarding the recycled glass was that it created an extremely high level of dust in the blast cabinet, such that the visibility was reduced to virtually zero within seconds of commencing the blast. A high proportion of the glass abrasive was recovered by the cabinet dust recovery system with very little glass abrasive recycled back into the hopper.

Blast profile measurements were made in triplicate using Testex X coarse grade test tapes

GLASS	Min 21µ Max 36µ Mean 27µ
CHILLED IRON	Min 49µ Max 76µ Mean 66µ
Al_2O_3	Min 54µ Max 82µ Mean 71µ

Soluble chloride levels were measured in triplicate on each abrasive.

Test Method – Quantab Test Strips

- Glass abrasive, mean 27µg/cm^3
- Chilled iron , mean 10µg/cm^3
- Al_2O_3 + solvent wash, mean 6µg/cm^3

Phase 2 – Paint Adhesion / Mechanical Properties

Two model paint specifications were prepared, based on a simple polyamide cured epoxy primer, pigmented with zinc phosphate
Solids volume 75%
Pigment volume content 38%
Zinc phosphate content 40% on pigment weight

Two paint specifications :

1. 100 microns dft epoxy zinc phosphate primer (Non immersion testing)

2. 250 microns dft epoxy zinc phosphate primer (Immersion & cyclic testing)

   - All panels cured @ 23° C for 7 days

All schemes in duplicate

Prepared test panels were subjected to the following tests :

- Pull off adhesion using PAT hydraulic gauge
- Cross hatch adhesion to BS EN ISO 2409:1998 (2mm spacing)
- Cross cut adhesion to ASTM D3359
- Falling weight impact to BS EN ISO 6272 : 1994

PAT Adhesion Values

Abrasive	100µ Primer	250µ Primer
GLASS	min 850 psi max 1100psi mean 1025psi	min 625 psi Max 900 psi mean 850 psi
CHILLED IRON	min 925 psi max 1650 psi mean 1275 psi	min 1025 psi max 1850 psi mean 1350 psi
Al_2O_3	min 850 psi max 1450 psi mean 1300 psi	min 950 psi max 2000 psi mean 1475 psi

Adhesion Failure modes

- Chilled Iron & Al_2O_3
  - All samples 100 % adhesive failure (Araldite glue)
- Glass abrasive –
  - 50 % showed 100% adhesive failure,
  - 50 % showed varying degrees of substrate detachment (up to 30%)

Cross hatch adhesion (BS EN ISO 2409:1998 2mm spacing)

Abrasive	100µ Primer
GLASS	Class 0 (no detachment)
CHILLED IRON	Class 0
Al_2O_3	Class 0

Cross Cut Adhesion

ASTM D33583

Abrasive	250µ Primer
GLASS	Class 5A (no detachment)
CHILLED IRON	Class 5A
Al_2O_3	Class 5A

Falling Weight Impact

BS EN ISO 6272 : 1994

1 Kg weight, 1 metre drop (9.81 joules impact)

- All schemes displayed film deformation at point of impact.
- No radial cracking from impact
- No radial loss of adhesion from point of impact

Phase 3 – Performance Testing

Painted test panels were subjected to a variety of accelerated corrosion tests and real time external exposure and immersion tests, in order to compare the performance of the paint specifications over the three different abraded substrates.

- Accelerated testing:
  - Ambient & hot salt spray (ISO 7253)
  - Atlas Cell Immersion
  - Cyclic Testing (Norsok Rev 5) (ISO 20340)
  - Cathodic disbondment (BS 3900 : F10)

- Real time testing:
  - Industrial & Marine atmospheric exposure (C3 & C5 environment as defined in BS EN ISO 12944 : 1998).

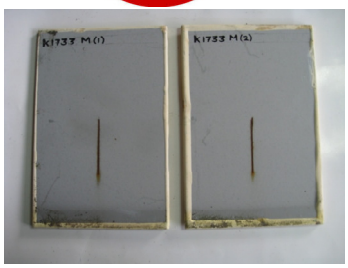
  - Salt water / Fresh water Immersion (BS EN IS0 2812-1)

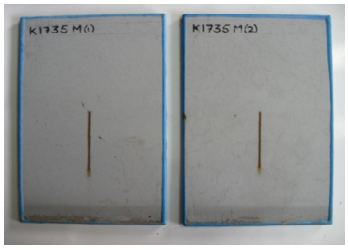
- All panels on test 6th Nov 2006
- Latest inspection Early July 2011
  54 months natural weathering (Some time off test for laboratory examination)
  2500 hours accelerated testing

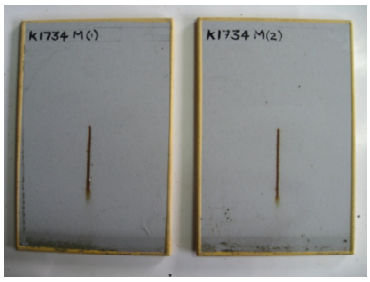
Marine (C5M) and Urban (C3) Exposure (54 months)

All panels in good condition other than normal chalking / dirt retention expected of an epoxy coating.
No corrosion creep or blistering extending from score

Marine Exp : 54 months

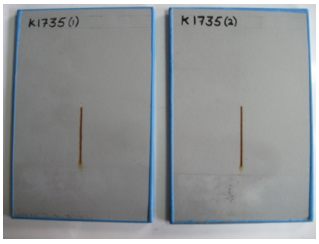


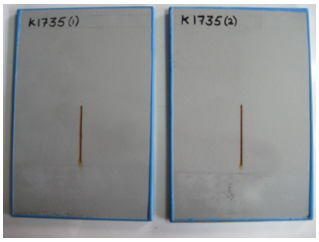


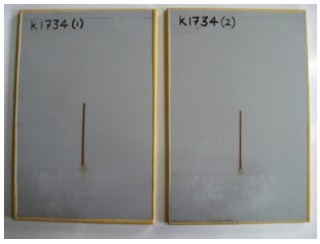


- K1733 – GLASS
- K1734 – IRON
- K1735 – Al_2O_3

Urban Exp : 54 months

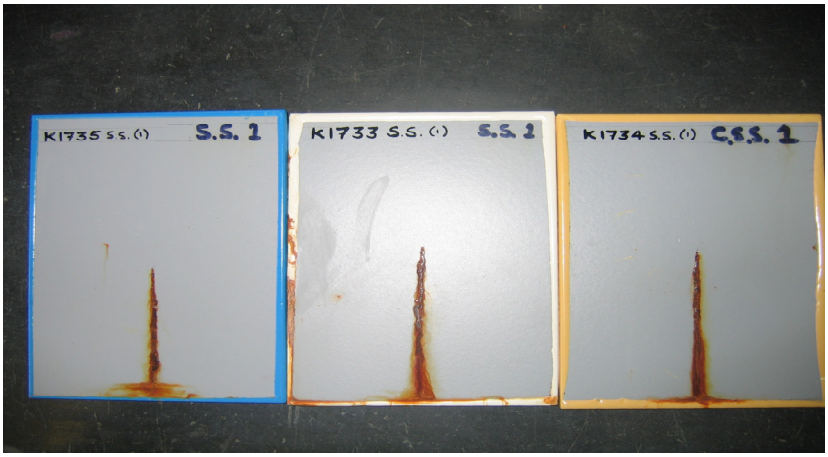






- K1733 – GLASS
- K1734 – IRON
- K1735 – Al_2O_3

Cold Salt Spray : 2500hrs



Aluminium Oxide Glass Chilled Iron

Hot Salt Spray :2500hrs

Glass Chilled Iron Aluminium Oxide

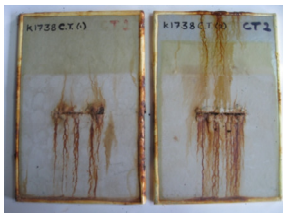
Other Tests:

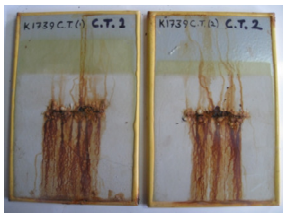
- **Humidity @2500 Hours – No Defects**
- **NORSOK Cycle (HSS / QUVA)**
  4200 hours
  Glass Abrasive : 7.3 mm av disbondment

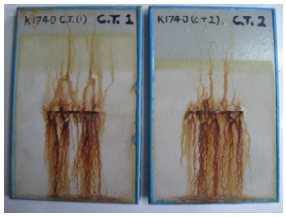
  Chilled Iron : 4.8 mm av disbondment

  Al_2O_3 : 5.0 mm av disbondment

Norsok cycle 4200hrs





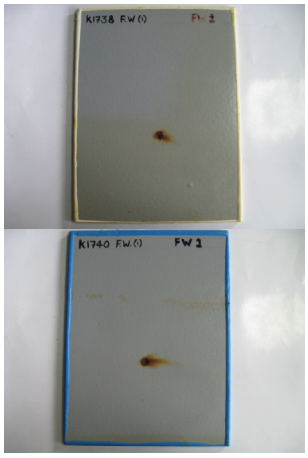


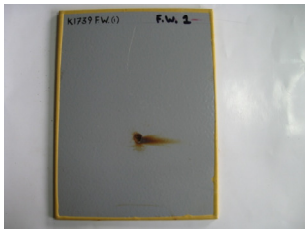
- K1738 – GLASS
- K1739 – IRON
- K1740 – Al_2O_3

28 Days CD @ - 1.50 volts

Glass : 10 -12 mm Chilled Iron :4-6 mm Aluminium Oxide 2-4mm

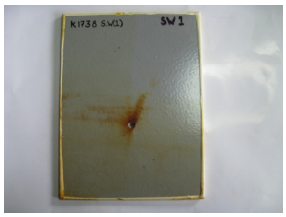
Fresh Water : 50 months





- K1738 – GLASS
- K1739 – IRON
- K1740 – Al_2O_3

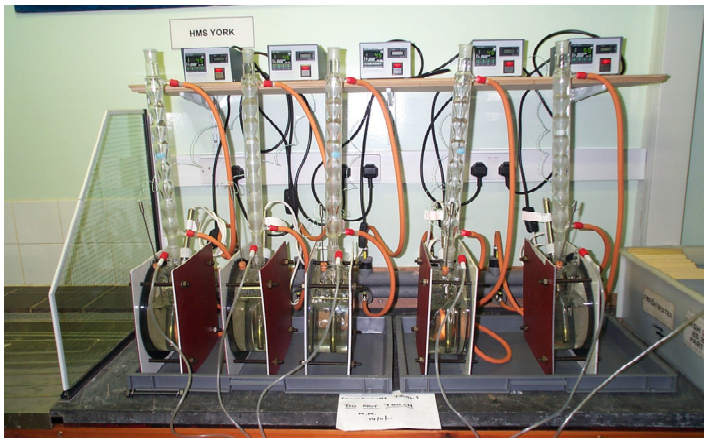
Salt Water : 50 months



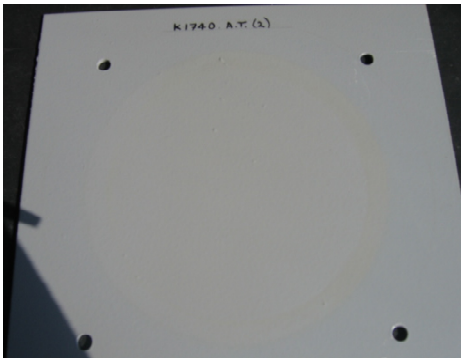
- K1738 – GLASS
- K1739 – IRON
- K1740 – Al_2O_3

Glass Chilled Iron Aluminium Oxide

Atlas Cells



Atlas Cells 4 months



Chilled Iron **Aluminium Oxide**

Atlas Cells : 4 months

Glass abrasive – Different viewpoints

Comments and Conclusions

Whilst it is appreciated that this work is by no means a comprehensive analysis of the performance of all recycled glass abrasives, and the work has only scratched the surface to give a snapshot example of one grade of glass against two commercially available standard abrasives, the following comments are offered as a summary of the observations made to date.

1. Glass abrasive, whilst able to achieve a visual cleanliness standard of Sa2½ equivalent to G17 grit or aluminium oxide, appeared to shatter on impact with the steel substrate. This shattering effect created a huge amount of dust compared to the standard abrasives, which would be a potential issue if glass abrasive was to be used in a commercial situation using open blasting equipment.

2. The glass abrasive could not achieve as great a surface profile as the two standard abrasives (Less than 50 microns). This profile is below the level generally specified for high build coating systems (Typically 50 – 75 µ or above).

3. I terms of the performance test results obtained to date:

- Natural Weathering – No Defects
- Fresh water / Salt water immersion – No defects
- Hot & cold salt spray / Humidity - No difference in performance – As expected
  CD & Atlas cells – Glass inferior to G17 & Al_2O_3 … Increased Disbondment & blistering. Possibly due to lower surface profile.

- Performance of all abrasives in non-immersed conditions appears satisfactory at this point.
- Real time immersions still OK, but accelerated immersion, CD & Atlas Cell are a cause for concern, over glass prepared surfaces.