SERIES SIX

RAIL EMBEDMENT MATERIAL

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SERIES SIX RAIL EMBEDMENT MATERIAL
INTRODUCTION

In the early 1970's ALH Systems developed resin systems for the encapsulant of underground gas pipes. In order for these encapsulation systems to be effective a number of unusual application and performance parameters had to be fulfilled. The resin system had to be applied to recently exposed cast iron pipe, bonding to that pipe in order to effect a seal against the internal gas pressure. The systems had to be capable of application on site by semi-skilled personnel in all climatic conditions of temperature and humidity.

Once installed the encapsulation system was buried and was required to resist flexing and vibration of the pipe in varying soil conditions for a considerable period of time without failure of the material or disbonding from the cast iron.

With the rapid developments of liquid polyurethane resins in the 1980's ALH Systems produced their "Series Six" encapsulant system which, when tested through an 18 month test programme, met all the requirements of the gas industry for an encapsulant capable of satisfactorily sealing in underground conditions with a life expectancy in excess of 50 years.

This material has now been in use for 13 years throughout the world with well over 1.5 million litres successfully applied.

"Series Six" has been utilised in other applications for example water sealing between concrete slabs, encapsulation of concrete pipe joints, and rail embedment where long term resistance to the environment and flexibility are paramount.

TYPICAL PROPERTIES OF PRODUCT AS SUPPLIED

Form:-	Two component liquid material
Colour:-	Base Material:-Standard product is BLACK but other colours are available on request. Hardener Material:-Translucent and slightly yellowish. Mixed:- As base material.
Viscosity @ 20^{o}c:- (Brookfield Viscometer using No.3 spindle @ 10 rpm)	Base Material:- 15 Poise Hardener Material:- 50 Poise Mixed Material:- 30 Poise
Pot Life @ 20^{o}c:-	12 minutes standard but can be varied if required.
Mix ratio (by weight):-	2 parts Base : 3 parts Hardener
Specific Gravity @ 20^{o}c:-	0.95 cork filled 1.13 unfilled 1.55 bauxite filled

PROPERTIES OF CURED MATERIAL

IRHD Hardness @ 20^{o}c:-	60
Tensile Strength (BS903:A2):-	4N/mm^2
Tear Strength (BS903:A3)	19.5 N/mm
Glass Transition Temp:-	-46^{o}c
Electrical Resistance on Track:-	>1000 single track ohm Km
Electrical Resistance of:- Test Piece of Surface Area 12.5 cm^2 and width 1cm	>2 x 10^8 ohms
Abrasion Resistance:- (1000 cycles Taber method with H18 Wheel)	0.61g weight loss (cork filled) 0.15g weight loss (bauxite filled)
Water Absorption:- (7 days total immersion on 6mm thick sample)	Less than 0.1%
Swelling:- (7 days total immersion on 6mm thick sample)	Less than 0.1%

SERIES SIX - ELECTRICAL TEST

INTRODUCTION

The rail embedment material must adequately insulate the rail. The resistance, rail to earth, must not be less than 100 single track ohm kilometre.

METHOD

The electrical test was carried out on a 500mm long section of rail, embedded in a metal trough. The electrical resistance between the rail and the surface of the embedding material in contact with the trough was measured.

The electrical resistance of the sample, expressed in single track ohm kilometre, is given by the equation:

$$R = 25 \times 10^{-5} \frac{V}{I} \text{ single track ohm}$$

where V is volts and I is amps.

RESULTS

Approx 1000 single track ohm Km.

CONCLUSIONS

Series Six is an excellent insulator, far exceeding the current requirements.

ELECTRICAL RESISTANCE OF SERIES SIX
RAIL EMBEDMENT MATERIAL

INTRODUCTION

Samples of Series Six with various fillers were tested at D.G. Electronics, Warminster to evaluate materials in both the dry and wet states.

METHOD

Two test samples of each of the following materials were prepared:-

Series 6 (No additional filler)
Series 6 (Cork filled)
Series 6 (Bauxite filled)
Competitors Material

Each sample was prepared by pouring between two primed steel plates placed 10mm apart. The surface area of each bonding face was 50mm x 25mm. The test pieces were left for 72 hours at 23^{o}C to cure prior to the electrical resistance being measured.

RESULTS

Material	Resistance Dry	Resistance Wet
Series 6 (No additional filler)	2000 x $10^6\Omega$	660 x $10^6\Omega$
Series 6 (Cork filled)	2000 x $10^6\Omega$	660 x $10^6\Omega$
Series 6 (Bauxite filled)	2000 x $10^6\Omega$	1000 x $10^6\Omega$
Competitors Material	20 x $10^6\Omega$	17 x $10^6\Omega$

CONCLUSIONS

In both the wet and dry states Series Six is classed as an Electrical Insulator as its resistance is greater than $10^8\Omega$.

ABRASION RESISTANCE OF SERIES SIX RAIL EMBEDMENT MATERIAL

INTRODUCTION

The abrasion resistance of Series Six was measured using a Teledyne Taber Model 503 Abrasion Tester. This equipment measures the abrasion resistance of materials in terms of weight loss over a set number of cycles using standard abrasive wheels.

METHOD

Test samples of each of the following materials were prepared:-

(i)Series 6 (Cork-filled)
(ii)Series 6 (Bauxite -filled)
(iii)Series 6 (Bauxite-filled) plus bauxite surface dressing
(iv)Competitors material
(v)Competitors material plus Bauxite

Each sample was prepared in a circular mould of dimensions 100mm diameter and 10mm depth.

The samples were allowed to cure for 72 hours at 23^{o}C and then tested on a "Teledyne Taber" Model 503 Abrasion Tester.

Prior to the test runs each sample was subjected to a conditioning run of 1000 cycles so that the surface was removed and the filler fully exposed. Each sample was then subjected to 3 tests of 1000 cycles. The average of the 3 tests for each sample is recorded on the test result table below.

For the cork-filled samples, testing was carried out with both soft and coarse abrasive wheels whereas the bauxite filled samples were only tested using the coarse wheels as they would have rapidly worn away the soft wheels.

RESULTS

Material	Abrasive Wheels	No of Cycles	Av. Weight Loss (grams)
ALH Series 6 (Cork-filled)	CS 17	1000	0.08
Competitor	CS 17	1000	0.49
ALH Series 6 (Cork-filled)	H 18	1000	0.61
Competitor	H 18	1000	1.24
ALH Series 6 (Bauxite filled)	H 18	1000	0.15
Competitor (Bauxite filled)*	H 18	1000	1.09
ALH Series 6 (Bauxite-filled) plus bauxite surface dressingdressing	H 18	1000	Test aborted after Run 1 due to erosion of test wheel but no weight loss to sample

* Also contains cork as product is supplied cork filled.
CS 17 is a soft wheel
H 18 is a very coarse wheel

CONCLUSIONS

In all three sets of tests Series Six proved to be excellent in terms of abrasion resistance. The incorporation of Bauxite makes the results even better.

SKID RESISTANCE OF SERIES SIX RAIL EMBEDMENT MATERIAL

INTRODUCTION

The skid resistance of Series Six was carried out by the Materials Laboratory of Avon Tyres, Melksham using a Stanley/TRRL Portable Skid Resistance Tester. This device measures the coefficient of friction between a patterned tyre skidding at 30 mph and a road surface.

METHOD

The test device consists of a pendulum, attached to which is a sample of "standard" Avon Tyre tread rubber mounted on a spring loaded slider. The pendulum height is adjusted to give a contact surface area length of 5". The pendulum is released and rubber surface of the slider passes over the test surface thereby slowing down the motion. The higher the friction forces the less distance the pendulum will travel. The distance travelled is recorded directly onto a scale in units of skid resistance (0-150, the higher the figure the higher the skid resistance). The test sample is placed under the pendulum and then subjected to 5 conditioning swings - the next three results are recorded. The slider is then removed reversed and the test repeated. The two sets of results are averaged.

The test samples (200mm x 150mm x 30mm thick) were cast and allowed to cure for three days before testing. The samples were then tested under dry conditions and wet conditions. For comparison a sample of smooth concrete, steel and a competitors material was tested under the same conditions.

RESULTS

SUBSTRATE	DRY	WET
Concrete	102	52
Steel	64	19
ALH Series Six	117	24
Competitors material	93	23
ALH + Bauxite Antiskid	108	88
ALH + Flint Antiskid	94	60

CONCLUSIONS

Polyurethanes in the wet, like steel, have poor skid resistance. By the incorporation of an antiskid surface coating to the polyurethane the skid resistance is dramatically improved.

LOAD DEFLECTION CHARACTERISTICS OF SERIES SIX RAIL EMBEDMENT MATERIAL

INTRODUCTION

A 500mm long section of 35g rail was prepared using Series Six polyurethane rail embedment material. The section of rail was then subjected to vertical and lateral loads and the deflection measured.

METHOD

In order to relate the load/deflection results obtained on the 500mm section to the wheel loads on the track it is necessary to establish the `ballast' modulus (c) of the embedding material.

The relationship between the load applied in the test (p) and the wheel load (Q) is given by the equation.

$$p=0.423C^{1/4}Q$$

Where C is the deflection in a 15mm thick circular test piece at a loading of $1N/mm^2$. The maximum load p is equivalent to a static wheel load of 4.25 tonnes multiplied by a wheel flat factor of 4.

In the first test, see figure 3, the load p is vertical and in the second test the load is applied at an angle of 31^o to the vertical to simulate a wheel travelling on the outside rail of a curve.

RESULTS

See Over Page

CONCLUSIONS

Series Six rail embedment material has satisfactory load/deflection characteristics.

VIBRATION TESTING OF SERIES SIX RAIL EMBEDMENT MATERIAL

INTRODUCTION

During the 20 year designed life of the system the embedment material could be subjected to some 10 million vibrations.

METHOD

The test sample was prepared as shown in figure 1. The concrete was cast into a section of steel pipe welded to a base plate. A plastic insert was used to form the central `rail slot'. The concrete was allowed to set for 7 days before casting cork filled embedment material around at a 50mm diameter steel tube representing the rail. Before priming with Series Six, 1 part primer the concrete `slot' and `rail' were abraded using a wire brush. The tube was supported on a 15mm thick pre cast spacer block, held vertically and the encapsulant poured. The encapsulant was allowed to cure for 3 days before starting the vibration test.

From load/deflection testing previously carried out it was found that at a loading of 4 tonnes the rail deflection was approximately 1mm.

The vertical tube (`rail') was deflected such that the movement at the rail/encapsulant surface was 1mm (see figure 2).

The frequency of cycling was set at 3Hz.

The test was carried out at room temperature (18^{o}C - 24^{o}C), running continuously for 82 days.

RESULTS

20.5 million cycles completed without failure.

CONCLUSIONS

1.There was no disbondment between the encapsulant and concrete.

2.There was no disbondment between the encapsulant and metal `rail'.

3.There was no tearing or splitting of the encapsulant at or around small holes caused by air bubbles present on the surface.

4.There was no change in the hardness of the encapsulant during the test period.

5.There was no increase in the temperature of the encapsulant during the test (hysteresis).

THE LOAD DEFLECTION CHARACTERISTICS OF SERIES SIX EMBEDDED TWIN BLOCK CONCRETE SLEEPERS

INTRODUCTION

The load-deflection requirements of a polyurethane encapsulated or rubber booted twin block sleeper varies with application. This investigation looks at factors affecting the load-deflection characteristics.

METHOD

A full size metal test piece (640 x 265mm) was used throughout to represent the concrete sleeper block. The blocks were cast and then allowed to fully cure before testing. The test blocks were loaded centrally by means of a hydraulic ram and the deflection measured. Each block was pre loaded upto the maximum test load three times and allowed to relax between each loading. Three further tests were then carried out and the results averaged.

The factors affecting the load deflection investigated were:

1. Material - Cork filled and unfilled Series Six Rail Embedment material (M).

2. Shape factor effect:

   a) Thickness of the block under load (T).
   b) Whether the block was unrestrained or restrained (R) ie whether the block is placed on a concrete sub base or embedded in a concrete.
   c) The ratio of loaded area (L) to force free area (f), this factor was varied using ribs or internally cast voids.
   d) The depth of the external ribs or internal voids (t).

RESULTS

A series of tests were carried out on blocks looking at the effect of each of the variables listed above. From the results obtained the load deflection envelope for Series Six Rail Embedment material was produced and is shown graphically over leaf.
This diagram can be used to assist with the selection of the various factors to match the performance required.

CONCLUSION

Within limits, it is possible to achieve any load deflection characteristics that may be required.