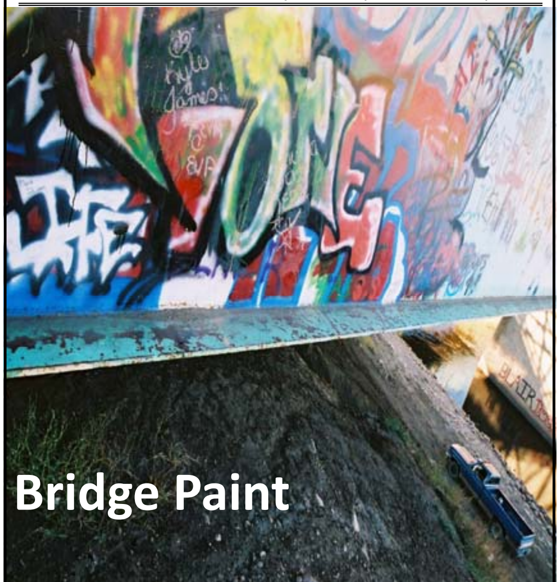
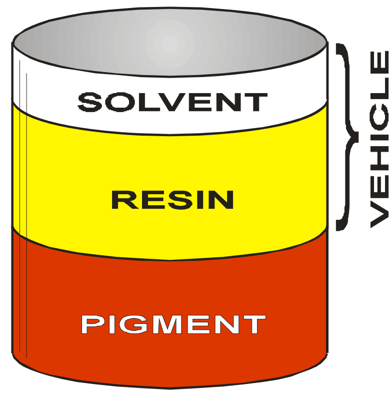


Bridge Paint

PAINT



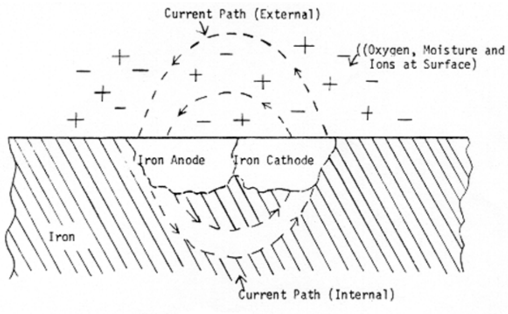
Types of Paint

Paints are generally solutions of solids such as pigments and other chemicals in a liquid carrier or vehicle used for transporting the solids to a surface needing protection. At the surface they may react chemically to polymerize. Some common types are:

1. latex coatings - emulsion in water (acrylics and vinyls)
2. lacquers - solutions in which the solid resins do not change or react as the solvent evaporates they become hard (chlorinated rubber, asphaltic coatings)
3. air oxidizing coatings - oil based coatings that react with oxygen to harden (alkyds, epoxy esters, linseed oil)
4. chemically reactive coatings - two component polymers sometimes without solvent (epoxy, urethanes)

Corrosion

1. Caused by thermodynamic instability of steel.
2. Is an electrochemical process.
3. The rate of corrosion is based on electric current generated by potential (voltage) differences with the steel.
4. Ohms Law: (current) $I = \frac{E \text{ (voltage)}}{R \text{ (resistance)}}$



"The Corrosion Battery" (Ready to Discharge)

Chemical Reaction (1st Stage)

Anode (where visible corrosion occurs)

(iron) Fe $\longrightarrow$ Fe^{++} (ions) + $2e^-$ (electrons)

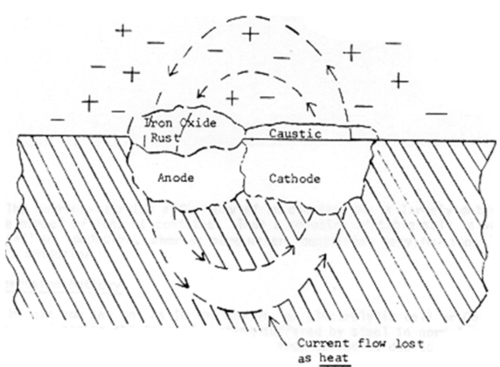
Cathode (adjacent protected area)

a) $2H^+ + 2e^- \longrightarrow H_2$ (hydrogen gas)

b) $4H^+ + O_2$ (air) $+ 4e^- \longrightarrow 2H_2O$ (water)

c) $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$ (alkali)

The alkali buildup attacks some paints.



Chemical Reactions (2nd and 3rd Stages)

Fe^{++} (@ anode) + $2OH^-$ (@ cathode) $\longrightarrow Fe_2(OH)_2$ (rust)

$2Fe(OH)_2 + O_2 \longrightarrow Fe_2O_3$ (iron ore hematite) + H_20

Requirements For Corrosion

1. thermodynamically unstable metal (iron)
2. electrolytic conduction of ions (water)
3. electrical conductor of electrons (metal)
4. electron acceptor (hydrogen ions or dissolved oxygen)

Corrosion Current At Breaks in Paint Coating

$$\text{electrical current } I = \frac{(PA - A_p) - (PC + C_p)}{RD\,t + RL + RC\,t}$$

PA = electrical potential @ anode

PC = electrical potential @ cathode

A_p = electrical potential @ anode from buildup of corrosion by products

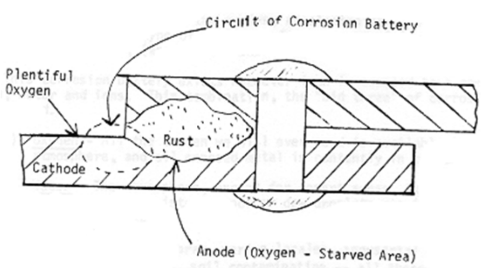
C_p = electrical potential @ cathode from buildup of corrosion by products

RD = electrical resistance at the discontinuity (electrolyte)

RL = electrical resistance of the moisture outside the discontinuity

RC = electrical resistance of the coating

t = coating thickness



Pack Rust or Crevice Corrosion

Pack Rust

Perforated Bottom Chord

Distorted and Perforated Plate Due to Pack Rust

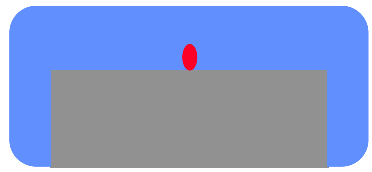
How Paint Works To Prevent Corrosion

1. Eliminates the electrolyte (separates it from the steel)
2. Increases the electrical resistance of the corrosion circuit
3. Reduces the concentration of electron acceptors (H^+ and O_2)

Paint System Design

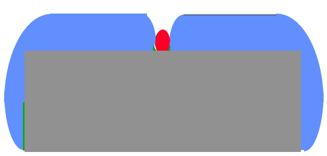
1. Primer Layer:
   - a) inhibitive
   - b) barrier (increase RC t)
   - purpose - increase A_p, C_p and R
2. Intermediate Layer:
   - a) increase R
   - b) reduces pinholes and permeability
3. Topcoat:
   - a) ultraviolet resistance
   - b) colour
   - c) toughness

Wet Paint on Steel – Trapped Air



- Paint thins on drying in relation to solids content
- 60% solids – 5mils wet – 3 mils dry

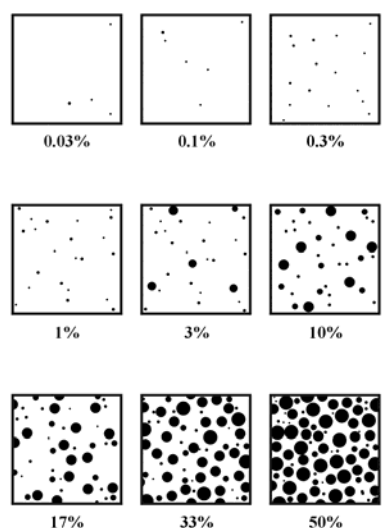
Results in a Pinhole



Physical Properties of Existing Paint Needed For Encapsulation

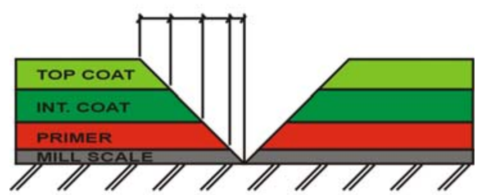
1. rust condition ≥ 7 (ASTM D610)
2. thickness ≥ 3, ≤ 12 mils
3. flexibility - chisel test
4. adhesion between layers and to substrate
5. Chalking
6. Substrate (Tooke Test)

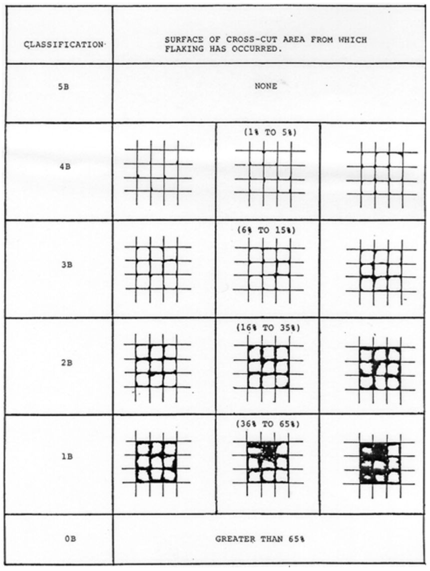
ASTM D 610



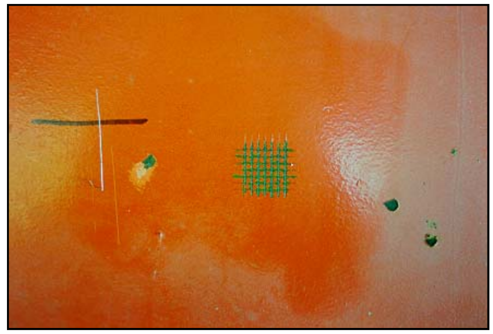
Blisters and Scaling

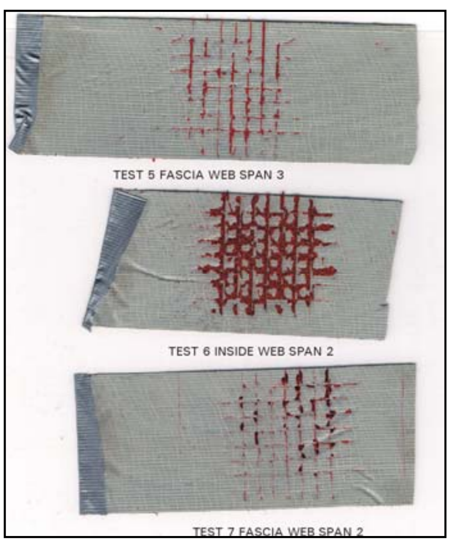
TOOKE TEST





CLASSIFICATION	SURFACE OF CROSS-CUT AREA FROM WHICH FLAKING HAS OCCURRED.
5B	NONE
4B	(1% TO 5%)
3B	(6% TO 15%)
2B	(16% TO 35%)
1B	(36% TO 65%)
0B	GREATER THAN 65%





Cause of Painting Cost Escalation

Various environmental and safety regulations concerning the removal and disposal of lead based paints.

LATE 1980'S	NO CONTAINMENT	$ 15 TO $ 20 / M²
EARLY 1990'S	ENCLOSURE	$ 50 TO $ 60 / M²
MID 1990'S	80% RECOVERY	$ 80 TO $ 100 / M²
1999	90% RECOVERY	$ 120 TO $ 140 / M²
2002	90% RECOVERY	$ 180 TO $ 200/M²
2004	90% RECOVERY	$ 225/M²
2006	90% RECOVERY	$ 300 TO $ 350/M²