

# Monitoring Corrosion of Reinforced Mortar using Guided Mechanical Waves

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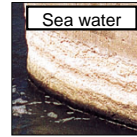
## Corrosion in Reinforced Concrete

- Number one infrastructure durability problem affecting
  - Aesthetics
  - Serviceability
  - Safety
- All geographic areas vulnerable
- Metallic corrosion in U.S. estimated at \$276 billion annually
  - \$22.6 billion estimated for infrastructure
  - Highway bridges are 37% of infrastructure, with majority being reinforced concrete
- Annual direct costs of reinforced concrete bridge corrosion is estimated at **\$4.2 billion**
  - Indirect costs estimated at 10 times the direct costs



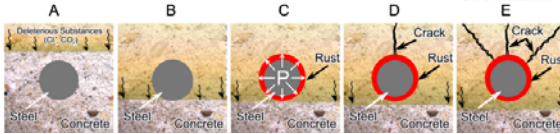
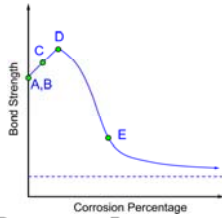
## What Causes Corrosion?

- Chlorides and CO<sub>2</sub> penetrate concrete, primarily by diffusion
- Chlorides break down oxide layer
- CO<sub>2</sub> reacts with concrete (carbonation)
  - Lowers pH
  - Destroys oxide layer
- Chlorides present from:
  - Deicing salts on roads
  - Marine atmosphere
  - Ground salts
  - Admixtures (e.g. accelerants)
- CO<sub>2</sub> is in atmosphere



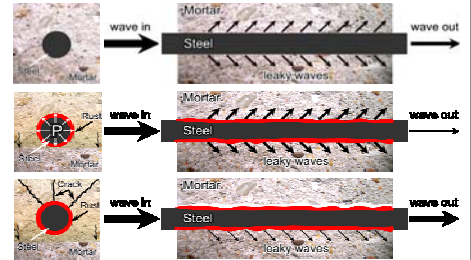
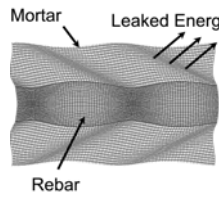
## Corrosion Process

- Deleterious substances ingress to rebar depth
- Rust product builds at interface creating pressure
- Tensile hoop stresses created in concrete cause cracking
- Loss of cross-section and degradation of concrete affect bond strength



## Guided Mechanical Waves

- Combination of compressional and shear waves continually interacting with boundaries to form a composite wave
- Interface pressure affects amount of wave energy leaked into surrounding concrete



## Experimental Procedure

- Accelerate corrosion (impressed current) while monitoring using guided waves
- Convert wave energy to attenuation
- Conduct pullout test to find bond strength
- Form relationship between attenuation of guided wave and bond strength of corroded specimen

