

# Concrete Spalling

A common but not well understood problem with older concrete structures is spalling.

Concrete spalling is usually caused by corrosion of the steel reinforcement bars embedded in the concrete matrix, but can be caused by other ferrous elements either fully or partially embedded in the structure. Steel frame window systems, handrails, structural I-beams, metal pipes and conduits are among the most common of the damage causing building components. Corrosion of the reinforcement steel however, is by far the most common cause of spalling and splitting in older concrete structures.

Steel reinforcement bar (rebar) is used in concrete to provide strength to a material that is extremely high in compressive strength but has very limited flexural or tensile strength.

One of the principles of reinforced concrete is that the high alkaline content of the concrete passivates and protects the embedded steel from corrosion. One of the main components of this corrosion protection is provided by the amount of concrete cover protecting the steel. As a general rule of thumb one inch of cover is required to protect the steel rebar, in other words, no rebar should be nearer than one inch of the concrete surface.

Another important factor for the protection rebar is to make sure that the concrete is properly consolidated during installation. Good consolidation is achieved by installing concrete that is the proper consistency, and by vibration of the wet concrete before it begins to set. Concrete that is too stiff (has too little water) is often not consolidated properly which allows air bubbles and voids to be left in the finished matrix. If these voids (commonly known as rock pockets) are large enough or extend all the way through the wall structure, water can easily penetrate the finished wall and/or contact the rebar and cause corrosion.

Another problem that occurs as concrete ages is a process called carbonation. In this process carbon dioxide penetrates the concrete via pores, cracks, and imperfections in the concrete. A chemical reaction occurs in the affected areas

that reduces the pH level of the matrix and nullifies the passivation of the steel by the high alkalinity of the concrete.

The net result of the corrosion of the rebar is the growth of ferrous oxide scale on the rebar. The ferrous oxide scale exerts enough force on the surrounding material that it splits the concrete. This splitting is what we refer to as spalling. The spalling can occur at any location on a building but generally shows up in areas where the steel is concentrated, such as at window heads and jambs, building corners, pilasters and column corners.

While there are products on the market that penetrate the concrete and reverse the effects of carbonation and resultant loss of alkalinity, the products must be used before the corrosion is severe enough to cause spalling. The normal method of repair therefore, is to remove the spalled and infirm concrete, coat the steel with an anti-corrosion coating and patch the spalled area with a repair mortar.

The good news is that as concrete technology has improved over the years, designers and contractors have become particularly good at placing and installing rebar and concrete. As a result of better quality control of materials, inspections, and general work practices, modern concrete construction generally suffers few defects compared to older concrete structures.

The following photographs show some typical concrete spalls:



Glacier Northwest Silo 14  
Spalling Concrete at Base Prior to Removal of  
Loose Concrete



Glacier Northwest Silo 14  
Spalling Concrete at Base After Removal of  
Loose Concrete



Pacific Coast Feather  
Typical Concrete Spalling at Window Jambs,  
Field and Corners



Spalling Concrete at Window Headers  
Poorly Consolidated Concrete



Spalling Concrete at Window Headers  
Poorly Consolidated Concrete

Frye Industrial Buildings  
Spalling Concrete at Window Jambs and Heads.  
This Damage Was Caused by a Combination of  
Rebar Too Close to the Edge of the Jamb and  
Corrosion of the Embedded Steel Window  
Frames.

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