Understanding a Post-Tension Slab

by Richard A. Slider, P.E.

Concrete has, historically, been the material of choice for the construction of condominium buildings because of its durability and economy. A type of construction called a post-tension slab system is commonly used for condominiums.

One of the distinct advantages of a post-tension concrete slab system is the ability to accommodate floor plans with irregular column alignments. A post-tension slab is also typically thinner than a conventionally reinforced slab resulting in less overall weight of the structure.

Post-Tension Slab Construction

A post-tension slab is constructed with cables laid out in two directions, typically at 90 degrees to each other. The cables are enclosed in a plastic sheathing to separate them from, and allow for movement within, the surrounding concrete. Each cable is anchored at one edge of the slab and then laid out loose across the slab to another steel anchor at the opposite end of the slab. Two steel reinforcing bars known as “bursting bars” are placed immediately behind the anchors to help distribute the high tension forces from the anchors. Once the steel, cables, and anchors are installed, the slab is ready for concrete placement.

After the concrete is poured and has reached an acceptable strength, the cable is “tensioned” within the concrete slab, stretching the cable to a force of 33,000 pounds. Two steel wedges are placed around the cable and within the anchor to lock the cable at the applied tension load.

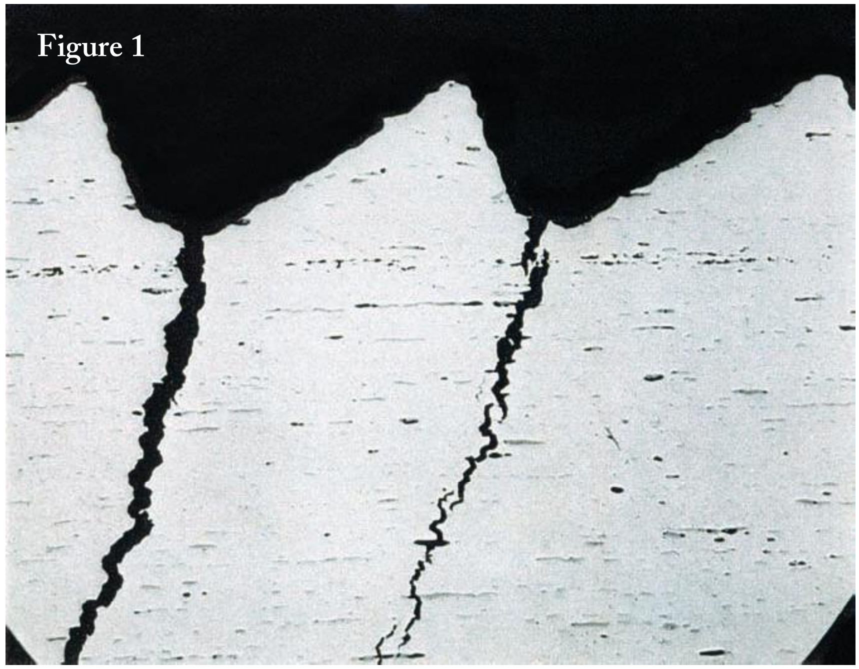
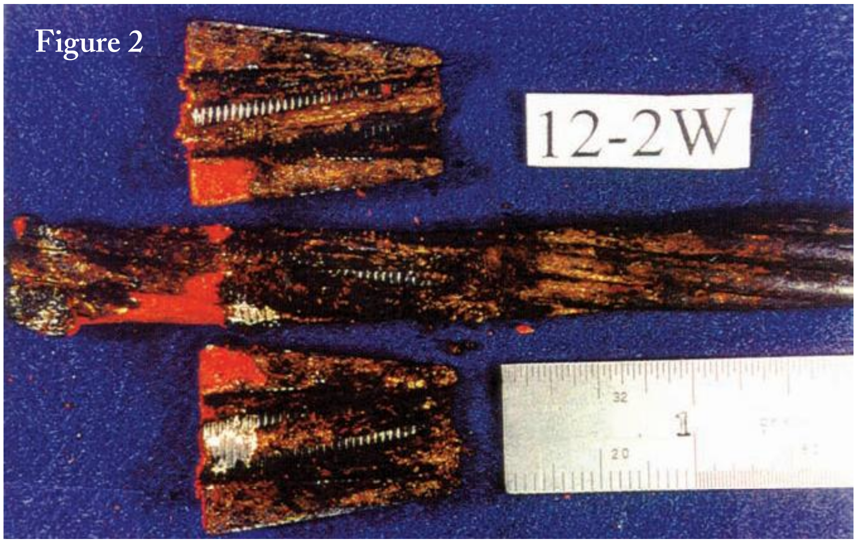


Figure 1

Post-Tension Repair

While the post-tension anchor system is an efficient structural system, most early systems did not include corrosion protection of

Figure 2



the steel anchorage and cable ends. As a result, infiltration of moisture through the concrete often results in corrosion of the post-tension cable, anchor, and wedges. The corrosion of the anchors and cables are most often identified by rust bleeding at the edge of the slab.

The presence of corrosion in the post-tension cable and wedge assembly can have a significant impact on the structural integrity and adequacy of the post-tension system. Corrosion will result in the inability of the wedges to adequately grip the cable resulting in a failure of the cable.

Deterioration of the post-tension slab system is, also, often identified by cracks at the top or bottom surface of the slab at a location approximately three inches back from the slab edge and aligned parallel to the slab edge. These cracks are typically the result of corrosion of the bursting bars behind the anchors. This corrosion is also the result of exposure to moisture.

The adequacy of the corroded anchor assembly can be difficult to assess. A typical survey to evaluate the condition would require exposing the end anchorages for a visual observation. While corrosion on the surface of the components may be visible, the anchorage assembly may still have sufficient capacity for the intended use. In conjunction with the visual observation, samples of the anchorages are often removed and subjected to a microscopic examination to observe and measure the integrity of the teeth on the wedges and to evaluate the condition of the strand (**Figure 1**). The repair of the anchorage would include removal of surface rust and the application of protective coatings. Cables which have been damaged by corrosion would have to be replaced (**Figure 2**).

Due to the extremely high force in the cables (33,000 pounds), removal of concrete behind the anchor and bars can cause a significant failure of the slab. As a result, replacement of deteriorated anchors requires de-tensioning of the affected cable. Only the damaged portion of the cable is de-tensioned during repairs. The remaining cable must retain the post-tension force to maintain structural capacity in the slab.

The de-tensioning of the cable is accomplished by opening a small

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area of the concrete slab inward from the repair area. Within this opening, a temporary cable "lock-off" device is installed (**Figure 3**). The lock-off location is typically two to three feet from the edge so that the cable forces can "flow" or be redirected around the opening without a risk of a concrete failure (**Figure 4**). The outer portion of the cable is then released, and repairs of the anchor and bursting bars can commence.

During concrete repairs, replacement anchors and cables are installed. In order to provide corrosion protection, current technology utilizes a plastic encapsulated anchorage system that protects all the parts of the anchors and cables. Once the new system is installed, and the new cables spliced to the locked-off cable, the repair area is ready for concrete placement (**Figure 5**). The repaired concrete is then allowed to cure.

After curing, the spliced cable is re-tensioned to the outer anchor, and the temporary lock-off is removed.

Figure 3

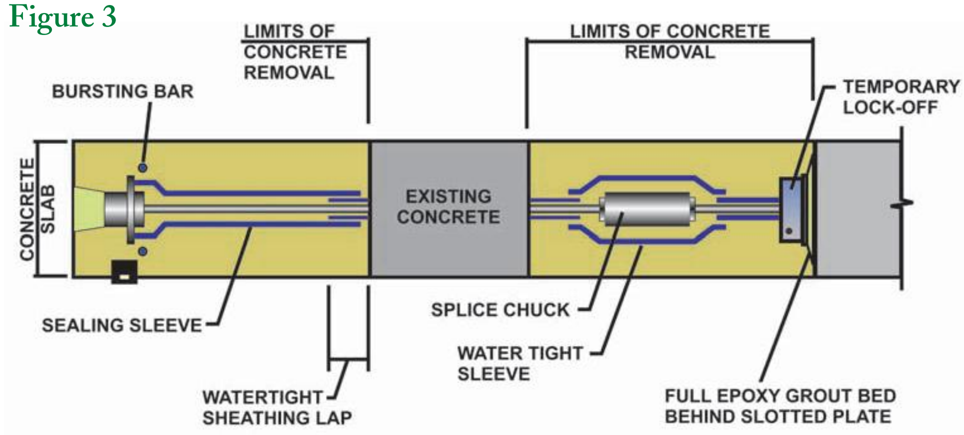

Figure 4

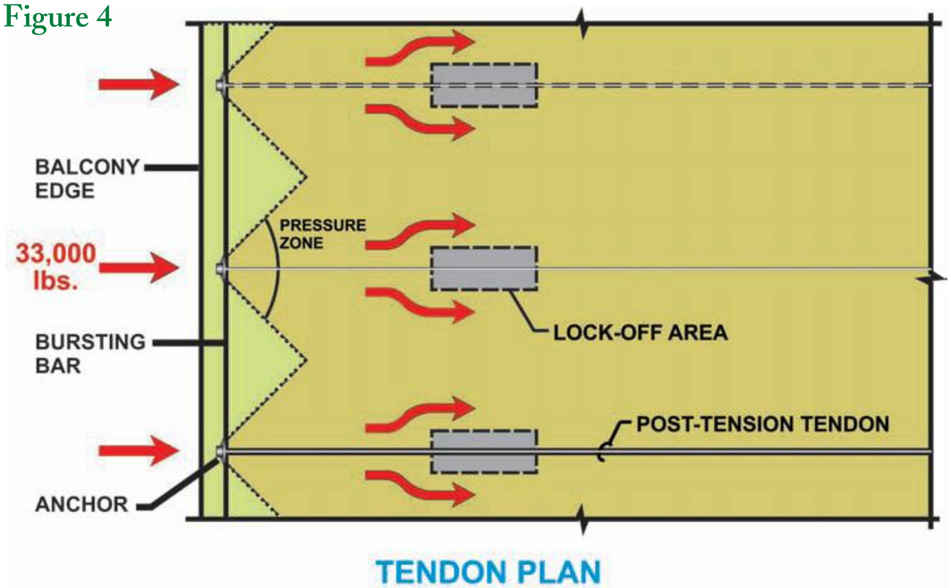


Figure 5

The inner lock-off opening is filled with concrete to complete the repair.

The lock-off and re-tensioning activities tend to be expensive. I have observed several unsuccessful projects where an attempt was made to remove only the material on the outside face of the bursting bars without de-tensioning of the cable (**Figure 6**). Without removing the high-tension force at the edge of the slab, the concrete behind the anchors and bars cannot be removed. Within a short period of time, the corrosion process continued and the condition reappeared. While the shortcut repair effort saved on cost, the technique is ineffective. In addition, the technique is unsafe due to the potential of the slab edge failing from the post-tension force.

The replacement of deteriorated anchors with an encapsulated system provides adequate protection of the cable from further corrosive deterioration. The reinforcing at the slab edge, however, remains vulnerable to corrosion. As a result, waterproofing of the slab surface is recommended to reduce the deterioration of the reinforcing steel at the concrete edge.

The cost of a single cable repair will typically range from $800 to $1,200 and does not include the cost of other concrete repair. In most slab systems, the cables are spaced about 30 to 36 inches apart. As a result, a significant expense for cable repairs can be experienced.

Figure 6

Conclusion

Only a contractor qualified in post-tension cable repairs should perform this work. Improper release of the cable anchors can cause significant structural damage and injury.

A structural survey should be conducted at the first signs of cracks or stains in the slab system. Early detection may permit the cleaning of the end anchorage without the expense of a de-tensioning effort.

Post-tension replacement should include an encapsulated anchor system.

Protection of reinforcing steel at the slab edge can be enhanced with the application of a quality waterproofing system.

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