



# Review on Reinforced Concrete Slabs behavior with Presence of Openings

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## Abstract

Openings in slabs are an important issue that needs to be studied carefully because these openings have an important effect on load capacity and the general behavior of RC, reinforced concrete slabs. This research aimed to review the previous studies that highlighted the impact of presence of opening in RC one-way and two-way slabs in addition to a review of four important codes, ACI Code, British Standard, Canadian Standard, and European Standard, that focused on this topic. The review of previous studies is divided into two sections, the first is the effect of opening in one-way slabs and the second is the effect of opening in two-way slabs. These studies produced that the opening size and position significantly affect load capacity, flexural, shear resistance, and deflection of slabs. The opening in the slab reduces the load capacity and shear resistance by reducing the concrete mass of the section where the concrete is cut. The flexibility of that slab is reduced in the existence of the opening caused by reinforcement cutting. The effect of opening can be reduced by using additional reinforcements or by using CFRP, carbon fiber reinforced polymer-strengthening.

**Keywords:** Review; RC; Opening; slabs

## 1. Introduction

Due to a large number of service requirements for construction buildings, nowadays, openings are intensely needed in slabs and even in beams, such as openings for electrical cables, sewer, and cooling pipes or ducts or openings for stairs, elevators, or even for architectural purposes. Care shall be taken while incorporating these openings. Some are before construction which can be planned and some are after construction.

There are many different ways of restrengthening of opening in slab. These ways, are conducted internally before casting by adding additional reinforcements around the opening, externally by using carbon fiber reinforcement with casted and cut slabs, or by using both strengthening methods.

Several studies have been conducted on reinforced concrete slabs with openings to highlight the effect of opening on the shear, flexural, and general behavior of slabs in addition to the effect of size, shape, and position of opening on these slabs. This research will review the limitations and conditions of ACI code, BS code, ES code, and CSA code in addition to many researches that studied the effects of openings in one-way and two-way slabs.