



## Laser Drilling of Small Holes in Different Kinds of Concrete

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### Abstract

Recently, in Japan, safety measures such as earthquake-resistant reinforcement work and tile-reinforcement work are increasing. Current concrete drilling methods have issues such as noise, vibration, dust, and reaction force. These methods are causing stress for the residents. Consequently, solutions are being sought for work taking place on skyscrapers and at facilities that cannot shut down during construction, such as hotels, schools, hospitals and geriatric facilities for instance. This study investigated how laser drilling change the conditions, depending on the type of concrete in order to determine the possibility of using laser drilling for tile-reinforcement work and repairing concrete on building exterior. The results confirmed that it's possible to successfully drill holes for drilling diameters of 4 to 6 mm and depths of around 50 mm in concrete with a compressive strength within the range of 20 to 100 N/mm<sup>2</sup> by adjusting laser conditions. In case of deep holes the CW-mode should be chosen. Furthermore, by controlling laser irradiation conditions, it is possible to change the shape of the holes. These different kinds of holes are suitable for different applications. It is expected that laser irradiation drilling will be applied to new construction methods.

*Keywords:* Laser Drilling; Various Types of Concrete; Laser Irradiation Condition; Tile-Reinforcement.

### 1. Introduction

Recently, in Japan, awareness of disaster prevention is rising owing to the Great East Japan earthquake and the Kumamoto earthquake, and earthquake-resistant constructions and tile-reinforcement research are increasing. [1]

For this study, holes are drilled into concrete in order to install anchor bolts and pins. The drilling conditions necessary for reinforcement work are shown in Table 1 [2-4]. Earthquake-resistant constructions need holes with big diameter and depth. That means, big bolts for concrete reinforcement are required. In the case of tile-reinforcement, almost invisible holes and pins with small diameter and depth for fixing and adhesive are necessary. A tile is a thin plate fixed on the exterior surface of a building.

Nowadays the stress for the residents arises during working with standard concrete drills. Therefore, solutions for reducing these problems are required for working performed on skyscrapers and at facilities that must remain open to the residents, such as hotels, schools, hospitals and geriatric facilities for instance.

As countermeasures for these issues, low-noise and low-vibration backwards during working or drilling on the exterior. Concrete drilling technology using lasers to deal with reaction force [4]. But laser technology is rarely implemented in the construction field [5-7] however, it is being used in the manufacturing as drilling [8], cutting [9], welding [10], ablation and additive-manufacturing and microfabrication of medical devices, food industry, metal items,

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