

Safe Coring and Drilling Areas Found Quickly, Efficiently

Accurate hand tool is easy to learn and use on reinforced concrete

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Coring and drilling into a reinforced concrete member may be required when installing pipe railings and hangers, or when investigating the in-place strength of concrete. Damaging the reinforcement in a structural member must be avoided, and it's also desirable to avoid damaging drill or core bits. Thus, it is prudent to use a metal locator to find areas in the concrete that are free of steel before drilling or coring concrete.

Many metal-locating devices on the market today tend to be expensive and require trained personnel for successful use. Another factor contributing to their lack of use on a construction site is difficulty in getting the equipment and the right personnel, when needed, on site to locate steel. In most cases, contractors will simply gamble that they will not hit steel during coring or drilling operations.

To address this problem, Southern Illinois University at Edwardsville (SIUE) launched an undergraduate research project to investigate the performance of several inexpensive and easy-to-use metal-detection devices for reinforced concrete. This study indicated that the Zircon 6.0 metal locator was accurate and easy

to operate. Subsequent to this study, the company produced a new version costing less than \$200. In preliminary tests, the new locator, the Zircon MT6 (Fig. 1), performed even better than the 6.0 model.

Following the preliminary investigation, one of the authors spoke at the First Mongolian Concrete Conference and gave a presentation on nondestructive testing techniques. The MT6 metal locator was used as part of the presentation. A series of discussions ensued, and the authors proposed a joint research project for evaluating the accuracy of the MT6 in metal location to determine specifically how easily this instrument can detect safe coring and drilling areas. This investigation was undertaken at each author's university, in the United States and in Mongolia, respectively.

COMPACT UNIT

The MT6 is relatively small at about 9 in. (230 mm) long, 3-3/4 in. (100 mm) wide, and 2-1/4 in. (60 mm) deep. The unit weighs about 10 oz. (290 g). It requires a 9-volt alkaline battery. The manufacturer's literature states that the unit's operative temperatures are 20 to 120 °F



Fig. 1:
The Zircon MT6

(-7 to 49 °C) and that it can locate steel to an embedment of 6 in. (150 mm) within a ±1 in. (25 mm) accuracy.

Zircon Corp. posts on its website (www.zircon.com) step-by-step instructions for the use of the MT6. After turning the device on, a technician holds the instrument in an area of concrete that does not contain steel. After pushing its recalibration switch at this location, the technician then moves on to scan the concrete surface. It will give a beeping sound when it is directly over steel, and the depth of the steel is displayed on the built-in screen.

INITIAL LABORATORY EXPERIMENTS

Initially, the device was used in a series of laboratory experiments

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with No. 4, 6, and 10 (13, 19, and 32 mm) reinforcement at known locations; spacers had been put above reinforcing bars. The data in

Table 1 was obtained using the MT6.

The equipment does not determine the size of the reinforcement, thus some inaccuracies would be expected

in the depth measurement as the mass of the reinforcement varies. From our research, the depth measurements were accurate to 1/2 in. (12 mm).

TABLE 1:
MEASUREMENTS TAKEN AT SET LOCATIONS IN LABORATORY

No. 4 (13 mm) steel reinforcement		
Measured clear cover in. (mm)	Accuracy of horizontal location	Instrument reading clear cover in. (mm)
1 (25)	Accurate to ±0.5 in. (13 mm)	3/4 (20)
2 (50)	" "	2 (50)
3 (75)	" "	3 (75)
4 (100)	" "	3-3/4 (95)
5 (125)	" "	4-3/4 (120)
6 (150)	" "	5-3/4 (145)
No. 6 (19 mm) steel reinforcement		
Measured clear cover in. (mm)	Accuracy of horizontal location	Instrument reading clear cover in. (mm)
1 (25)	Accurate to ±0.5 in. (13 mm)	1 (25)
2 (50)	" "	2 (50)
3 (75)	" "	3 (75)
4 (100)	" "	3-3/4 (95)
5 (125)	" "	5 (125)
6 (150)	" "	6 (150)
No. 10 (32 mm) steel reinforcement		
Measured clear cover in. (mm)	Accuracy of horizontal location	Instrument reading clear cover in. (mm)
1 (25)	Accurate to ±0.5 in. (13 mm)	1/2 (13)
2 (50)	" "	1-3/4 (45)
3 (75)	" "	2-3/4 (70)
4 (100)	" "	3-3/4 (95)
5 (125)	" "	4-1/2 (115)
6 (150)	" "	5-1/2 (140)

FIELD INVESTIGATIONS IN THE U.S. AND MONGOLIA

In setting up the field tests to ascertain if locations for safe coring could be identified, the construction site had been visited prior to concreting and an as-built sketch of the reinforcement positioning had been made. After the concrete was cast, a student with little experience in using the equipment sought to locate, with the metal locator, a safe area to core or drill.

He first determined the position of the steel by scanning along the surface of the concrete and putting chalk marks initially at the location of the embedded steel. Next, he moved approximately 3 ft (1 m) on each side of the marked location and scanned the surface again marking as necessary. The chalk notations were then connected. He repeated the entire procedure, with scanning as well at 90 degrees from the original locations observed. The resulting grid indicated the positioning of the reinforcement. The areas between the marks were in turn scanned to check for freedom from steel.

When he found no steel present, the student marked the location to identify it as a safe area to core or drill. These locations were then compared to the as-built sketch, and were verified to be free of steel—thus being safe coring locations. The entire sequence is depicted in Fig. 2 to 4.

Mongolian students followed the same procedures. They, too, were able to locate steel reinforcement in precast concrete pipe and slabs and on a construction project as shown in Fig. 5.

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Fig. 2: Student in the U.S. prepares the as-built drawing



Fig. 3: Students scan and mark the concrete surface



Fig. 4: A "safe" location is found and marked

In the authors' opinion, personnel with minimal training and accurately using the Zircon MT6 located steel reinforcement within a ± 1 in. (± 25 mm) accuracy in both horizontal and vertical directions. The directions on the website and on the equipment are easy to follow, and can be quickly implemented. This permits the technician and coring crew to swiftly and safely locate areas in concrete members that are free from steel.

Selected for reader interest by the editors.

—Zircon Corp.
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Fig. 5: Students from the Mongolian University of Science and Technology follow the same procedure with the MT6 on a variety of reinforced concrete elements



Luke Snell (right) presenting an ACI tie to Yagaanbuyant Duinkerjav during the formation of the ACI Mongolia Chapter

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