DETECTING THE COVER AND SPACING OF WELDED WIRE REINFORCEMENT

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Introduction

For any Welded Wire Reinforcement (WWR) to perform effectively, two major conditions must be satisfied: 1) the spacing and size of WWR is in accordance with the required design and 2) the cover of WWR is maintained within tolerance limits. Typically, these conditions can be verified by a pre-placement inspection and by following proper techniques of controlling cover during the placement. Occasionally, when a pre-placement inspection is not done, issues arise about the placement of WWR and questions may even arise about whether the WWR was actually installed.

There are several kinds of metal locators that can be used to answer the above questions. Typically this equipment is expensive and requires a highly trained engineer to operate. In many cases, all that is needed is a simple verification of whether the WWR was installed and that the cover is adequate.

The Concrete Construction Resource Unit (CCRU) at the Southern Illinois University Edwardsville had, in an earlier research work, evaluated an electronic metal locator called the Zircon MT6. This is relatively inexpensive and easy to use equipment that can accurately locate reinforcement in concrete. The research was published in Concrete International, July 2003.

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The objective of this research work was to find out if Zircon MT6 can accurately locate WWR and to determine if a novice user can easily learn how to use this equipment to solve the above mentioned problems.

Product Detail

The Zircon MT6 metal locator is a relatively compact unit measuring about 9 in (230mm) long, 3-3/4 in (100mm) wide and 2-1/4 in (60 mm) thick and weighs about 10 oz (290 gm). It runs on a 9V alkaline battery and according to the manufacturer's literature, operates in temperatures ranging from 20 ^{0}F to 120 ^{0}F.

Fig.1, Zircon MT6.

The price of this piece of equipment is around $200 and it comes with a complete step-by-step operating instructions sheet in both English and Spanish. Further product details and a copy of our article are available on its website (www.zircon.com).

Working Principle

Zircon MT6 is basically an electronic device that locates metals beneath any surface. It has a digital display screen and an optional beep-sound system which will sound whenever the equipment encounters a metal object beneath the surface. The digital display will indicate the depth of steel (cover) in the English system (inches) or Metric System (cm). Whenever metal is encountered beneath the surface being scanned, a plus sign is displayed. The user will know that the instrument is directly over the steel and the depth is shown on the digital display.

The Experimental Measurement Procedure

An experimental set up was made in the laboratory to assess the accuracy of Zircon MT6 in locating WWR. The "cover" over a given WWR was varied by using some wooden pieces, each of ¾ in thickness and 2 ft in length. A ½ in thick transparent Plexiglas sheet, sufficiently large to cover the area of WWR was used as the scanning surface. This Plexiglas sheet gave the other advantage of visually verifying the accuracy of metal detection on a real time basis. A schematic of the experimental set up is shown below.

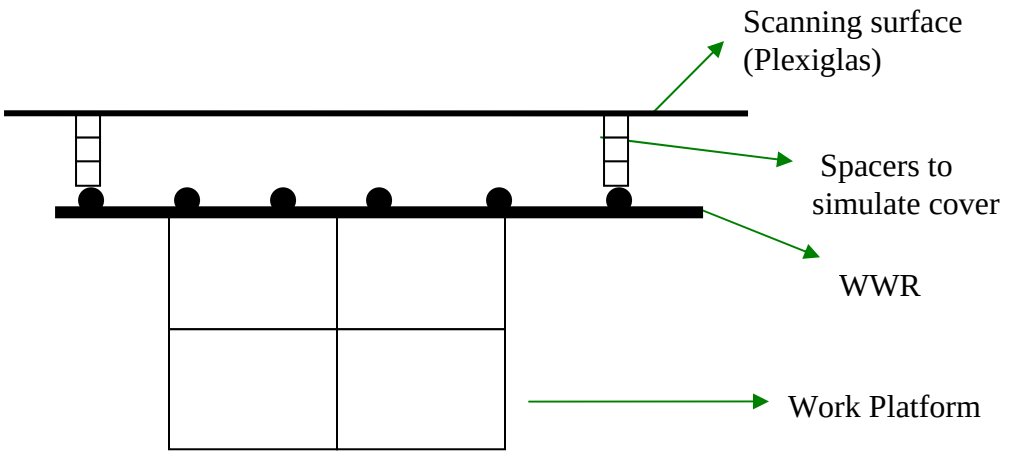

Fig. 2, Schematic of the Experimental set-up

Fig. 3, a picture of the actual set-up

Fig. 4, Close up view of scanning procedure

The steps followed during the experiments are shown below:

- A 2.5 ft X 3 ft. sheet of paper was placed over the Plexiglas to make note of the location and depth readings during the scanning process.
- The user would scan the surface.
- When the (+) sign appeared, a mark would be made on the sheet of paper and the reading of cover would be recorded.
- The user would then move approximately 2 ft (600mm) and then repeat the scan. The grid pattern of WWR should become apparent.
- The depth of WWR (cover) would be the average of all readings.

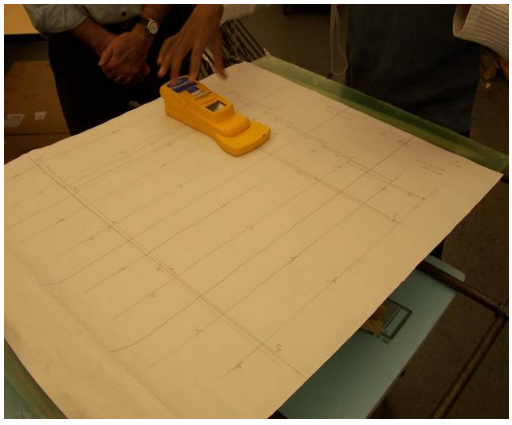

Fig. 5, The WWR 'grid'

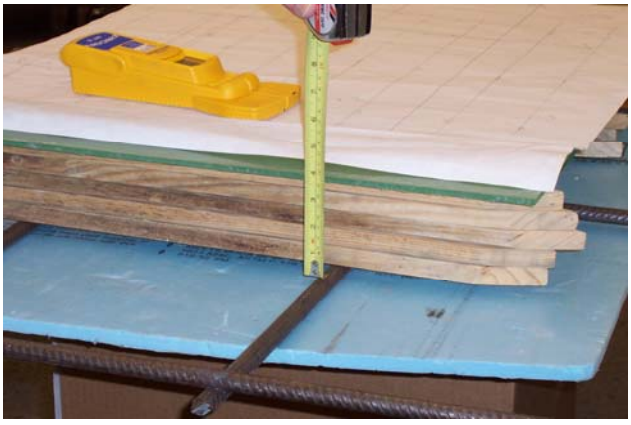

Fig. 6, verifying the cover using measurement tape

A total of ten different WWR were tested using this experimental set up. Although this does not represent all of the possible variations of WWR, the experiment did include the range of most sizes and spacing styles used in construction.

Results and discussion

The table shown below shows the result of measurements taken at various cover thicknesses for each of the ten different types of WWR.

Note: All measured values are in inches

Sample No	(1) Actual WWR Style	(2) Maximum Depth of detection of WWR	(3) Accuracy of detection of cover thickness	(4) Accuracy of location of longitudinal bars	(5) Accuracy of location of transverse bars
1	6 X 6 - W1.4 X W1.4	4.25	Readings not dependable	± 0. 5	± 1.0
2	6 X 6 - W2 X W2	3.75	± 0.5"	± 0. 5	± 1.0
3	6 X 6 - W2.9 X W2.9	4.25	± 0.5"	± 0.75	± 1.0
4	4 X 4 - W4 X W4	2.50	Readings not dependable	Readings not dependable	Readings not dependable
5	4 X 6 - D6.5 X D4	4.0	± 0.75"	± 1.25	± 1.0
6	6 X 6 - D8.3 X D8.3	3.75	± 0.5"	± 1.5	± 1.25
7	6 X 12 - D9 X D10	4.25	± 0.75"	± 0.5	± 1.0
8	6 X 12 - D16.5 X D10	3.25	± 0.75"	± 0.5	± 1.0
9	12 X 4 - D15 X D11.6	3.0	± 0.75"	± 1.5	± 0.75
10	12 X 18 - D31 X D31	3.5	Readings not dependable	± 1.5"	± 1.5

Table 1: Summary of Measurement Data

The data obtained from the experiments shows that in all cases, the equipment can be used to verify if WWR is in the upper 2 ½ to 3 inches of the slab and the spacing can be verified with some limitations discussed below.

1) 1. For WWR 4 X 4 - W4 X W4, the MT6 confirms that WWR was installed and that the WWR is within 2 ½ inches from the surface or the cover was between 0 and 2 ½ inches. The spacing and the cover readings were unreliable.

2. For WWR 6 X 6-W1.4 X W1.4, the MT6 confirms that WWR was installed, the spacing is on 6 inch centers, and that the cover was between 0 to 4 ¼ inches. The cover readings were unreliable.

3. For WWR 12 X 18 - D31 X D31, the MT6 confirms that WWR was installed, and the spacing of the WWR was within 3 ¼ inches from the surface or the cover was between 0 to 3¼ inches.

4. For all the other tested WWR, the cover was determined up to +/- ¾ in accuracy and to a depth of 3 inches.

Some Observations

From the very beginning of the experiment Zircon MT6 was easy to use and appeared to provide good measurement results. During our experiments, one of the undergraduate students from SIUE was asked to use the equipment to locate WWR. He had never seen the equipment prior to this and had no experience in using any metal locating devices. . He was able to obtain fairly accurate results on his first try. His accuracy of measurement increased as he gained experiences by just using the MT6. He was also able to gain confidence and was of the opinion that he would be able to successfully use the MT6 on a "real" project.

SIUE routinely uses the Zircon MT6 in one of our Construction classes. The students spend about an hour in the laboratory duplicating our experiments that we did for this study. They are then asked to determine if WWR was installed in our large concrete patio that is in front of the Engineering Building. If they find WWR, they were to determine the spacing and cover. These students have easily found that the concrete patio was reinforced with WWR, that the spacing of the WWR was on 6 inch spacing and that the cover varies from 2 to 4 inches.

Conclusion

1) Zircon MT6 can be used to check the presence of WWR in a concrete provided the cover is 3 ½ inches for all types (or 2 ½ in if 4 X 4 - W4 X W4) and the spacing of WWR can be confirmed. It is a simple and easy to use metal locator and is relatively inexpensive.

2) It is suggested that whenever possible, before using the Zircon MT6 on a job site, the user should take some trial readings similar to our experimental test procedure. This will result in the user being able to confidently provide accurate test results

3) The authors would recommend that the more sophisticated equipment and a professional engineer be retained if life safety or litigation issues concerning the reinforcement need to be evaluated.

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References:

1. "Controlling the WWR Cover", CS299-R-03, technical report for WRI
2. "Safe Coring and Drilling Areas Found Quickly, Efficiently", by Luke M. Snell and Yagaanbuyant Duinkherjav, Concrete International / July 2003.
3. "Cover of Welded Wire Fabric in Slabs and Pavements" by Luke M. Snell, Concrete International / July 1997.
4. http://www.siue.edu/CCRU/articles/wwr.htm