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Low Maintenance Slabs

Supports Are Needed for Long-Term Performance of Welded Wire Reinforcement In Slabs-On-Grade

INTRODUCTION

With its cost-efficiency and superior performance attributes, welded wire reinforcement (WWR) frequently is the reinforcing steel of choice for slabs-on-grade. However, WWR's full benefits in controlling cracking and reducing maintenance can only be realized when it is accurately positioned with properly installed supports.

One of the primary causes for an under-performing slab-on-grade is the inadequate positioning or complete absence of supports. Yet, there is no justification for improper placement or inadequate support of WWR, particularly since the process is relatively easy and inexpensive to accomplish.

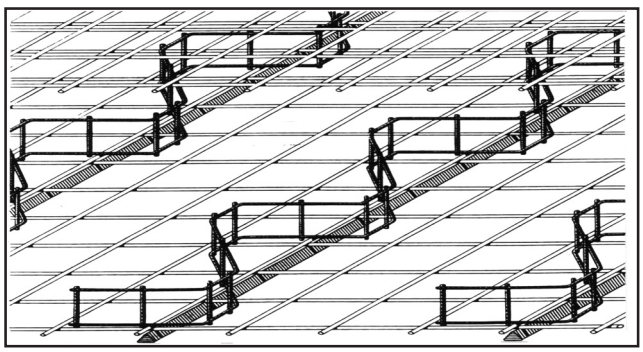
This report, which is directed largely to architects, engineers and contractors, encourages the use of proper supports for WWR in slabs-on-grade, including industrial floors, light commercial floors, residential floors, parking lots, sidewalks and, in general, all concrete flat work. It supplements the Wire Reinforcement Institute's Tech Fact 705, Innovative Ways to Reinforce Slabs-On-Ground.

WWR is used primarily to control cracking due to shrinkage, thermal stresses and other effects, and thus reduces future maintenance while helping to produce a higher quality slab. However, WWR also may be designed and used as structural reinforcement for the slab.

The design of slabs-on-grade is less straightforward and less restricted by building codes than is the case for supported slabs. While these less prescriptive requirements have led to a variety of practices in the field, it has also allowed significant innovations by designers and constructors of slabs-on-grade. Whatever the case, however, reinforcement must be properly detailed on the project drawings, and then be accurately located and securely tied before and during concrete placement. It may be necessary with light WWR styles to place supports and properly position reinforcement as the concrete is being screeded. With heavier styles or wide wire spacings the supports could be placed before concrete placement. These steps are absolutely necessary for the reinforcement to perform its intended function.

Tying WWR is very quick and easy – simply tie at overlaps and a few ties may be required at supports.

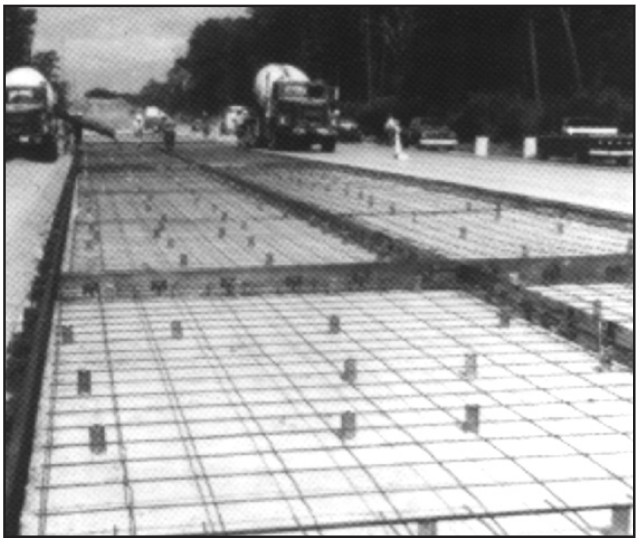
When WWR (deformed or plain wire) is specified, the combination of wire diameters and wire spacings should be selected to maintain the WWR's proper position during the construction process. Moreover, WWR always should be supported as described in this report.



Welded wire reinforcement placed on welded wire supports.

DESCRIPTION OF A SLAB-ON-GRADE

A number of phrases are used to describe a slab-on-grade, including a grade slab, a floating slab and, simply, a slab. The key point is that such a concrete slab has continuous contact support with a prepared base or subgrade material. The report by ACI Committee 360 defines a slab-on-grade as a slab which is continuously supported by "ground," may be of uniform



Welded wire reinforcement for highway paving and white topping is being specified more today– properly supported WWR helps protect against damaging transverse and longitudinal cracking.

or variable thickness, and may also have stiffening elements such as ribs or grade beams.

WHY SUPPORTS FOR REINFORCEMENT ARE NECESSARY

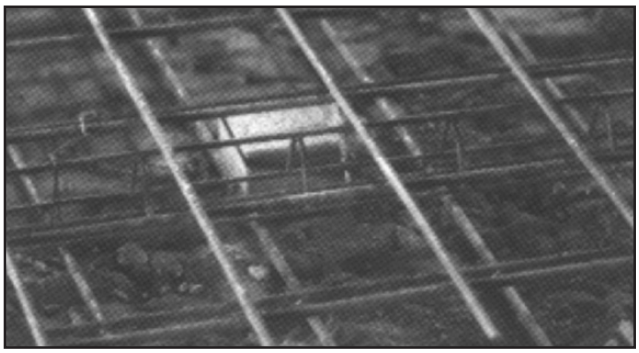
The primary performance requirement for supports of welded wire is that the supports hold the reinforcement in the proper vertical position within the slab during placement of the concrete. Properly positioned welded wire will reduce future maintenance costs for the slab.

It is not recommended that reinforcement be placed on the grade surface and then pulled up (so-called "hooking"), nor is it recommended that the reinforcement be placed on the freshly placed concrete and depressed into the concrete (so-called "walking-in"). Both of these practices are no longer used because the resulting location of the reinforcing steel is approximate and can not be inspected for actual placement. Project specifications should indicate the requirements for properly supporting the reinforcement.

Various types of supports for WWR are commercially available. The types of supports include wire and welded wire supports, individual high chairs with plates, bolsters with plates, all-plastic supports, concrete blocks, and others. Individual high chairs or bolsters without plates may be used with a firm subbase or mud mat. See Figure 1 for some examples of supports.

POSITION OF REINFORCEMENT AND COVER

The proper position for the steel reinforcement is a decision based on the design itself and is controlled by the intended function of the steel. When one layer of reinforcement is used, then it should be located at or above the mid-depth of the slab. Some architects/engineers require that the single layer be placed 2 inches below the top surface of the slab. In thicker slabs, the reinforcement must be low enough so that it will not interfere with saw cutting. Others recommend that the layer be placed at one-third the depth below the top surface. Any of these locations can be the appropriate choice, depending on the design concept – for example, whether the slab is reinforced for crack control, or is reinforced for structural reasons, or designed for shrinkage-compensating concrete. When one layer of reinforcement is used, it should not be allowed to be below mid-depth. In general, positioning at one-third the depth below the surface is sufficient.

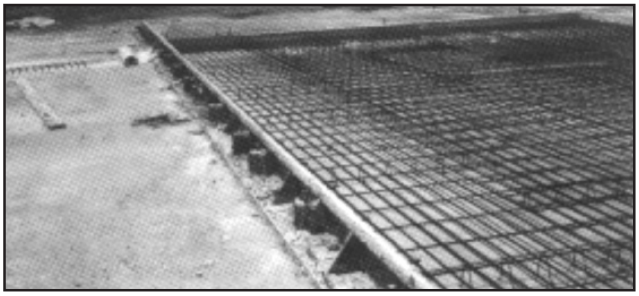


Here concrete blocks support the bottom layer of WWR and continuous wire chairs support the top layer.

When two layers of reinforcement are used, the question of cover applies to both layers. The upper layer should be placed at least 1 inch below the top surface of the slab. However, it should not be positioned too close to the top surface due to the variation in flatness created when that surface is finished. The specified depth of any saw cut must also be considered and

Wide spaced wires and wide support spacings are cost effective while maintaining proper positioning of reinforcement.

the upper layer placed below that saw cut. In the case of the lower layer, when the concrete slab is placed on a well-constructed base course (normally graded, compacted and porous), many who design floors consider $1^1/_2$" of clear cover below the steel to be adequate. Additional cover should not be necessary unless the governing building code requires a bottom cover of up to 3 inches.



Highway reinforcement supported on continuous wire chairs.

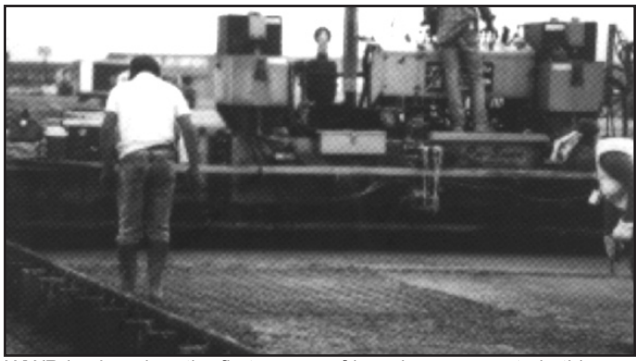
TYPES OF SUPPORTS

Although this report concentrates on slabs-on-grade, supports are also used for foundation mats and supported slabs. Some are shown in Figure 1 but these and others are well described in support manufacturer's brochures.

For a particular project, the supports should be selected taking into account the size and weight of the welded wire reinforcement, the stiffness and strength of the base or subgrade, the specified position of the reinforcing steel including the number of layers, and the construction process to be used for placement of the concrete. The supports selected must properly position the reinforcing steel so it remains in place during the construction process and until the concrete hardens. Supports must be compatible with the concrete and be positioned firmly on the top of the base surface or subgrade. It is not necessary to stagger supports. Generally, vibration of the concrete is specified to obtain adequate consolidation of the concrete materials and would be sufficient to encase the supports, thus preventing voids.

The supports selected must properly position the welded wire reinforcement and provide adequate support until the concrete cures.

Two-course slab construction is occasionally used in airport and paving work where the slab is thicker than normally encountered in industrial plants, commercial buildings, and residential buildings. The WWR is placed on the first course of low slump concrete and the remainder of the concrete is then placed. This two-course technique is not common in building construction; when it is used the resultant position of the reinforcing steel may not be as accurate as when supports are used.



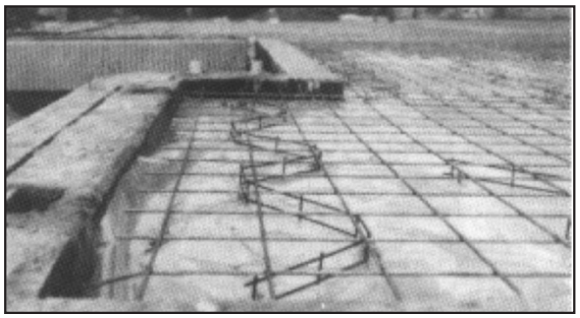
WWR is placed on the first course of low slump concrete in this airport taxiway.

INFLUENCE OF BASE CONDITIONS ON SELECTION OF SUPPORTS

The condition of the upper portion and top surface of the subgrade is crucial to the proper selection of the support system. For example, soft base materials, such as loose sand, require supports with base plates or with appreciable contact areas. Stiffer and more stable base materials, such as a compacted granular base, should allow the use of wire and plastic supports without base plates or concrete blocks. In selecting the supports it is necessary to consider both the reinforcement to be supported and the base directly under the supports. Most manufacturer's brochures will indicate the base surfaces required for their products.

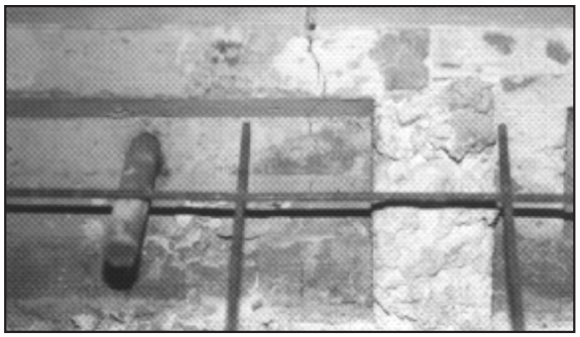
The ACI Committee 360 report recommends a graded granular fill, appropriate for compaction and trimming, as the base material for slabs-on-grade. Gravel bases, when compacted, fit this description. Compacted granular fill allows a greater variety of supports for consideration due to the inherent strength and stability of gravel. The so-called sand cushion (a few inches of uniformly graded sand) is usually not stable or stiff, and thus demands the use of supports with base plates or concrete blocks. The supports must not penetrate the base (subgrade) during the construction process because the specified position of the reinforcing steel could be changed and its beneficial effect diminished. When polyethylene sheeting is used under a slab the selected supports must not puncture the sheeting. Other materials

may be required under a slab due to special circumstances or conditions. For example, the floors in cold storage or freezer warehouses are usually placed upon insulation boards. The selected supports must not penetrate the insulation board.



SPACINGS AND STRENGTH OF SUPPORTS

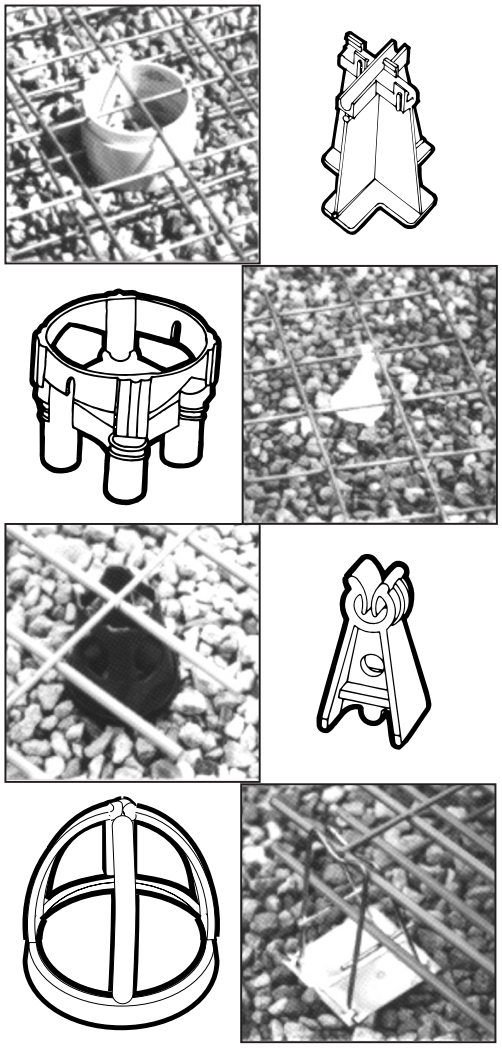
After having determined the amount of reinforcement required, the next step is to determine its correct position within the slab. To accomplish the purpose of the reinforcement it is essential that it be placed on supports and these requirements should be stated in the project specifications. Many types and configurations of supports, as well as devices for special purposes not discussed in this report, are commercially available.



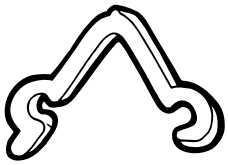
Properly positioned steel below the saw cut control joint allows concrete to crack the full depth and adds load transfer capacity across the joint.

Examples of some types of supports are shown in Figure 1. Generally these supports are spaced 2 to 6 (or more) feet apart, depending on the stiffness and weight of the WWR being supported. Between the supports, the reinforcement must not deflect or sag excessively. While there are no criteria for limiting this deflection, the reinforcement must not deflect beyond any required clearances.

There is limited information available on requirements for support spacings for welded wire reinforcement. There are several factors to consider before determining support spacings. These factors include the diameter and spacing of the reinforcement (larger wire diameters with wider support spacings will allow workers to step through rather than on the reinforcement); and general recognition of any construction loads that will be applied before and during concrete placement. The welded intersections of WWR provide a very rigid sheet of reinforcement.



A variety of wire and plastic supports are available – many are made especially for welded wire reinforcement. Adequate spacing of supports depends on the style and size of wires. Spacings of supports varies from 2 - 6 feet and more depending on wire sizes and spacings.



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The suggested spacings of supports in Table 1 may be used for estimating and construction. However, the preceding factors should be considered.

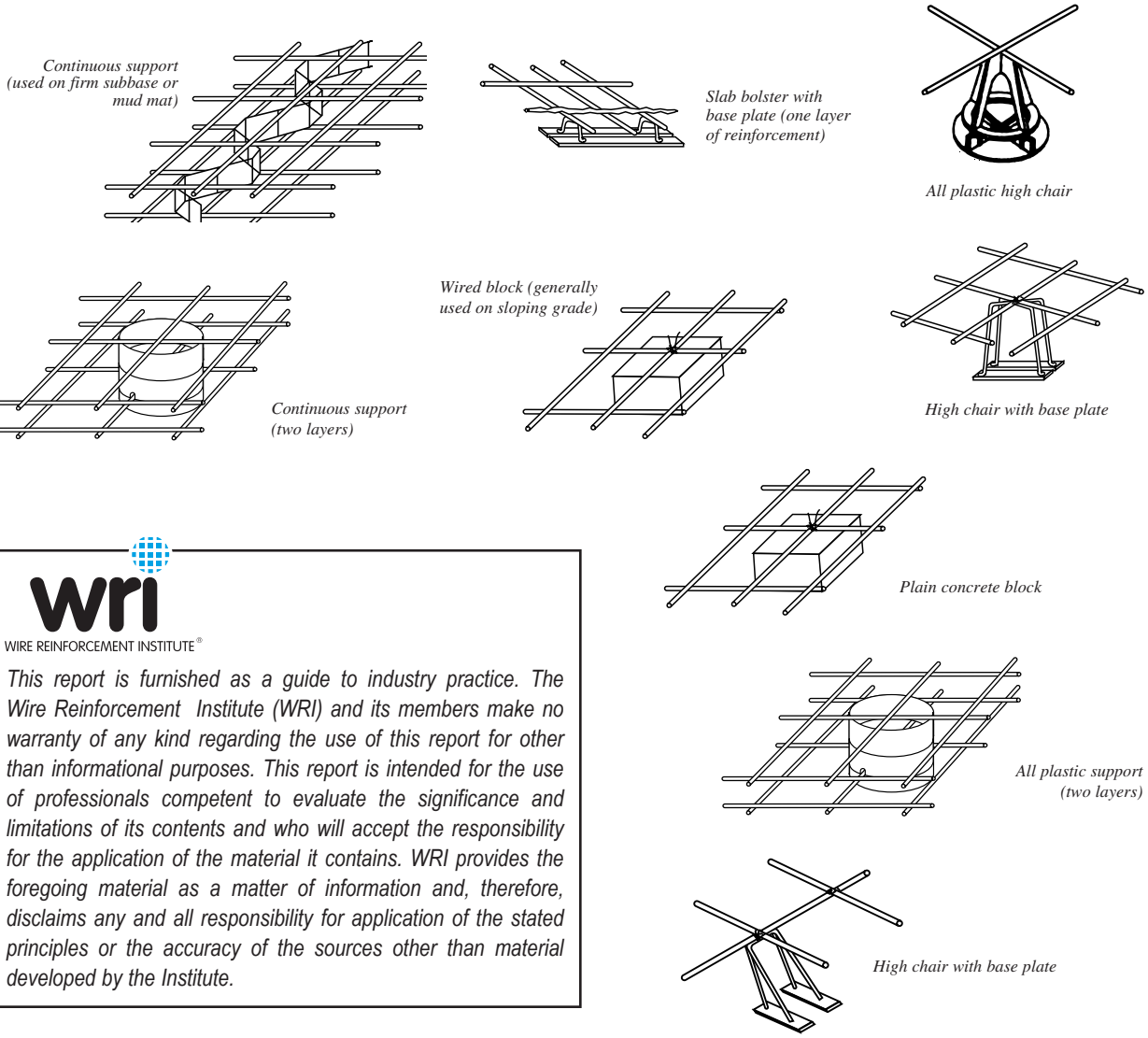
TABLE 1. SUGGESTED SPACINGS OF SUPPORTS

Welded Wire Reinforcement Range	Welded Wire Spacing	Suggested Support Spacing
W or D 9 or larger*	12" and greater	4-6 ft.
W or D5 to W or D8	12" and greater	3-4 ft.
W or D9 and larger	Less than 12"	3-4 ft.
W or D4 to W or D8	Less than 12"	2-3 ft.
Less than W or D4**	Less than 12"	2-3 ft. or Less

*Spacing of supports for WWR with wires larger than W or D9 could possibly be increased over the spacings shown depending on the construction loads applied.

**Consider using additional rows of supports when large deflections or deformations occur – also spacing of supports may be increased provided supports are placed and properly positioned as concrete is screeded.

FIGURE 1 – TYPES OF SUPPORTS



As ready mix trucks leave after tailgating the concrete in strip pours, supports are placed to stay ahead of the laser screed on this project . . .

. . . laser screed rides easily over supported welded wire without excessive displacement or distortion.

For welded wire reinforcing sheets, spacings of the individual wires should be a consideration to avoid permanent displacement due to workers walking on the reinforcement. This spacing should be 12 inches or more (up to 18 inches may be specified). If the design requirements do not allow larger spacings, then the wire stiffness and the support strength and spacings must be adequate to carry all anticipated construction loads.

The strength of the supports and their spacings required to carry construction loads, other equipment and workers must also be considered. There are no exact guidelines, but the requirement for strength and stability cannot be ignored.

The applicability of the suggested spacings in Table 1 may best be confirmed by conducting on-site testing of the proposed arrangement of supports. Loadings caused by personnel and equipment can be checked with minimum expense before proceeding with construction of the slab.

More cost-effectiveness and ease in placing can be achieved with step-through styles of WWR (12x12 and larger).

Pumping concrete is a sure way to maintain proper position of supported reinforcement.

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Based on a contribution by Boyd C. Ringo, P.E.