THE QUESTION OF BOND.

By H. F. Porter, C.E.

There are examples almost without number, in all parts of the globe, of the successful and satisfactory adaption of plain steel bars to the problems of the reinforced concrete constructor. In Europe, where this construction has reached its highest development, fully 90 per cent. of the installations have been with plain bars, and mostly plain round bars. These facts speak for themselves.

There are likewise many examples of the use of the so-called deformed bars, or bars of special section, designed to enhance the effectiveness of the mechanical bond or interlock between the concrete and the steel. Especially in the United States has this type of reinforcing met with extensive use. Wide and systematic advertising undoubtedly has played a large part in this popularity.

Plain bars, used scientifically, are a positive success—this fact stands on rock.

Deformed bars, used scientifically, are equally a success. There is certainly no disadvantage in having the unevennesses in the steel exaggerated in order to make a greater mechanical bond.

Plain bars are generally easiest to obtain, the simplest and cheapest to handle, and can be bought in open market anywhere for the lowest price per pound. They amount to a staple commodity.

Deformed bars are "legion," and each one is supposedly superior to all the rest. The prospective user, provided he decides to employ a patent section, is confronted at the outset with the problem, "Well, which one?" Besides, no matter the type selected, the market is a closed one and more or less limited, entailing added trouble, delayed deliveries and more expense. Being of special section, and patented, the initial cost always exceeds that of plain bars, from $5 to $25 a ton, and in the field because of the unevennesses the bars are more awkward to handle, thus further increasing the cost. Patented bars are a "fancy" commodity.

Plain bars are never advertised, or rather their merits set forth in the advertising columns of the trade journals—no more than flour.

Patented bars are widely advertised, and peculiar emphasis laid upon their salient supposed points of advantage. This is legitimate, but to hold up any one type as the only one and imply that to use any other is "risky," and to use a plain bar "fatal," is illegitimate. No one patented bar is a "cure-all," and all others dangerous. Engineers may be fooled once, but they will not be fooled the second time. Let the honest facts stand forth.

This much is obvious—the use of deformed bars will continue to increase, whether merited or otherwise, and will gradually undermine the popularity of plain bars unless plain-bar advocates stand firmly by and the mills loosen up and advertise as well. Certainly, engineering journals, as reflectors of human opinions, cannot be expected to forever continue to give space to the exposition of the merits of plain bars when their advertising columns abound with copy relative to patented bars and nary a line relative to plain bars.

Both kinds of bars have their province, no doubt, for everything has its own peculiar field. In the writer's experience in reinforced concrete, as applied to building construction, the best results and cheapest have followed the use of plain round bars. As to the reputed inefficiency of the bond of plain steel, which is the bone of contention always, if the reinforcing is done scientifically, with proper regard for the stresses that ensue due to the monolithic nature of the construction, the reliance on mere bond becomes a minor consideration. Let the steel be placed in the moulds so as to approximate the catenary curve as closely as practicable; then it is at all times in position to assume all tensile strains; and further, let an absolute tie be provided across the support by lapping, splicing, or anchoring one span against another; then the matter of bond becomes a minor issue, for the concrete is relieved of all differential strains, acting only in compression, compelling the otherwise loose and flexible steel to definite lines of action, lending general stiffness to the construction, and furnishing a rigid, durable, indestructible floor. Engineers are coming to see that this is the natural way to treat the mechanics of reinforced concrete.

If deformed bars are employed, they should be held to the same requirements as plain bars, and no preference given or concession made in manner of placing. Too often have designers fallen into the error of assigning unwarranted value to the efficiency or application of a nicked section, to the extent of eliminating all, or nearly all, vertical stringers and neglecting to truss up the bars near the supports where the shear attains a maximum, and develop them over the supports. No amount of exaggeration of the surface of the bars can compensate for these omissions, and this fact is attested by the statistics of failures, that by far the larger number have been patented-bar installations. Experience has taught many that little or no real reliance should be placed on concrete in tension; hence all tensile stresses, horizontal, diagonal and vertical, should be provided for with steel. The catenary curve, or a modification thereof, seems best to fulfil the conditions. And plain bars are as effective this way as deformed.

Vertical stirrups should never be dispensed with in beams or girders. In a sense they do amount to deformations on the plain bars, preventing slippage, but they do far more. They serve the triple purpose of (1) tying support and flange of beams together, offsetting horizontal separation at the junction of slot and soffit, and aiding to develop Tee-action; (2) they take vertical tension, and by resolving the internal action into a sort of Howe-truss arrangement, heighten the efficiency of the horizontal steel; (3) they afford a convenient and economical means if bent over to rest on the slab centres, thus forming a true stirrup, of supporting the steel, both in the soffit below and in the slot above, in proper relative position during the operation of concreting. Besides, in deep beams especially it would seem wise practice to use stirrups liberally on the principle that concrete should be well tied together in every direction. Many designers make it a practice to space stirrups continuously throughout the beam at a maximum spacing not to exceed the distance centre of compression to centre of tension, and closer progressively towards the supports—and some building codes, notably the new Philadelphia code, expressly requires this.

The deformed bar is, perhaps, better adapted where the embedment is short compared with the diameter of the bar, as in small footings or stubby beams. Many experienced engineers prefer deformed bars for hydraulic work, on the ground that infiltration of water would in time destroy the bond. While the writer has never personally witnessed a failure of bond due to this cause, he has heard of instances of failure of bond where this was assigned as the cause; however, it would seem that if sufficient moisture could penetrate to destroy the bond, it would also in time destroy the steel by oxidation, in which case bars, not only effectively anchored by mechanical deformations, but protected from corrosion by suitable paint, would seem to be called for. More facts on this point would be of great value to the engineering world.

The Victor Preservative Co. have opened a Toronto office in the Peterkin Building, Bay Street. Their product is a metal preservative, water purifier and a scale remover. The "Victor" is a liquid, and easy to handle, and the manufacturers are willing to submit to a sixty-day test.