

Delivery systems for resin bonded anchors

An article for the CFA website by John Burch on behalf of 2K polymer systems Ltd.

The use of a chemical resin to bond continuously threaded rod, deformed reinforcing bar and internally threaded sockets is a well-established method of producing reliable fixings and structural connections into concrete, with major advantages over mechanical fixings in that they offer stress free anchorages, accommodate a wide range of sizes and performance and work in the widest range of substrates.



A threaded rod set in a hollow clay pot using injection resin and a perforated plastic sleeve

Over the years a variety of packaging and delivery systems has been developed, each new system usually being an improvement over its predecessors; resulting in a broader range of applications and, in some cases, much cheaper unit costs. In this article John Burch explains the development of the various systems and their advantages.

BULK MIX SYSTEMS

The earlier resin systems were invariably of the “mix and pour” type, where the components of the resin were (and still are) mixed and then placed, either by pouring under gravity or by pumping, into the prepared drilled hole, followed by insertion of the threaded rod or rebar.

The chemistry involved in these resin systems demands good control of the mixing process, especially for pure Epoxy resins which require molecule to molecule

contact to achieve complete curing. Ensuring that the components are mixed in the correct proportions is best managed by the mixing of only complete packs of the product, the system of European Technical Approvals^[1] allows only this approach. This full-pack mix requirement may not present a difficulty when installing a significant number of large anchors but in the case of smaller fixings, these systems become both inconvenient and uneconomic. Additionally, the open handling of chemicals may introduce health and safety issues, with their attendant costs.

CAPSULE SYSTEMS

The need for smaller-scale packaging led to the development of the encapsulated type of product, where all of the component chemicals are contained in separate compartments within an outer glass tube, a soft plastic skin or a foil tube.



Glass and foil type “Spin-in” capsules – ideal for use in concrete

In “Spin-in” versions the capsule is inserted into the prepared hole, and the fixing is mechanically rotated and driven through the capsule, rupturing the capsule and its compartments, and mixing the components in-hole. One aspect common to all resin systems is the need to remove all dust from the hole sides before introducing the resin. The use of a brush as well as blowing or vacuuming techniques is important for all systems but the spinning action of capsule systems means that any dust adhering to the sides is drawn into the mix making them less sensitive to poor hole cleaning. Thorough cleaning should always be employed on all systems.

“Hammer-in” capsules are a development of the glass capsule system for rebar anchoring in which the rebar is hammered through the special capsule pulling the catalyst through the resin components thus forcing them to mix.



Although the rebar may be literally hammered in using a large club hammer most manufacturers provide adaptors to harness the power of drilling machines. The lack of spinning action means there is no tendency to draw any residual dust into the mix so thorough cleaning is vital.

For capsule systems it is necessary that the capsule, the size of the drilled hole and the fixing rod are matched, and frequently this results in limiting the depth of anchorage to one value for each diameter. Usually the anchorage depth is optimised to match the strength of the resin/concrete bond with that of the anchor rod. However, for specific applications requiring higher loads two capsules may be used to double the embedment depth with high strength rods. .

Capsule systems provide exactly the correct amount of resin for use in concrete but masonry - with poorly filled mortar joints, perforated bricks and hollow blocks - demands another solution. This, together with the need to provide specially shaped anchor rods, different sized capsules for each rod diameter and spinning adaptors (sometimes provided free), opened the door to the introduction of injection systems.

INJECTION SYSTEMS

Injection systems, using cartridges to deliver the resin, allow any quantity of bonding resin to be placed in the hole and also bring major economies to the fixing process. Cartridge capacities vary from as small as 150ml, to cater for small jobs, up to 1400ml pneumatically powered systems to cope with large numbers of anchors such as starter bars.

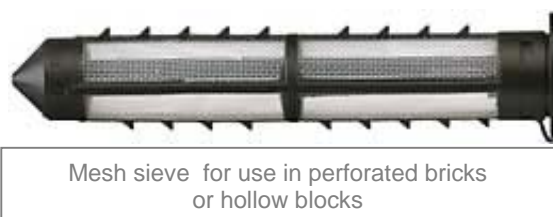
In these systems the components of the bonding resin are contained in separate compartments, traditionally either one inside an outer rigid cartridge or as two side-by-side cartridges. By using a suitable manual, cordless or pneumatic gun two pistons extrude the contents of each compartment from the cartridge into a special mixing nozzle, from where the mixed product is injected directly into the hole.



Because the resin is mixed only when it is being delivered any unused material still within the cartridge can be kept for later use, and any waste is restricted to the that contained within the mixing nozzle. Some powered guns meter the exact amount to eliminate wastage from over filling.

One of the advantages that resin bonded anchors have over other fixings is that they avoid the production of high, localised crushing forces, and this advantage becomes even more pronounced when fixing into low strength bricks and aerated or lightweight aggregate blocks.

Injection systems, with their ability to deliver as much bonding material as is needed, can be used most effectively in conjunction with perforated sleeves (mesh sieves) to provide fixings that have optimum performance into voided substrates such as perforated bricks and hollow blocks.



CARTRIDGE TYPES

Since the introduction of the cartridge as an all-in-one means of supplying, extruding, mixing and placing the chemical bonding material there have been numerous innovations to, and variations in, the design of the cartridge. Generally, these variations have been produced not to replace or supersede earlier versions, but rather they have been developed to address differing requirements for different market areas. In some cases the developments have been driven by the chemistry of the bonding resin (e.g. ratio of components) and in others by specific application requirements (e.g. pack size, applicator gun).

Twin cartridges (side-by-side and co-axial)

The earlier (and, probably, still the most common) types are represented by the side-by-side cartridge, often used for the 1:1 to 3:1 epoxy resin systems and 1:5 ratio vinylester (epoxy-acrylate) systems, and the co-axial (one rigid tube inside the outer) cartridge, usually used for the 10:1 polyester and vinylester systems.

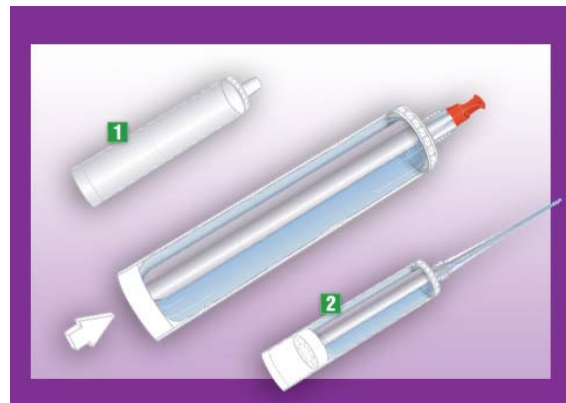


Co-axial cartridge showing two components mixing in the nozzle

Because of their twin-piston method of extruding the components from the cartridge most of these, and their volume and ratio variants, require the use of special twin-plunger guns, although the smaller (150ml) version of the coaxial cartridge can be used with an adaptor which permits its use in a standard single-plunger (“Mastic”) skeleton gun while another, using a screw-in plunger, requires no gun at all.

Capsule in Cartridge (“CIC”) system

This system was introduced to allow the use of an industry standard single-component skeleton (mastic) gun, thus eliminating the need for a dedicated applicator gun. For its design it drew upon the proven technology of the soft-skin capsule, and married this with the application techniques of the co-axial cartridge.



The CIC consists of the capsule [2], which holds the two chemical components in separate longitudinal compartments, contained within an outer rigid cartridge [1] which is fitted with a single piston. In use, the plunger of the standard gun drives the piston, and the two components are co-extruded from the capsule directly into the mixing nozzle.

The CIC concept is used for two-component resin systems with ratios of 5:1 to 10:1, but with careful formulation and production control by the manufacturer this range can be widened to 3:1 to 20:1.

“Splitter” (“Peeler”) cartridge

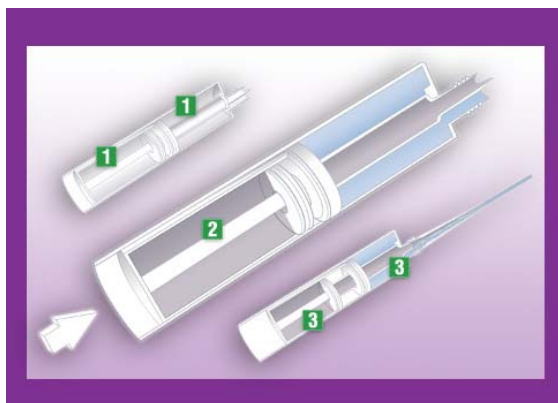
This cartridge is a direct derivative of the two-component co-axial cartridge, but instead of using two concentric pistons extruding the components it has only one, and therefore it can be used with a high power single plunger gun.



This single piston [1] is fitted with a special splitting device [2] ; in use, pressure on the piston causes the device to cut, split and separate the centre tube, in effect peeling it back, to allow the free passage of the piston along the length of the cartridge and thus extruding the two components correctly into the mixer/delivery nozzle.

Tandem cartridge

The tandem type of cartridge contains the two components packed into compartments one behind the other [1], separated by a fixed seal; each compartment has an interlinked piston [2], and both move at the same rate, in tandem.



The component in the rear compartment extrudes via a concentric tube from the fixed (separating) seal to the cartridge outlet, and at the same time the forward component is extruded directly to the outlet [3].

Due to the complexity of manufacture these cartridges are available in a very limited range of sizes, and at mixing ratios of 1:1 and 2:1.

EUROPEAN TECHNICAL APPROVALS.

A significant number of the resin systems currently on the market have achieved the important status of having European Technical Approval, in accordance with ETAG 001 Part 5, the vast majority being injection systems. In achieving this ETA a product is typically tested and approved for one specific bond length within the range of 8 to 12 times the anchor diameter. There are some products on the market that have been tested and approved for use at any bond length within this range, thus giving the end-user more choice in his design, and making the most of the variable bond length advantage that injection systems have over capsules. In future the bond lengths allowed by the ETA system will extend from 4 to 20 anchor diameters, further extending the flexibility and application range of injection systems.

THE FUTURE

Manufacturers are very much aware of the “easy to use” principle, and they are investing ever increasing resources in developments to simplify still further the use cartridges for resin-bonded anchors.

The latest cartridge designs, associated as they are with low-cost applicator guns or even without any gun, are already leading to a wider use of these systems throughout the construction and building industries, and this growing market can now be serviced through specialist distributors and DIY stores.

■ ■ ■