



# Cem-FIL® GRC in Drainage

## Watchgate Water Treatment Works

### INTRODUCTION:

Watchgate Water Treatment Works, built in 1972, is North West Water's largest water treatment plant with a maximum throughput of 700 MI/day, principally serving South Cumbria, Lancashire and Manchester. This equates to over 30% of the total daily demand throughout of NWW. The treatment process is based on gravity filtration, with 456 rapid gravity filters. The efficiency of the existing filters has fallen over the 27 years' continuous service, leading to a marked increase in maintenance requirements. Bechtel Water Technology, managed the filter refurbishment project.

A feature of the water treatment process is that the backwash cycle uses treated water to carry out a high rate 'water only' filter backwash. The uplift pressures imposed on the filter floors during the backwash cycle provide the worst case loading condition used for the structural design of the floor.

To maintain the highest possible operational throughput at all times, an effective solution to the refurbishment of the filter floors was required, together with careful phasing of the construction works. The project also included the introduction of an air scour system to each filter and the replacement or refurbishment of control and isolation valves.

### EXISTING FILTER CONSTRUCTION:

The existing filters were of traditional plenum-floor construction, in that the filter was supported on a perforated structural slab - the plenum itself is the volume of the filter between the plenum floor and the filter base slab, through which both filtered and backwash water pass as it exits and enters the filter.

It is theoretically possible, although in practice very difficult, to enter the plenum to inspect the underside of the plenum floor, its supports and the filter nozzles. The existing plenum floors are precast concrete panels into which are cast filter nozzles at close centres. The panels are restrained by holding down bolts into perimeter and central support walls, the joints between panels and the perimeter walls being sealed by a proprietary joint sealant.

Investigations showed the floors had become unserviceable in three ways:

- Media migrating through the joints between panels because of the poor condition of the sealant, or via broken nozzles, resulting in nozzles becoming blocked during backwash.
- Displacement of panels through failure of the holding down bolts and support walls below. The condition of the central support walls is such that they cannot be used to restrain upward pressure on the plenum floor.
- The floors had become very sensitive to increases in pressure above the current limitation of 6m head of water. This sensitivity has affected operational versatility.

### FILTER REFURBISHMENT:

To improve the efficiency of the backwash cycle, the new air scour system operates simultaneously with the water backwash. However, to cope with seasonal algal blooms, the capacity of the floors to cope with the full high-rate water wash had to be assured. This entailed replacing the existing plenum floors with in-situ reinforced concrete floors.

The floor system proposed by Morrison Construction Ltd and developed by BCM Contracts Ltd is just such an in-situ reinforced concrete floor, complete with intermediate supports and an arrangement of filter nozzles suitable for both air and water backwashing.

### FACTS:

- Refurbishment of 16 year old structure
- Treats 30% of NW Water requirements
- Short construction time
- GRC gave economic solution
- High durability / low maintenance
- £6.2 million contract



Anchor bars fixed with epoxy



Joints sealed with mastic



Pouring and levelling of concrete

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BCM monolithic floors are a composite of preformed glass reinforced cement (GRC) panels and in-situ reinforced concrete. In this application, the lightweight GRC flat panels are rested on 160mm OD plastic piers through which are fixed reinforcement anchor bars epoxy bonded into the existing floor slab as shown in Figure 1.

The modular GRC panels are laid onto the piers and existing perimeter support walls to form a permanent GRC platform. A typical installation will be made up of middle, edge and corner panels manufactured to suit the installation. The panels are strong enough to support men during concrete placing and lightweight enough to make handling relatively easy.

Inevitably, with the number of panels in use, sealing of the joints between panels and perimeter walls using mastic, tape or grout is a critical activity before the concrete is placed over it. Figure 2 shows mastic sealing in progress.

A filter nozzle consists of a nozzle head and tail pipe. The nozzle tail pipe is screwed into a pre-positioned bush in the GRC floor panel and a disposable sealing cap is fitted to prevent ingress of concrete while the floor is being cast. The structural reinforcement is laid at uniform spacing between the tail pipes. Concrete is poured over the GRC platform, filling the pier support tubes. It is spread until level with the sealing caps, as in Figure 3. Special care is required to ensure that each pier is sufficiently compacted, as there are no simple ways of visibly checking afterwards. The nozzle tail pipe disposable sealing cap is removed and the filter nozzle head screwed into position. The nozzle head incorporates narrow slots, of the order of 0.2mm, which prevent filter material passing through into the plenum chamber. The filter refurbishment is completed by the addition of the filter media.

### STRUCTURAL DESIGN:

The plenum floor is designed as a suspended flat slab in accordance with BS8110 and BS8007. Restraint against uplift forces is achieved using pairs of tension anchor bars within each pier, epoxy bonded to the existing chamber floor, and by keying-in around the perimeter with dowels epoxy bonded into the walls of the filter chamber. The use of pairs of bars in the piers, each with 200mm minimum embedment, provides sufficient factors of safety to guarantee performance similar to that normally expected of proprietary epoxy resin anchor systems. Test anchors were employed to prove pull-out performance.

Benefits of using GRC permanent formwork:

- Largely jointless construction improves durability and reliability resulting in reduced inspection and maintenance activities for the client
- Accurate construction method employed to achieve the tolerances required by the air scour system ( $\pm 3\text{mm}$  over 12m)
- Lower construction costs for the client, by avoiding the use and removal of temporary staging under the floors
- Shorter construction period giving shorter stoppage time, and improved security of supplies to the client

This article was prepared with assistance of the organisations involved with the contract.

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