
1.

The London Regatta Centre and powered rowing tank


2.

James McLean

Introduction

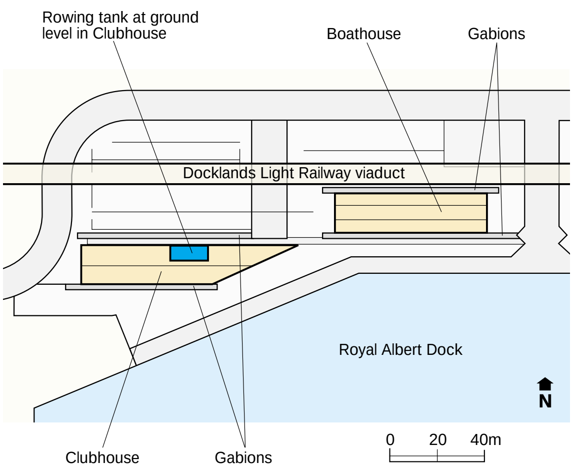
Jointly funded by the London Docklands Development Corporation (LDDC) and the Sports Council Funding Body via the National Lottery, this new centre provides permanent facilities for rowing activities organised by the Royal Albert Dock Trust. The site is at the north-west corner of the Dock in East London, near the rowing course finishing line, and on the opposite bank to City Airport. Works to extend the course to 2000m are now complete, thus providing the first Olympic-standard rowing facility in south-east England.

Following his introduction to the Trust by Mike Davis of Richard Rogers Partnership, Ian Ritchie of Ian Ritchie Architects acted as their conceptual adviser, because of his knowledge and continuing advisory role within the LDDC. At Ritchie's recommendation, the Trust approached Arup to act as engineers, one member of the team being specifically requested by the client for his rowing knowledge and expertise. Arup added input to the building grid and space planning to suit rowing needs; the passive servicing, foundation, and structural design for the boathouse resulted in overall savings, whilst the design of the powered rowing tank gave the client a unique and innovative training facility.

Layout

The Centre comprises two buildings: a boathouse to store up to 80 'Eights' with an insulated workshop space, and a clubhouse for all the necessary facilities, plus the powered rowing tank. The buildings' overall outline is defined by freestanding 3.5m high stone-filled gabion walls on strip footings along the length of the site. The boathouse is enclosed by gabion walls and a lightweight stainless steel roof, with steel mesh panels where needed for security. The clubhouse sits back from its north gabion wall, providing an access and assembly zone running the length of the building. Full length terraces on the upper level sail over the gabion to the south, providing viewing areas from the bar and restaurant for racing events.

3.
Site plan.



Gabions

The gabions are independent structures, framed with steel tees at 5.6m centres. Longitudinally, three of the four edges are trimmed with angle members and filled with 100mm+ granite fragments, retained with 5mm diameter wire mesh restrained by crossties in vertical rows at 1.4m centres. The mesh acts in catenary, and 'pillows' by around 60mm when loaded. The in-plane tension in the mesh is anchored to the main gabion frame by bolts securing an edge plate welded to the individual strands. The mesh is supported at the lines of ties by a small channel section, running vertically up the height of the gabion, to which the ties are anchored.

Boathouse

The boathouse comprises three 6m wide, 70m long bays, with metal sliding doors at each end. It is 4.5m high and the 1m slot above the gabions and doors is meshed, providing venting to the structure which reduces vertical wind loads on the roof. Small canopies down each side of the building resist high local perimeter wind pressure.

The design fulfilled a need to provide shelter economically for an area of about 1200m^2 from wind, rain, and sun, but not be completely watertight. It had to support racks for 20m long rowing boats needing level storage to prevent warping, so it was important to avoid building movement.

'Arup added input to the building grid and space planning of the London Regatta Centre to suit rowing needs...'

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4.
Main entrance, with gabion wall on right.


5.
The boathouse with its catenary roof, and racks supporting 20m boats needing level storage.

The powered rowing tank

Rowing tanks are used to teach rowing to beginners, to improve the technique of more experienced rowers, and as a training environment in bad weather. The modus operandi has been for the rowers to push the water round the tank, sitting in rowing stations fixed to concrete and using oars resembling sticks of wood. The experience is unrealistic, a chore for experienced athletes, and difficult for beginners to master, leaving them unprepared for the feel of a real boat.

An 'eight', its rowers, cox, and oars weigh about 1 tonne (1000kg). When on water, the rowers' energy is spent pulling (or pushing) themselves through the water, overcoming the drag on the shell of the boat - altogether equivalent to each rower pulling 125kg through the water. In traditional tanks, four rowers sit on the site of each channel and have to move approximately 20 tonnes of water past themselves.

With normal rowing oars, this is about 40 times harder than rowing a real boat on water. The oars are torn through the water and the feel of the rowing stroke is not accurately reproduced. Also, traditional tanks are generally limited to rowing and cannot accommodate sculling. As part of the London Regatta Centre project, Arup examined these issues from first principles, and produced a revolutionary design that moves the water past the rowers, thus creating the feel of rowing in a boat on water and providing an excellent environment for teaching, developing, and training.

Water is powered by submersible electric pumps through hydraulically efficient channels, the flow adjustable electronically to simulate speeds up to 3m/sec. A rowing frame provides rowing stations that represent the layout and structure of a boat, allowing rowers to sit behind each other as they would in the boat.

6. The tank in use.

The frame is set to a chosen level above the water surface, and rocks about its longitudinal axis to enable the 'crew' to feel the balance of the boat'. Standard equipment for fitting out boats is used in the powered rowing tank, with the gearing adjusted so that conventional oars and sculls can be used.

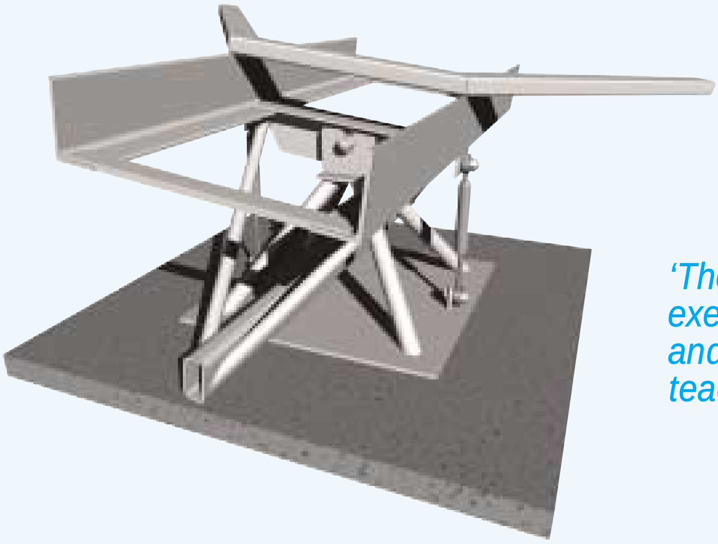
The powered rowing tank can be easily adapted for either rowing or sculling. The gearing gives a realistic feel for training intensities and for teaching beginners about the feel of the stroke.

A coxing position is also included so that coxes can be taught the control of crews and commands before taking to the water. Feedback from users of the tank now installed at the Regatta Centre has been very positive, and it is proving to be an excellent teaching facility. Arup has sold the design of a powered rowing tank to the Scottish Amateur Rowing Association (SARA) for inclusion in a facility at Strathclyde Park. This design has been developed from the Regatta Centre tank, based on operational feedback, and has been tuned to SARA's requirements. The powered rowing tank exemplifies Arup project innovation.

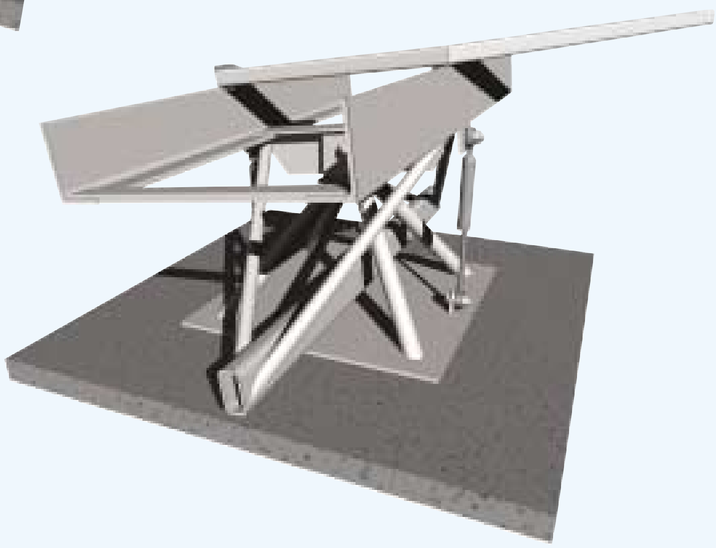
This product was designed to meet the needs of the client at the London Regatta Centre, and has the potential to be developed further and used in many more applications around the world. The specialist is now working with *Design by Arup* (the product design network within the firm) to examine this potential, looking at the development of design alternatives, methods of procurement, and advice on financing options.

A market study is under way with nearly 1000 potential clients around the world, and it is hoped that many more powered rowing tanks will be in use in the not-too-distant future. The cost of building a powered rowing tank is approximately £100 000 and would normally be incorporated in a new facility. The market for it is thus substantial: national rowing centres, clubs, or an association of clubs in one area, as well as universities.

(Arup's website on powered rowing tank design can be viewed on http://www.rowingtank.com).



'The powered rowing tank exemplifies Arup project innovation and is proving to be an excellent teaching facility....'



7 above: and 8 right:
Sections through rocking mechanism showing extreme left and right tilt.

Credits

Powered rowing tank design:
Arup James McLean

Website design:
Arup Kevin Franklin, Ray Ingles, Tristan Simmonds

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A frame and fabric roof was not considered strong and secure enough, so a robust, durable, and weathertight skin was suspended from a simple galvanised steel frame hung in catenary. The roof structure is 6m x 1.4m stainless steel sheets, 3mm thick, jointed with curved 102mm x 127mm x 11mm structural tees. These hang from 219mm diameter CHS section gridline beams running the length of the building at 6m centres. For robustness, the stainless steel sheet has been designed to span between the tees for 'people' loading, although it is able to hang in catenary from the gridline beams. The tees were designed to resist symmetrical loading by catenary action, whilst asymmetric loading and settlement of supports induce bending moments in the tees. These moments govern the tee section design. The curved form of the roof acts as large gutters, draining rainwater to the ends of the building.

Longitudinally the building is stabilised by two bays of cross-bracing, central on each external face. The stainless steel roof sheets act as a stressed skin to provide stability to the internal rows of columns.

Lateral stability is from diagonal props at each external column position, which also restrain horizontal catenary loads in the roof. These elements are contained within the gabions that run either side of the building.

10.
Part of the line of gabions along the clubhouse.

9 below:
The boathouse exterior showing the end of the gabion wall on the left.

Foundations

As the soil is weak, the ground was surcharged with type 1 material for about a year before construction to induce predicted long-term settlements from building loads when construction began. Additional surcharge was added along the line of gabions due to the high loading imposed by them. The columns are supported on longitudinal ground-bearing strips and the gabions and perimeter columns on a combined strip footing to resist uplift from the diagonal props stabilising the roof. The column strips are tied together at column positions with concrete tie beams to ensure the base geometry is maintained.

Clubhouse structure

The 90m long, 20m wide clubhouse has two storeys: the ground floor houses the reception area, gymnasium, rowing tank, changing facilities, and plant room, whilst the first floor contains the bar / club room, restaurant, kitchen, accommodation, and caretaker's flat. Between ground and first floor a mezzanine level plantroom occupies part of the area.

11 right:
The fitness centre.

12.
Roof-mounted solar panels providing solar water heating.

'The London Regatta Centre is the first Olympic-standard rowing facility in south-east England...'

14.
First floor restaurant.

13 left:
Exterior corridor, the long gabion wall is on the left.

The external envelope of the building is a mix of contractor-designed glazing, metal-clad blockwork, and fairfaced concrete walls. The ground, first floor, and roof slabs are of concrete flat slab construction of varying thickness supported on circular concrete columns and a concrete blade wall to the north, which also provides stability in conjunction with internal shear walls. Building loads are transferred to the ground via piles of varying diameter. A deep Thames Water Authority sewer underlies one corner of the building; this limited pile spacing, and the structure therefore cantilevers over the sewer using deep beams beneath the slab.

There are balconies on the south and west faces. The south balcony is in steel and timber and cantilevers from the first floor slab, whilst a steel and glass canopy cantilevers from the north wall creating an enclosure between the building and the gabion.

The 90m concrete blade wall is fairfaced and continuous, so the concrete mix and construction method were carefully controlled to minimise shrinkage cracks.

This external wall is joined to the internal slab, so both had to be designed and reinforced to resist differential strains from temperature changes.

Clubhouse services

The services design is integrated into the architectural and structural form, with the building form and fabric used to control the internal environment and create a comfortable and energy-efficient solution. To minimise operation costs, simple, energy-efficient, heating and ventilation systems reduce heat losses in the winter and avoid the need for cooling in summer. Passive design features have been used as part of this strategy to optimise the building performance. External shading to the south-facing restaurant, bar, and gymnasium areas reduces direct solar radiation in summer, but low-angle winter sun is allowed to penetrate the building façade to directly heat areas within.

The exposed concrete soffits throughout the building help to reduce sudden temperature swings. The north elevation is virtually solid, to reduce heat loss and protect from northerly winds, with minimal glazed areas providing vision and some daylight. Gabion walls to the lower level provide further protection from the elements and help reduce unwanted infiltration losses by reducing external wind pressures. High levels of CFC-free insulation retain heat in winter, helping to lower the energy consumption of the building by reducing both maximum heat demand and the internal summer temperatures.

The primary services are fed from plantrooms in the western end of the building, running within a mezzanine spine above the 'wet areas' of the changing rooms and the multi-gym areas. Mechanical ventilation recovers heat and expels moisture from exhaust air. Perimeter heaters controlled by thermostatic radiator valves beneath the full height south façade glazing provide rapid response heating to offset fabric losses and downdraughts, while an underfloor heating system is used in the changing rooms.

Evacuated tube hot water solar collectors, mounted on the roof, provide 60% of the average annual domestic hot water (based on the estimated daily demand as recommended by solar heating design guidelines). Solar water heating pre-heats the domestic hot water calorifier that maximises the temperature difference between the solar and hot water circuits, in turn maximising the overall efficiency of the system.

Credits

Client:
Royal Albert Dock Trust

Architect:
Ian Ritchie Architects

Consulting engineer:
Arup Patrick Bravery, Nick Dibben, Nick Howard, Sara McGowan, John McKenna, James McLean, Paul Sloman, John Thornton

Quantity surveyor:
Davis Langdon & Everest

Illustrations:
1: Ian Ritchie Architects
2, 4-6, 9-14: Graham Young
3: Penny Rees
7, 8: Tristan Simmonds