Good hydraulic fill makes a difference

RENÉ KOLMAN, SECRETARY GENERAL, INTERNATIONAL ASSOCIATION OF DREDGING COMPANIES

Large-scale reclamation projects, such as the new Khalifa Port and Industrial Zone (KPIZ), Abu Dhabi require stabilised hydraulic fill. The initial phase of KPIZ, a 2.7 km² offshore port in Taweelah, involved two years of dredging 45 million cubic metres to create a deep-draft, 12km approach channel to the port, and reclamation of the offshore port island. The project comprises the port, which is 4.6km offshore and connected by causeways to the mainland, and a 417km² inland free zone that will be the site of factories for aluminium, chemicals, paper and glass.

Thinking of port expansion or of developing a new port? If the answer is yes, then it's time to think about the quality of the hydraulic fill.

Hydraulic fill is the material that makes it possible to build a land reclamation site, such as has been done at the Port of Rotterdam's Maasvlakte II or Khalifa in the UAE or Hong Kong or Port 2000-Le Havre, to randomly name just a few port expansion projects.

Deciding on a land reclamation solution

The decision to proceed with an extensive maritime infrastructure project is of course not taken lightly. Nor is the new land constructed overnight. These plans are a thoroughly vetted and calculated choice for economic development. And they involve a series of societal, political and environmental considerations.

But once the choice has been made to build, another process begins: how to best realise the project. And that is when the expertise of dredging engineers is called upon. Knowledge which is embedded in the member companies of the International Association of Dredging Companies.

The IADC is the umbrella organisation for the worldwide private dredging industry with over 100 main and associated members. For almost 50 years the IADC has been committed to promoting professional expertise in the industry. Improving working relationships with stakeholders by sharing this knowledge is one of its main goals. Consequently the IADC was more than happy to support a recent book project which would provide the most up-to-date information regarding hydraulic fill and clarify the complexities of land reclamation.

Why worry about the quality of hydraulic fill?

To ensure that a land reclamation site will be able to bear the pressure of the structures to be built upon it, the foundation must be strong enough. A failure of the foundation will mean a collapse of infrastructure that one does not even want to contemplate.

Drawing on the expertise of dredging engineers should be a given, but in fact it was not that obvious. Despite its fundamental importance, a thorough study of hydraulic fill had virtually been overlooked in the dredging literature. Then, a few years ago, a group of engineers within the dredging industry agreed that a widely accepted standard reference work was sorely needed. A manual that outlines theoretical and practical guidelines for the planning, design, construction and quality control of hydraulic fill. Rigorous research and writing ensued with contributions from scores of highly respected engineers.

The results, the *Hydraulic Fill Manual for Dredging and Land Reclamation Works,* was published in late 2012. The book was guided by CIRIA (Construction Industry Research and Information Association, UK) and CUR Building & Infrastructure (the Netherlands), two editor-experts, Jan van 't Hoff and Art Nooy van der Kolff and the financial support of the IADC as well as other public and private organisations.

Finding viable hydraulic fill

Hydraulic fill is the sediment or rock found on the seabed or at other borrow areas, excavated by dredgers and then transported to and placed in the reclamation site.

The *Hydraulic Fill Manual* assumes that the design and construction of a reclamation site should be a rational process that results in the most optimal and economical match between the specified properties of the site, the requirements for its future use and the environment of its location. Part of that is determining the availability and suitability of the hydraulic fill.

An early phase of land reclamation work at London Gateway Port, on the north bank of the River Thames: the new port is only 25 miles from the centre of London and close to key business locations. The first stage of construction was started in February 2010, with a £400 million dredging and reclamation programme. The port became be operational in November 2013.

Basically, the quality of the hydraulic fill needed is determined by the future land use. For instance, the function of a beach nourishment site differs from that of a reclamation area intended to accommodate a container terminal or LNG harbour. Consequently, corresponding technical specifications resulting from the design process will also differ. Geotechnical specifications must be commensurate with the function of the reclamation. They should be reasonable, measurable and feasible.

The need to know

What does a client need to know? Said directly: a lot.

The client needs to be aware of soil conditions and techniques for soil improvement. As well, understanding the capabilities of dredging equipment and what construction methods – rainbowing, side-stone dumping, and building bunds – are applicable to a particular situation. Environmental issues must be considered.

A client needs to know how and what technical data should be collected and applied. How does one select a borrow area and assess the potentials of the materials in the borrow pit? Clients may be surprised to discover that fill material may not always have to be restricted to sandy material. With certain ground improvement techniques the properties of the fill and subsoil can be improved.

The effects of the design on its surroundings, the strength – bearing capacity, slope stability, stiffness, deformation, density and sensitivity to liquefaction – and design considerations for special fill material such as silts and clays, carbonate sands and problematic subsoils such as sensitive clay, peat, glacial soils and sabkha and hydraulic rock fill must be examined. Natural hazards including earthquakes, tsunamis and the occurrence of Karst are crucial to consider.

Other issues such as drainage, wind erosion, slope, and bank and bed protection must be evaluated. This is done by the use of field and laboratory tests, correlations and corrections, and geotechnical principles. And lastly, after construction, follow-up quality control and monitoring of the fill mass and its behaviour are a must.

Don't compromise – cooperate

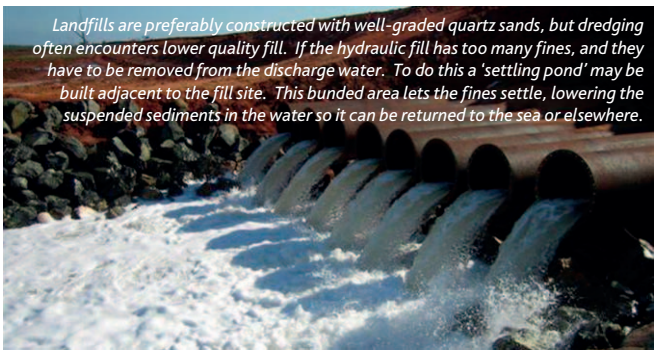
When it comes to hydraulic fill, compromise is not an option. If you settle for lesser quality hydraulic fill for your land reclamation project, you'll find that it literally doesn't settle well in the long run.

Using high quality fill or improving lesser quality fill is always the priority. After the completion of a filling operation, the reclaimed land must be such that the stability of the structures to be built upon the site is completely trustworthy.

The IADC dredging companies are constantly investing in research to improve their knowledge and expertise. They are anxious to share this information and help clients understand the complexities of hydraulic fill. Good preparation can help guide the client towards realistic choices, resulting in better-designed, more adequately specified and less costly hydraulic fill projects – a win-win for everyone.

About the author: As Secretary General of the International Association of Dredging Companies (IADC), the umbrella organisation for the world-wide private dredging industry, René Kolman takes a leading role in promoting the industry's long-standing commitment to research, quality standards and sustainability. Mr Kolman studied at the Nautical School in Rotterdam and holds a degree in Economics from the University of Groningen, The Netherlands.

International Association of Dredging Companies, Alexanderveld 84, The Hague, The Netherlands
Tel: +31 70 352 3334
Fax: +31 70 351 2654
E-mail: info@iadc-dredging.com
Web: www.iadc-dredging.com



Landfills are preferably constructed with well-graded quartz sands, but dredging often encounters lower quality fill. If the hydraulic fill has too many fines, and they have to be removed from the discharge water. To do this a 'settling pond' may be built adjacent to the fill site. This bunded area lets the fines settle, lowering the suspended sediments in the water so it can be returned to the sea or elsewhere.