Beneficial Reuse of Dredged Sediments, Soils and Coal Combustion Products for Reclamation of a Refinery Surface Impoundment

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Introduction

Increasing pressure in reclaiming land with engineering or environmental shortcomings has resulted, in recent years, in an increased use of ground improvement technologies for a variety of materials with heterogeneous composition and complex geotechnical behavior such as waste, sediments, tailings, and sludge. This project, located in Richmond California, involved the closure by capping in compliance with California landfill closure regulations and the reclamation of a 26 hectare surface impoundment formerly used for treatment of oil refinery effluent. The impoundment contained sediments (Figure 1) with up to 50% oil content, which were treated using solidification/stabilization (S/S) technology to improve their geotechnical properties, immobilize the oily constituents and thus create usable land for future refinery use. To minimize the carbon footprint of the S/S treatment, the binder content usage was minimized by blending the refinery sediments with environmentally dredged silty sediments, coal combustion products (fly ash) and sandy soils available from capital improvement projects within the refinery

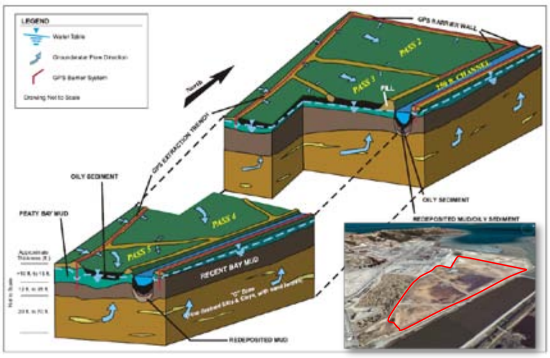

Fig. 1: Oily Sludge and Dredged Sediments Surface Impoundment.

Approach

The impoundment cap, which included a foundation layer, a grading layer and an erosion resistant layer, was designed to prevent human and animal contact with the oily sediment and create usable land for future refinery use. The foundation layer was constructed by solidifying a layer of oily sediments to achieve a bearing capacity sufficient to support short-term construction loads and to allow long-term use of the area to support refinery production activities. The foundation consisted of a 1m to 2m thick layer of treated sediments with an undrained shear strength of 70 kilopascal "floating" over a maximum thickness of untreated oily sediments of 5 m. Additional design criteria for the "floating foundation" layer were to minimize infiltration by achieving a permeability of 1×10^{-6} centimeters per second (cm/s) andminimize differential settlements and potential formation of cracks and fissures. All the above design criteria were satisfied by accurately selecting the type and quantities of soil amendments and binders other than the mechanical mixing technologies to allow proper homogenization of sediments, binders and amendments. This approach is applicable for the reclamation of land impacted by past industrial use including industrial ponds, mine tailings and red-mud ponds, and sediments within confined disposal facilities.

Results

The construction of the cap foundation layer involved the blending of over 400,000 m^3 of oily sediments with dredged sediments, soils, fly ash, and Portland cement. Mass mixing technology (Figure 2) was used to blend homogeneously the different materials. During the full scale implementation, an observational approach based on real-time verification of the laboratory and pilot tests based stabilization design was adopted to account for the effects of sediments heterogeneities and seasonal moisture changes. The observational approach resulted in optimization of binder usage and minimization of deficiencies and repairs. A total 26 hectares of previous unusable land were reclaimed and returned to the refinery as usable land. Completion of construction was achieved in 3 working seasons (May-November 2008, 2009, 2010). Cost of reclaimed land was approximately \$1M/ha. Use of dredged sediments, available soils and fly ash minimized the amount of binder required to solidify the oily sediments. A flexible design approach allowed material heterogeneities to be addressed while minimizing the amount of binder required to solidify the oily sediments.