Wave Climate

The wave height adopted for engineering design purposes is 50 years average recurrence interval (ARI). The wave height is discussed in terms of significant wave height (Hs) which is the highest 1/3 of waves. The maximum wave height in these shallow conditions may be assumed to be 1.7 times the significant wave height. The design wave is Hs = 3.3 m at Taylor Island and 1.6 m at Paihia wharf with a period of around 14 seconds. In such an event waves would run straight onto the road and across it.

Swells from the 20̊ to 120̊ sector occur 90 days of the year with an average height of 0.5 m. Northeasterly winds are the most common of all directions, and combining with swells creates superimposed waves, every 7th is a high one. The navigation channel turns the wave direction from 20̊ to 30̊ directly to the wharf and the wave remains virtually undiminished by the time it strikes the shoreline.

Waves from the east have been calculated with a wind/wave model based upon the 50 year ARI windspeed from Opua. The design wave is calculated as Hs = 1.0 m with period 3.5 seconds. The easterly wind waves are the least frequency of all directions. Some protection to the wharf area can be provided with floating pontoons.

Northern Breakwater

The northern breakwater has been kept as low as possible, at 1.7 m above high water to minimise visual effect. During a severe storm coinciding with high water some spill over will occur but the waves will be broken up. The breakwater would have a crest width of 3 m with a relatively flat 3(H) : 1(V) seaward (northern) slope to dissipate wave energy. The leeward (southern slope) is 1.5(H) : 1(V). This profile will create a typical footprint width of around 30 m on the seabed. The volume of material will be 16,500 m^3. The breakwater will comprise two layers of 2 tonne rock armour covering smaller filter and core rock. The rock armour would be around 1 m diameter and would be volcanic origin for strength.

Basalt boulders are readily available in Northland and would be ideal for this purpose.

Western Breakwaters

The western breakwaters are recommended to break up the pattern of ocean swells which refract around Motumaire Island thereby further reducing the wave energy entering the basin. The inner-west breakwater ties into the westerm beach abutment which stabilises the beach, which is discussed in beach renourishment below. The western breakwaters are predominantly designed with the purpose of breaking the average swell which occurs 90 days of the year. For this purpose, instead of a conventional breakwater design, the western breakwaters are constructed to high tide level only. This height allows for the breakwaters to be partially submerged, minimising visual impact. These breakwaters will intercept the long period swell.

The top of the breakwater comprises clusters of 2 tonne boulders being the same material as the armour on the northern reef. The inner west breakwater clusters have been designed with openings to minimise visual impact and the clusters sit on a rock core built to low tide height. The western breakwaters will have side slopes of 1.5 (H) : 1 (V) and a crest width of 2 m which will create a typical footprint width of 11 m on the seabed. The volume of material is 7,000 m^3. The breakwaters extend as far as the existing channel markers, so the existing channel here is maintained.

Human access along the breakwaters would be very difficult. The large rocks with interstices would have to be clambered individually. The rock clusters will make access along the breakwaters to Motumaire practically impossible.

Beach Renourishment

The Paihia seafront area between Nihinui Pt and the wharf can be converted to an attractive and people friendly beach area by eliminating the destructive action of ocean waves and replenishment of the beach. The refurbished beach has been designed with a 15 m width berm at around road level, sloping down at a gradient of 10 (H) : 1 (V) to intersect the sea bed. This will create a 21 m width from the berm to the high tide level and a further 20 m to low tide. Much of the berm will be grassed and landscaped with a timber boardwalk providing separation between the grassed and renourished beach areas.

Stability of sand is associated with grain size. Kohimarama Beach and Mission Bay were both replenished with imported sand not finer than d_{50} = 0.4 – 0.5 mm, and these beaches, with similar grades, have remained stable for the last 10 years. The source identified for this sand is offshore Pakiri beach in approximately 35 m of water, for which a dredging company has a license. There may be some land based sand deposits in Northland which could be considered, however finding a suitable source has proven difficult.

The beach will be constructed with a 1 m layer of imported sand over fill formed from dredging of the Paihia basin. The fill will comprise local finer sands. The volume of material for beach replenishment is 41,000 m^3 comprising 15,000 m^3 of imported sand and 26,000 m^3 from local dredging.

The western beach abutment is critical for a renourished beach to retain the sand. The western abutment will be at least 750 mm higher than the imported sand to stop sand escaping to the east. The abutment follows the beach profile into the water, merging with the inner west breakwater. The abutment will be a mass sand cement stabilised structure, shaped and finished with cement to mimic a natural rock spur, like Kohimarama beach in Auckland. The abutment will slope down to the natural rock platform at a grade of 1.5 (H) : 1 (V) with a volume of 3,500 m^3.

The eastern beach abutment is to extend outwards from the existing restaurant, virtually flush to the sand level. The abutment will therefore be slightly below the sand level at the crest and will be 500 mm higher than the sand as it slopes to the sea bed. The abutment will be constructed with rock, with an average armour size of 550 kg and a smaller rock core material. The abutment has side slopes of 1.5 (H) : 1 (V) and a volume of 1,500 m^3.

CONSTRUCTION

The breakwaters will be built using equipment on floating barges. No local earthworks are involved. Inshore parts of the beach abutments will be built using land-based equipment. Barges would be loaded to ferry materials to site.

The replenished beach will be built up with dredgings from both creation of the commercial berth area and establishment of a new navigation channel prior to completion of the northern breakwater. The dredgings will be retained on the beach by creating a stabilised toe. Silt control during the replenishment with dredgings will be put in place. Imported sand at Mission Bay and Kohimarama Beach was barged to site and pumped onto the beach, and the same is envisaged here.