

SHORE-PROTECTING MULTILEVEL INTELLECTUAL DAM

Kozlov Alexandr

M-r. Ashdod, Israel

Email: kavkas@ukr.net тел.: +(972)535320164

Kozlov Michail

Ph.D. Director of Institute integration and professional adaptation, Netanya, Israel.

Email: 19mike19k@gmail.com tel: +(972)527 052 460,

Kuklev Sergey

Ph.D., Shirshov Institute of Oceanology, Russian Academy of Sciences, Director of the Southern Branch, Moscow, Russia

Email: kuklev@ocean.ru тел.: +7(918)4443754

Abstract. Based on the basic concept of the development of the coastal zone of Israel, a shore-protecting multilevel intellectual dam is proposed that runs along the coast from Nahariya to Ashkelon, consisting, depending on local conditions, of a series of bridges, under which placed converters and additional sea waves energy dissipators, as well as a series of artificial underwater reefs with energy converters of sea waves. Throughout the length of the intellectual dam, on bridges, or in tunnels laid in the body of underwater reefs, a high-speed multi-lane motorway has laid connecting all the cities of the coast. Depending on the volume of car traffic communication with the coastal road network is carried out using interchanges on bridges or at underwater tunnels.

Key words: Intellectual dam, submerged artificial reef, wave energy converters, underwater car tunnel.

An increase in the temperature of the oceans leads to more severe storms and this increases the destructive influence of waves on the coast [1], in connection with which the relevance of work on the creation of coastal protection structures increases.

As a development of the concept of a multi-disciplinary intellectual dam [2], a shore-protecting multilevel intellectual dam is proposed that runs along the coast from Nahariya to Ashkelon, consisting, depending on local conditions, of a series of bridges, under which placed converters and additional sea waves energy dissipators, as well as a series of artificial underwater reefs (Wide Crest Submerged Breakwater) with energy converters of sea waves. Throughout the length of the intellectual dam, on bridges, or in tunnels laid in the body of underwater reefs, a high-speed multi-lane motorway has laid connecting all the cities of the coast. Depending on the volume of car traffic communication with the coastal road network is carried out using interchanges on bridges or at underwater tunnels.

This will allow not to obscure the view of the sea landscape near the coastal cities and places of resort and recreational purposes, and the deep flooding of the crest of the breakwater will not interfere with the navigation of small vessels.

In coastal areas where disturbance of the underwater coastal slope is not desirable, or where the effect on the sea landscape is not critical (outside the settlements), the intellectual dam located above the sea surface may be used. Since the height difference between the motorway in the underwater tunnel and the motorway on the bridge of the intellectual dam will be no more than 20 m, this will not affect the speed of traffic.

Protection of the coast from the destructive effects of sea waves is achieved by creating at the distance from the coastline, on the underwater coastal slope, a raised section of the bottom (artificial underwater reef), the critical depth of which is sufficient to wave breaking. When a wave passes over the rough surface of a reef crest, it collapses, and losses due to turbulent friction lead to

dissipation of wave energy. Due to this, the zone breaking is removed from the coast, which creates favorable conditions for the accumulation of sand on the beach.

Such an artificial underwater reef can be placed at a depth of 7-10 m, 300-400 m offshore. The reef crest can be flat, it can also be given additional macro-roughness to increase turbulent friction. To do this, can use old car tires, permeable pyramids, reef balls. In Fig. 1 is shown hemispherical reef ball [3]. The height of this design is 1 - 2 m. Roughnesses and holes in it create favorable conditions for colonization by marine animals and aquatic plants.



Fig.1 Reef Ball [3].

In Fig. 2 is shown a schema of an artificial reef with a flat surface (Wide Crest Submerged Breakwater) [4].

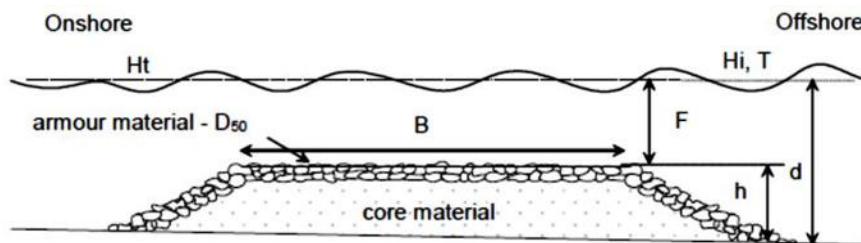


Fig. 2 Artificial reef with a flat surface (Wide Crest Submerged Breakwater) [4].

In Fig.3 is shown hemispherical shape artificial reef as submerged breakwater [4].

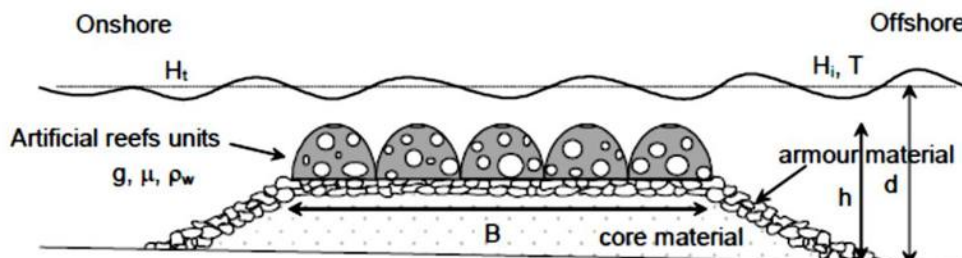


Fig. 3 Hemispherical Shape Artificial Reefs as Submerged Breakwater [4].

The creation of a continuous artificial underwater reef (wide crest submerged breakwater) along the coastline also:

- provides water exchange in area after the breakwater and favorable conditions for the development of living marine organisms;
- prevents the appearance of discontinuous flows;
- prevents the outflow of the surf stream, increasing the speed along the coastal current carrying sand;
- creates a strip of weakened excitement, which facilitates the conditions for navigation on small vessels.

According to [5], in the coastal waters of Israel, approximately 90% of annual winds are weak (wind speed below 6 m / s). At such wind speeds, the wave height does not exceed 1.6 m. About 9% of the annual winds are fresh (wind speed from 6 to 10 m / s). In general, only 1.2% of annual winds are strong and exceed 10 m / s. The maximum wind speed of 21.8 m / s was recorded during the winter storm 12/12/2010. During this storm, the wave height was more than 6.0 m. Analysis of

extreme wave phenomena shows that once every 50 years the wave height is about 7.2 m, once every 100 years the wave height is about 7.6 m, and once every every 200 years - about 8.0 m.

Based on the aforementioned wave height, preliminary calculations of lowering the wave height after passing the wave through an Hemispherical Shape Artificial Reef were made using the Armono formula [4] (1) and formula (2):

$$KT = \frac{1}{1 + 14.527 \left(\frac{H_i}{gT^2} \right)^{0.901} \left(\frac{B}{gT^2} \right)^{-0.413} \left(\frac{h}{B} \right)^{-1.013} \left(\frac{h}{d} \right)^{4.392}}, \quad (1)$$

where: KT - wave transmission coefficient; H_i - height incident wave, m; T - wave period, s; B - artificial reef crest width, m; h - artificial reef height, m; d - water depth, m; g - acceleration of gravity, 9.81 m / s².

$$H_t = KT * H_i, \quad (2)$$

where: H_t - height transmitted wave, m.

The following parameters of the artificial reef are taken for calculation: B – artificial reef crest width, 50 m; h – artificial reef height, 8 m; d - water depth, 10 m.

The calculations were carried out according to the values of the heights and periods of the waves given in Table 3 of [6]. The results of preliminary calculations are shown in Table 1.

Table 1. The results of preliminary calculations.

Height H_i , m	Period T, s	Kt	Height H_t , m
0,75	3	0,384	0,288
1,25	4	0,343	0,429
2	5	0,298	0,596
3,5	7	0,263	0,919
6,0	9	0,219	1,313
8,5	11	0,199	1,695
11	12	0,177	1,946

In Fig. 4 is shown the section of an artificial underwater reef with the estimated dimensions in m. The slope angle of the reef slopes is 26 °.

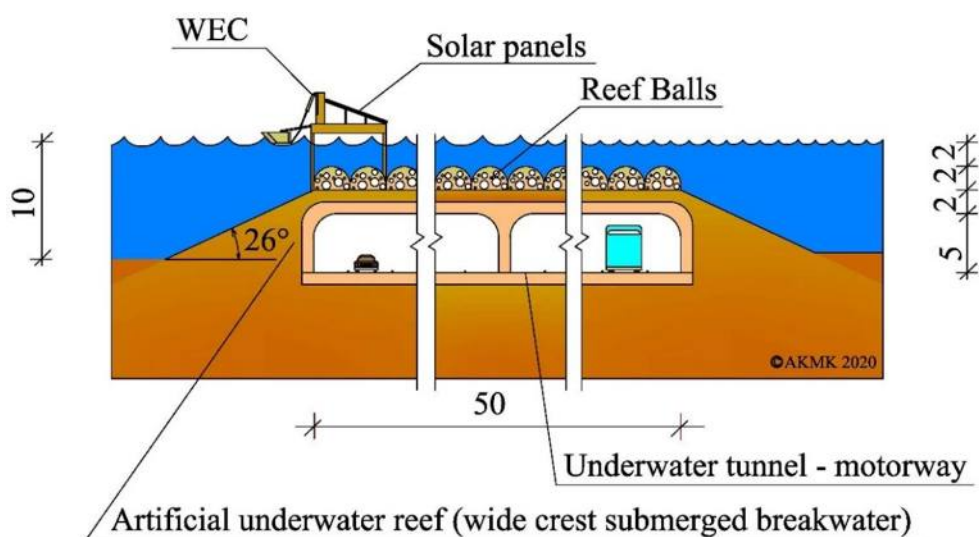


Fig. 4 Section of an artificial underwater reef.

A tunnel for the motorway has been laid in the body of the underwater reef. The standard overall height of the tunnel is 5 m. To ensure safety in case of flooding, the tunnel should be divided into compartments with the possibility of sealing. It is also advisable to split the motorway into two parallel tunnels. Each tunnel has a 5 - lane road. The total width of the two tunnels will be up to 50 m. Accordingly, the crest width of the underwater reef - breakwater will also be 50 m. To increase the turbulent friction of transmitted waves, Reef Balls are installed on the crest.

To extract the energy of sea waves and solar energy, on the sea side along the crest of an underwater reef, WEC wave energy converters and racks with solar panels are installed on piles. To cool the surface of solar panels, periodically (upon reaching a critical heating temperature) sea water is pumped.

Such a complex of transformers of energy of sea waves and solar radiation can be created on the basis of the coastal power-producing dam (CPPD) structure "NPO Gidroenergospetsstroy" is shown in Fig. 5 [7].

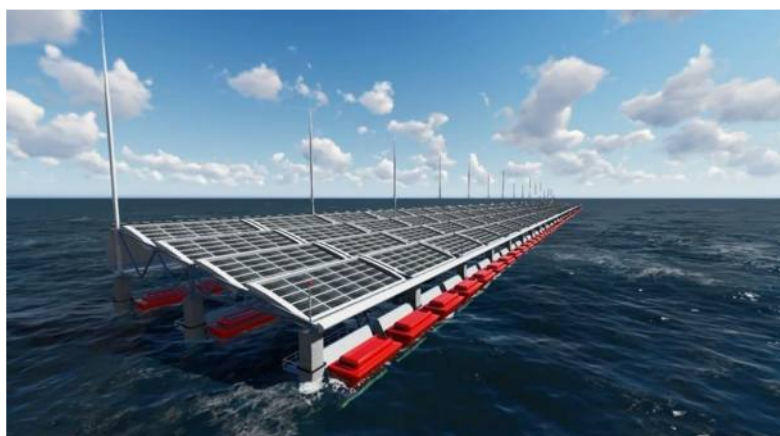


Fig. 5. General view of the Coastal Power-Producing Dam structure [7].

To communicate the expressway with the coast, can make underwater or above-water interchanges. In Fig. 6 is shown a bridge over Qingdao Bay in China [8]. As can see, the denouement covers an area of about 0.48 sq. km. Therefore, it is more preferable to construct above-water interchanges on bridges, as they will have less impact on the underwater coastal slope.

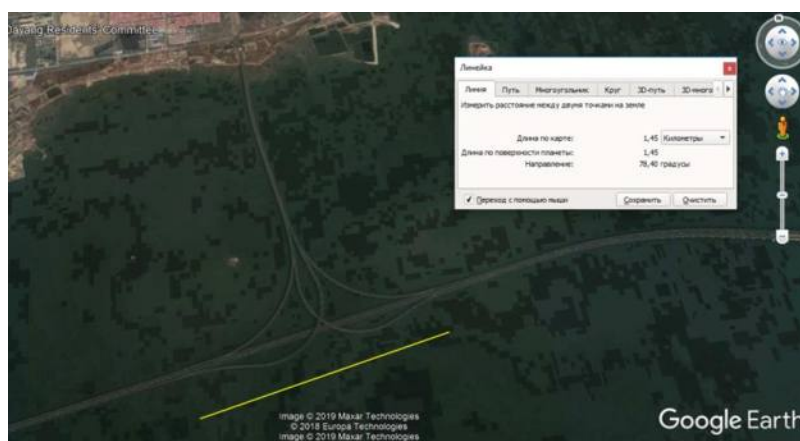


Fig. 6 A bridge over Qingdao Bay in China [8].

Transport interchanges should ensure the maintenance of the high-speed mode of the highway, taking into account the volume of traffic [9]:

- on the section Nahariya - Zikhron-Yaakov - 20,000 cars per day;
- Zikhron-Yaakov - Netanya - 100,000 cars per day;
- Netanya - Ashdod - 250,000 cars per day;

- Ashdod - Ashkelon - 100,000 cars per day;

It is advisable to place transport interchanges at a some distance from settlements, so as not to close the horizon. In the locations of cities where communication with the coast is necessary, underwater lateral premises adjoin underwater tunnels for the exit of the transport from the motorway into turns to the coast. Turns are placed above the water on the bridges. The overall dimensions of height of the bridges is not less than 8 m above sea level (taking into account the possible height of the storm wave 7 m). Underwater-abovewater tunnels with a slope of 10% provide a safe departure from bridges to the underwater tunnel.

Also in the underwater tunnel additional lateral premises should be provided for exit from the road for rest, located after each 5 - 10 km.

In Fig. 7 a general view of the underwater artificial reef with tunnels for the motorway and transport turns is shown the coast laid on bridges.

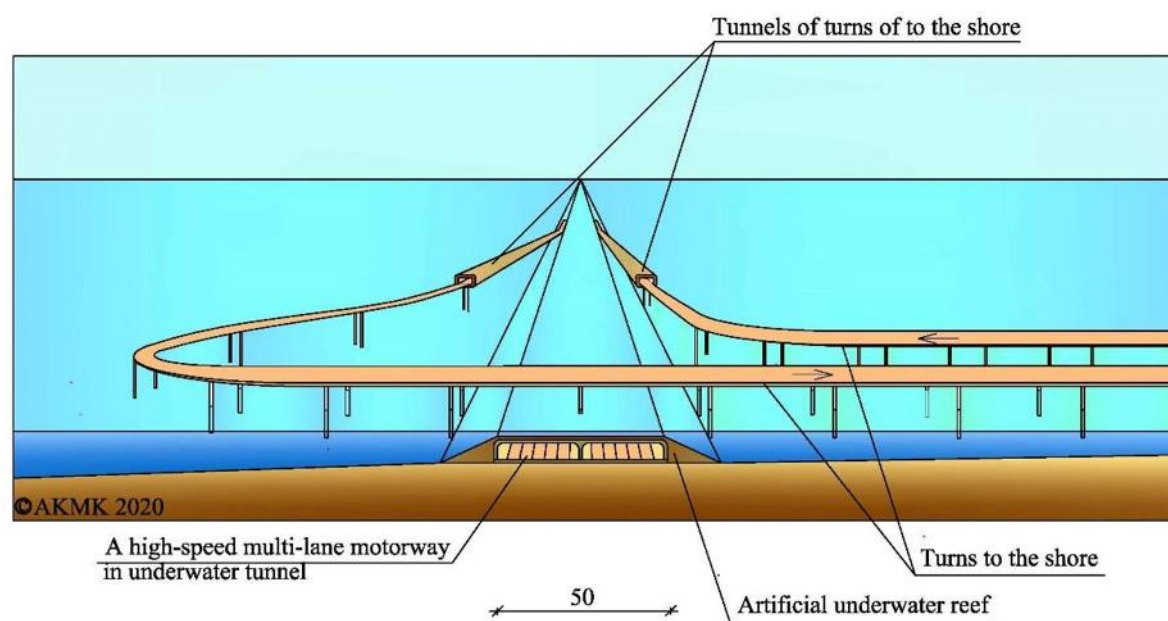


Fig. 7 General view of the underwater artificial reef with tunnels for the motorway and transport turns to the coast laid on bridges.

Prolonged movement in a confined space negatively affects the driver, so it is advisable to bring the motorway to the surface every 10 to 15 km.

To enter the underwater motorway of transport from the Ashdod Sea Port or from roads with a small volume of traffic, underwater tunnels with car turntables (platforms) and hydraulic swing elevators can be used. Since the average speed of turning car turntables is 360° in 40-60 s, the throughput will be 90 - 120 cars per hour.

Conclusions:

The results of preliminary calculations show that the design of an artificial underwater reef can provide a comfortable wave mode in the space after reef even during a storm. More justified conclusions can be drawn from the results of numerical experiments or laboratory modeling at the stand.

REFERENCES.

1. Damian Carrington. Ocean temperatures hit record high as rate of heating accelerates. The Guardian. 13 Jan 2020.
2. Kozlov A., Kozlov M., Polinov S. On the concept of forming local clusters along the Mediterranean coast of Israel // Proceedings of International Scientific-Practical Conference

"Problems of Integrated Sustainable Development of the Coastal Zone". Netanya, Israel. Publishing House: Print ABC. 2019. P. 25-30.

3. Harris, L.E., 1995. Engineering design of artificial reefs. Oceans '95, Marine Technology Society, Washington, D.C., Vol. 2, pp. 1139-1148

4. Armono, H.D., 2004. Artificial Reefs as Shoreline Protection Structures. Institut Teknologi Sepuluh. Paper presented at Seminar Teori dan Aplikasi Teknologi Kelautan IV, Surabaya.

5. Marine Policy Plan for Israel: Physical Oceanography, Deep Sea and Coastal zone Overview. Technion City, Haifa. 2014.

6. Bezrukov Yu.F. Fluctuations in level and waves in the oceans. Tutorial. - Simferopol: Taurida National University. V.I.Vernadsky, 2001.

7. Anosov V.N., Egurnov V.E., Kotunov V.V. Development of methods and designs for convertor of wave energy and protect of sea coast // Proceedings of International Scientific-Practical Conference "Problems of Integrated Sustainable Development of the Coastal Zone". Netanya, Israel. Publishing House: Print ABC. 2019. P. 62-68.

8. A snapshot in the Google Earth bridge over Qingdao Bay in China.

9. Statistical abstract of Israel 2012.