International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 07 | July 2018 www.irjet.net p-ISSN: 2395-0072

Possibility of Land Reclamation using Construction Waste in Gaza Strip

Mazen Abualtayef[1], Hassan Ziara[2], Ahmed Khaled Seif[3,‡], Ali Masria[4]

[1]*Environmental Engineering Department, the Islamic University of Gaza, Palestine*
[2]*Municipality of Gaza, Palestine*
[3]*Department of Civil Engineering, Al-Azhar University, Egypt*
[4]*Irrigation Engineering and Hydraulics Dept., Faculty of Engineering, Mansoura University*
[‡]*Corresponding author: Ahmed Khaled Seif, ahmedkhaledseif@azhar.edu.eg*

Abstract - *Coastal areas are suffering from a rapidly growing in population density as well as a lack of its area. This force the experts investigating different suggestions such as sea reclamation. Gaza Strip is considered one of the most occupied areas in the world with a population of two million inhabitants in an area is 365 square kilometers. The limitation of the lands compared to the dense population leads to the raising of the land price. The latest statistics indicate that, two million tons of debris have been accumulated in the last aggression on Gaza Strip in 2014. It contains a huge amount of concrete rubble that form a burden on the landfills.*

This study investigates a proposed alternative to benefit from the debris through land reclamation. It is proposed to relocate the construction features of the Gaza fishing port to reach sediment balance. The study plan started by estimating the construction waste quantity, then implementing standard tests of specifications to identify the possibility of using it in land reclamation. Furthermore, the sediment transport and different features at Gaza fishing port have been studied as well as its bathymetry was surveyed. Consequently, the new proposed reclaimed area was supposed to be at western side of the existing western breakwater at Gaza fishing port. Concerning our proposal, the required area has been estimated through the available debris of the current breakwaters, and construction wastes. The total estimated quantity of available debris is about one million cubic meters, which is sufficient to reclaim 11 hectares. However, the new reclaimed area should be surrounded by sheet piles. The total cost of the proposed reclaimed area was estimated as USD130 per square meter. In addition, it is recommended to construct a bridge to facilitate the transportation process and movement. Finally, the sea reclamation cost is of importance as it is a fishery seaport that is vital from economical side as well as recreational activities.

Key Words: Land Reclamation, Construction Waste, Gaza Fishery Port

1. INTRODUCTION

A huge amount of population around the world resides in coastal areas. A former statistic indicates that coastal population densities are nearly three times that of inland areas and are in continuous growth. Coastal human settlements are usually boosted through reclaiming tidal and shallow sea areas, which defined as land reclamation. This phenomenon can be noticed in many coastal countries, such as Korea, Japan, Singapore, Netherlands, Hong Kong and Macau (Feng et al., 2014).

Coastal zone' reclamation is effective for mitigating population pressure and ensuring food safety. Since the 1950s, a great attention on coastal zone development has entered a peak period. Recently, the reclamation of coastal zones has gained utmost importance, particularly in developing countries. The coastal reclaimed lands are basically used for agricultural production, urban and industrial development, and port construction (Li et al., 2014). Land reclamation is a process to create new land from the sea through different techniques. Among it, confining the area with large amounts of heavy rock and/or cement, then filling in between by clay and dirt until the desired height is reached (Nadzir et al., 2014).

As coastal area is a very sensitive area, any development needs to be highly evaluated for its possible disturbances. The coastal reclamation comes with its adverse impacts to the land. The negative impacts can be noticed in different patterns like erosion activity, environmental change and human actions. If ecosystem undermined, the ability of the coastal areas to adapt and regenerate would erode (Nadzir et al., 2014). Consequently, various changes in the natural characteristics of the coastal environment and considerable damage to the marine ecosystems may be occurring, hence affecting natural resources dependable by human beings. The impacts of reclamation not only limited to the damped/dredged area, but extends to nearby areas where siltation or change in current happened (Azwar et al., 2013).

This study deeply investigates the feasibility of sea reclamation practices in Gaza strip due to land area's shortage. Moreover, to give the decision makers a robust help regarding this target. Actually, Gaza strip is considered as one of the highly populated density areas around the world, with a population of 2 million inhabitants in an area of 365 km^2 (PCBS, 2018). The implementation of such reclamation projects is of importance to Gaza strip for a number of reasons: the population growth ascending, and the economic recession and lack of areas.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 07 | July 2018 www.irjet.net p-ISSN: 2395-0072

Indeed, Gaza coast suffered from man-made structures such as the construction of fishing harbor, which started in 1994 and completed in 1998. The fishing harbor has locally disturbed the coastal erosion and sedimentation pattern, resulting in sand erosion problems. In addition the infrastructure represented in the building and roads adjacent to the shoreline confront instability conditions and is expected to have a severe erosion problem in the coming few years, especially in the region of Beach camp that is located to the north of the port`s site (Abualtayef et al., 2013). As a countermeasure, the construction wastes were deployed in the eroded area, which works as a beach revetment, to mitigate the severe beach erosion and protecting the hotels. UNRWA has constructed coastal protection (gabions) along the Beach camp with a total length of 1650 m to mainly protect the main coastal road. Several short groins have been constructed along the Beach camp for shoreline preservation. Actually, these mitigations are not effective and significance measures should be undertaken to protect the beaches against coastal processes due to the fishing harbor (Abualtayef et al., 2013).

On the other hand, due to the three aggressive invasions that occur in Gaza strip in 2008, 2012, and 2014, about two million tons of debris have been accumulated in the lands from damaged buildings and facilities. However, the last war on the Gaza strip causes a severe deterioration in infrastructure. The ten-year' closure had already left most of infrastructure facilities inadequate to function. Hence, municipal services such as solid waste and solid waste treatment should be collected, otherwise, hundreds of tons of wastes will cause huge problems in the streets. Restrictions on the imports of essential consumables and other materials also reduced the efficiency of the operation of sanitary landfills and garbage collection trucks. (UNDP, 2014).

To overcome the accumulated solid waste problem, Municipality of Rafah was the first who carried out crushing activities in relatively large quantities. The municipality was supplied by a small-scale crusher capacity of 70 tons per hour funded by the Italian government, hence started crushing of concrete rubble generated in the south of the Gaza strip. The produced crushed material was recycled by the municipality in agricultural roads, and also by UNRWA in some roads in Tal Elsultan area in Rafah. In addition, big operation by UNDP was implemented to crush concrete rubble was followed after the disengagement of Israeli occupation from Gaza settlements. In 2006, UNDP was assigned by quartet to remove and crush more than 700,000 tons of mixed concrete rubble from Gaza settlements. Nearly 400,000 tons of this rubble were removed in very good and clean conditions (UNDP, 2014).

In general, huge amounts of construction waste (2 million tons) have been generated from the last war on Gaza. Accordingly, good management to these disposals should be addressed as almost all available landfills in the Gaza strip are already overloaded The Palestinians ministries proposed many ideas to effectively manage this debris. The current study, investigate an integrated alternative through land reclamation in Gaza strip, ensures disposing massive volume of concrete rubble besides mitigating the coastal problem at Gaza fishing port.

2. MATERIALS AND METHODS

The production of recycled crushed material was an essential step to obtain the best benefits from generated post-war rubble such as reducing the total volume of the rubble at overloaded landfills and decreasing the gap between demand and supply of construction aggregates in construction demand industry taking into consideration performing required tests that approve the application of such recycled materials.

In 2009, the quantities of debris were gathered from UNDP and other relevant authorities in the Gaza strip. Then, the samples were taken by two teams from IUL and AEL labs arranged for taking a sample from 30,000 tons of crushed materials from post-war rubble. The objective of testing crushed materials was to determine the technical applicability of using the recycled concrete rubble collected from post-war affected sites in Gaza strip in road construction as an alternative for the natural aggregate in road construction or other applications. The characteristics of such aggregates were determined and compared to international standards. The reuse alternative was investigated in road and concrete constructions throughout all performed tests. The test analysis showed that the recycling of the concrete rubble aggregates and its use in road sub-base give acceptable results. Thus, recycled aggregates can be considered as a good alternative to natural aggregates especially in road constructions.

2.1 Site Bathymetry

The bathymetric features at the Gaza fishing port were collected through a field survey using sonar as it is shown in Figure 1.

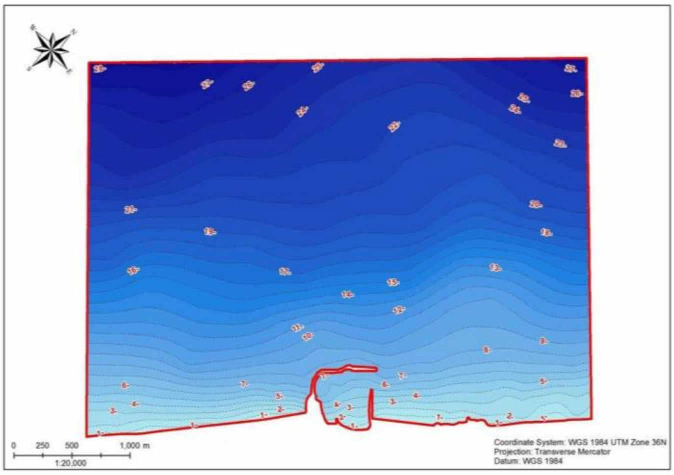

Fig -1: The bathymetric features of the Gaza fishing port

2.2 Materials and Rubble Quantities

The 51-day, July-August 2014, military operation in the Gaza strip has caused the destruction of infrastructure and buildings. A preliminary infrastructure damage assessment statistic has been conducted by UNDP in collaboration with line ministries, UNRWA, UNOSAT and WFP. UNDP to give a detailed infrastructure damage assessment. The estimation elucidated that nearly two million tons of rubble have been generated, which is three times more than the amount of rubble generated during 2008-09 Gaza war. The detailed quantity of the generated rubble, according to the Gaza strip governorates is shown in Table 2 (UNDP, 2016).

Table -1: Detailed quantity of generated rubble

Governorate	North	Gaza	Middle	Khan younis	Rafah	Total (Actual)
Total Rubble (×103 ton)	548	611	148	382	287	1,976
No. of Buildings	352	352	121	329	341	1,495

The resulting analysis of specific gravity for the crushed material is 2.35, accordingly the available volume of filling material for reclamation is about 850,000 m^3 (UNDP, 2016).

2.3 Characteristics of debris

UNIDO (2005) conducted a testing program to investigate the application of construction and demolition wastes in the construction industry in the Gaza Strip. The conducted testing program aimed to highlight the possibility of producing recycled aggregates from the construction and demolition wastes (CDW) and was performed on a sample taken from concrete rubble in Rafah area. The reuse alternative is investigated in concrete mixes and road construction throughout a comprehensive testing program. The test results showed that the recycling of the CDW aggregates and its use in both concrete and road subbase gives acceptable results.

Furthermore, UNDP (2009) conducted testing program on samples were taken from concrete rubble that collected from post-war rubble. The results indicate that crushed concrete rubble can be used in the construction industry. Many tests were performed taking into consideration previous international experience in this field where more than 900 million tons of concrete rubble are annually generated and partially reused in USA, Europe and Japan.

Sieve analysis: The collected samples of crushed concrete rubble were sieved, and the results were compared with the standard limits of AASHTO for base coarse and sub-base material grade (A). Results show that samples are descending to lower standard limit which represents the course limit. Some of the samples were coarser than the standard limits while, others were slightly matching these limits. From a technical point of view, this gradation is acceptable to some extent. Larger particles greater than 2.5 cm are suitable for road applications. However, for concrete application, it is recommended to use small particles, smaller than 2.5 cm. Accordingly, for concrete application, it was recommended to conduct three tests: compressive strength test at 7 and 28 days, slump test and air content test. Physical properties of these fractions as obtained from previous studies are shown in Table 2 (El Kharouby, 2011).

Table -2: Physical properties of concrete aggregate fraction

Type	Size fraction (mm)	Fineness modulus	Unit weight kg/m3	B.S.G	Absorption %
Type 1 (Folia)	25.0-4.75	7.42	1478.5	2.65	3.13
Type 2 (Adasia)	12.5-4.75	6.89	1468.1	2.60	3.00
Type 3 (Semsemia)	9.5-2.36	5.72	1526.6	2.55	2.00

Analysis of gradation: Sieve analysis results for road applications showed that the crushed material is classified as coarse material greater than 4.75 mm (sieve no. 4). As shown in Table 3, the coarse to fine materials ratio was ranged from 77% to 23%, respectively (El Kharouby, 2011). The amount of coarse materials according to AASHTO should not exceed 70% and for fine materials 40%. This means that an additional amount of fine materials should be added to meet the standards. Table 4 shows the test results for other essential requirements of crushed concrete compared to international standards (El Kharouby, 2011).

Recycled concrete rubble seems to have satisfying properties for the most common exposure conditions. It can solve many of the basic problems concerning shortage of construction materials in roads and concrete construction and reclamation. In addition, as natural resources diminish, the demand for recycled concrete aggregate is likely to increase, making concrete recycling the economically and environmentally preferable alternative to traditional “smash and trash” demolition. Wherever good natural aggregates are not locally available, where natural aggregate costs exceed removal and recycling costs or where disposal of existing concrete pavement or concrete structures is problematic, concrete recycling should be evaluated. Moreover, concrete recycling appears to be profitable. In most cases, it can meet demand requirements of lower value product applications such as land reclamation.

Table -3: Course and fine aggregate contents

Lab name	Coarse aggregate (%)	Fine aggregate (%)
Islamic University Laboratory	82	18
Association of Engineers Laboratory	71	29
Average	77	23

2.4 The Study Methodology

The analysis results of concrete rubble showed the possibility of using it in sea reclamation. Therefore, sea reclamation will be the best solution to alleviate these problems. The methodology was implemented according to the following steps: 1) estimating the total quantity of rubble resulted from the 2014 war on Gaza strip; 2) testing characteristics of concrete rubble for sea reclamation possibility; 3) studying the existing fishing harbor area and characteristics to determine the suitable interventions and which tongues will be removed; 4) defining the bathymetric features of the Gaza fishing port using sonar survey to determine the sea water depth at different points as it shown in Figure 2; 5) estimating the rubble quantity resulted from removing the existing breakwaters of the Gaza fishing harbor; 6) estimating the total rubble quantity will be reclaimed by adding the previously estimated removed rubble quantity to the resulted from the 2014 war on Gaza strip; 7) defining the proposed reclaimed area dimensions and estimating its area as it shown in Figure 2; 8) Designing the sheet pile required to reclamation based on the soil type, sea water depth and loads; 9) cost estimation of the proposed area reclamation; 10) finally defining the trucks movement and routes during reclamation implementation

Fig -2: The proposed reclaimed area

Table -4: Test results of essential characteristics of concrete rubble

Test Name	Standard	Aver. Result	Standard Requirements
Liquid limit, %	BS 1377	20.25	According to AASHTO and ASTM for sub-base and base materials, this value should not exceed 25%.
Specific gravity	ASTM-854	2.35	Lower than crushed nat ural rock stone
Absorption, %	ASTM-2216	5.55	
Finer than #200 Sieve, %	ASTM-1140	1.95	
Clay lumps & friable parti cles, %	ASTM-142	0.15	According to BS 882:1992, this value is very low which this is advantage for construction application.
Flakiness index, %	BS 812	24.5	According to BS 882: 1992, this value should be less than 40% for road construction.
Elongation index, %	BS 812	9.1	According to BS 882: 1992, this value should be less than 40% for road construction.
Max. dry density, gm/cm3	ASTM-1557	1.97	Local CODE 2.15%
Optimum water content, %	ASTM-1557	10.25	
Los AngelesAbr asion test, %	ASTM-131	41.75	AASHTO maximum allowed value, to be used in the road construction as base course material is 45% at 500 Rev.
California Bearing ratio, CBR at 100 Rev., %	ASTM-1883	163	Minimum required value (80%) for base course at 100% compaction according
Sand equivalent, %	ASTM-2419	66.6	Local standards for base course: Minimum 35% sand equivalent at any stage of road construction.
Impact value, %	BS 812	28	According to BS 882: 1992, this value is suitable.
Crushing value, %	BS 812	26.15	

3. RESULTS AND DISCUSSION

Gaza fishing harbor is the only port for the ships and boats of Gaza's fishers, unfortunately this port has negative effects along Gaza's coastline represented in severe erosion/accretion. In this regard, the coastal researchers deeply studied various alternatives to relocate/redesign the port in order to mitigate its impacts on the coastlines and nearby structures.

Abualtayef et al. (2013) recommended that relocating Gaza fishing harbor towards offshore, is the most proper alternative to mitigate the erosion/accretion impacts, but this option will generate a strong current of 1.0 m/s at the entrance of the harbor. However, this dilemma can be managed by good structures arrangements. So, this section explains and discusses the estimation process of the proposed reclaimed quantity and its related area, in addition to estimating the reclamation cost.

3.1 Existing Breakwaters Quantity Estimation

The quantity of construction wastes intended to be used in relocating the current design to offshore's fishing harbor is 850,000 m^3. Fortunately, the reclaimed area can be increased if used materials in the 300 m and 500 m breakwaters as shown in Figure 3. taken into the redesign.

Fig -3: The existing Gaza fishing harbor (source: Google earth, 2016)

To calculate the volume of rubble resulted from removing the 300 m and 500 m breakwaters extended from the beach, it is assumed that this area is divided into three different areas; A, B and C, then their dimensions are shown in Figure 4. After that, the area of each segment is calculated as shown in Table 5.

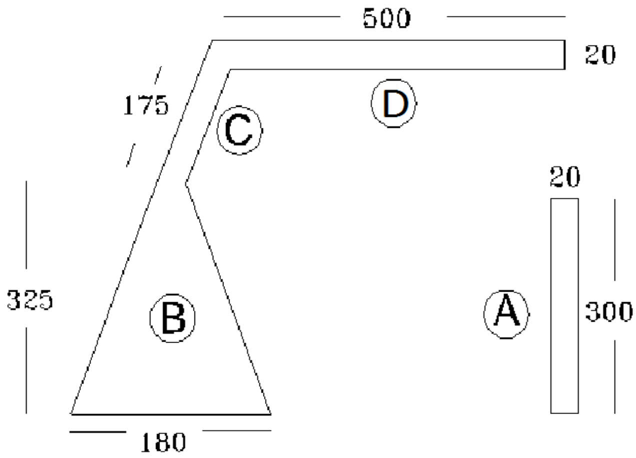

Fig -4: Illustration of the existing Gaza fishing harbor dimensions

Table -5: Volume estimation of rubbles resulted from removing the breakwaters

Segment	Area m×m	Average depth m	Volume m³
A	300 × 20	4.5	27,000
B	½ × 180 × 329	5.0	148,050
C	175 × 20	8.5	29,750
Total			204,800

Based on the calculated volume for each segment, the total volume of rubble produced from removed these three segments are 204,800 m^3. In addition, the available volume of rubble accumulated from the last 2014 war on Gaza Strip is approximately 850,000 m^3. Consequently, the total available rubble volume for the proposed reclaimed area is more than 1 Million m^3.

3.2 Estimation of The Proposed Reclaimed Area (New Offshore Gaza Fishery Port)

The required area for proposed reclamation is calculated by using the total amount of the produced rubble which previously estimated as 1,053,000 m^3.

According to the contour map shown in Figure 5, the sea water depth at 500m, 600m and 700m away from the beach are -7m, -8m and -9m respectively. However, the existing breakwater ground is 2m above sea water level.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 07 | July 2018 www.irjet.net p-ISSN: 2395-0072

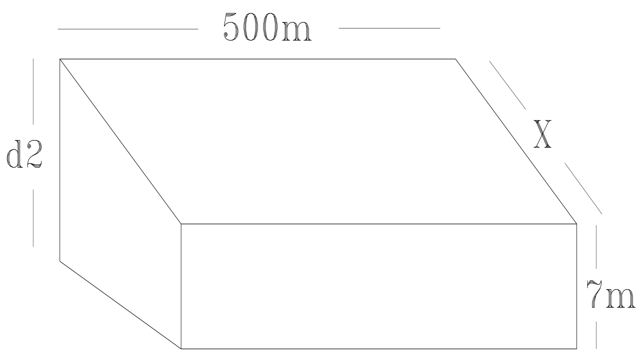

Fig -5: Dimensions of proposed reclaimed area

To calculate the required area shown in Figure 5, the following equation is used:

The volume of new reclaimed area = $\left[\frac{(d1+2)+(d2+2)}{2}\right] \times x \times l$

*d*1 is the seawater depth at 500 m away from the beach, which is equal to 7 m

*d*2 is the seawater depth at the end limit of the proposed reclaimed area

x is the width of the reclaimed area

l is the breakwater length (also the length of the reclaimed area), which is 500 m

By substitution with these values and using the volume of new reclaimed area of 1 million m^3, the resulted equation with two variables is solved by goal seek on excel program and keeping the minimum width of the reclaimed area 200 m. The resulted value of d2 and x are 9 m and 208 m, respectively.

As the width of existing breakwater, segment D (Figure 4) is 20m, the total width will become 228 m and a length of 500 m.

3.3 Cost Estimation of The Proposed Reclaimed Area

Rubble transportation cost estimation

Based on the coordination with rubble relevant sectors, the accumulated rubble from the last war in 2014 on Gaza Strip is considered available. So, the accumulated rubble will be transported to the project site by assuming that the truck capacity is 16 m3. As the cost of one truck trip is about 65$ and as the total quantity needs to transport is 1,000,000 m3, so the required trips number is 65813 trips. The total transport cost is 4.3M USD. The filling and damping cost is estimated to be 200% of the transport cost, so the total needed cost 8.6M USD.Sheet piles cost

It is assumed that the need sheet pile section is PZC 28 as it shown in Figure 6. The weight of 1 square meter of PZC 28 section is 166.1 kg/m^2.

The reclaimed area shape is rectangular, with the total perimeter of 1,456 m ((500+228) ×2). Assuming the average seawater depth at the new reclaimed area is 8 m and as the existing breakwater ground is 2 m above sea water level, the sheet pile will be installed at 5 m underground, so the total height of the installed sheet pile is 15 m. The total weight required of sheet pile 3630 tons (1457×15×166.1). The cost of PZC 28 sheet pile section is about 550$/ton. So, the total cost of need sheet pile steel is 2M USD

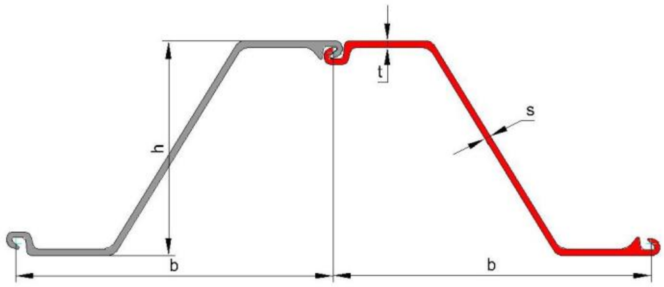

Fig -6: The proposed sheet pile section (PZC 28) (source: GERDAU, 2016)

Sheet pile installation cost

In common, the sheet pile installation cost at site is about 300% of the sheet pile steal cost. So, the installation cost is 6M USD.

Finally, the total cost of the new reclamation area is equal to the summation of rubble transportation to the site project cost and installation of sheet pile steel cost as shown in Table 6. Therefore, the total project cost is 14.6M USD. In conclusion, as the total reclaimed area is 114,000 m^2 (500×228), the cost per square meter of reclaimed area is 130 USD/m^2.

Table -6: Summary of cost estimation of proposed reclaimed area

Item	**Cost M USD**
Rubble transportation and dumping cost	8.6
Sheet piles installation cost	6.0
The total cost of the proposed reclamation area	14.6
The cost of one square meter of reclaimed area	130 USD/m^2

3.4 Proposed Reclamation Process:

- Defining the proposed reclaimed area as the area located in the west of the existing western breakwater.

Fig -7: Illustration of the proposed reclaimed area location and method (source: DEME, 2014)

- Selecting the sheet pile needed to reclamation based on the soil type, seawater depth and loads. Therefore, the chosen sheet pile type is hot rolled steel sheet pile PZC 28. The sheet pile installation will be around the entire proposed reclaimed area.

Fig -8: Installation of sheet piles (source: WIKI, 2016)

- Identification of the trucks movement and routes during reclamation implementation, which will be through segment B to segment C to fill the area located in front of segment D.

Fig -9: The trucks movement during the reclamation process Source: (Yin Pumin, 2014)

- Firstly, the reclamation will depend on the rubble material resulted from the 2014 war on Gaza Strip, and then continuing reclamation by using the rubble from removing the existing breakwater A, B and C, respectively. Trucks movement during the reclamation process is considered, so the removing will be started by segment A then B and will be finished by segment C.

Fig -10: Reclamation activities (source: Bart Callaert, 2016)

- Construction of a bridge to connect the new offshore fishing port to the land. The final shape of the new fishing port will be as in Figure 11 with a rectangular terminal.

Fig -11: The general view of proposed reclamation and bridge installation (source: Xinhua, 2016)

4. CONCLUSIONS

The following concluding remarks of the study are as the following:

- The implementation of such reclamation projects can be considered as an urgent to Gaza Strip because of the increasing in population growth, the economic recession and lack of areas.
- Land reclamation in Gaza Strip is significant choice to mitigate problems of the massive volume of concrete rubble that was generated from the last war on Gaza ,especially, that almost all available landfills in the Gaza Strip are already overloaded. On the other hand, the shortage of natural aggregate beside the high prices made the recycle of concrete rubble as one of top priority for land reclamation process.
- Sea reclamation is the best solution for many problems, mainly, it will solve the problem of the area located in the north of Gaza fishery seaport. Reclamation process will allow the movement of sediments to the northern area.
- Steel sheet piles are suitable to use because of their resistance to the high driving stress that is developed when they are being driven into hard soils. Steel sheet piles are also lightweight and reusable.
- The total cost of reclamation 114 dunums area is 15M USD. So, the cost of one square meter of reclaimed area is 130 USD. Accordingly, the cost of sea reclamation can be feasible as Gaza fishery seaport is very vital from the economic view.

REFERENCES

[1] M. Abualtayef, S. Ghabayen, A. Abu Foul, A. Seif, M. Kuroiwa, Y. Matsubara, and O. Matar, " The impact of Gaza fishing harbor on the Mediterranean coast of Gaza," Journal of Coastal Development,2012, 16(1), 1-10.

[2] M. Abualtayef, A Abu Foul, S. Ghabayen, A. Abd Rabou, A. Seif and O. Matar, " Mitigation measures for Gaza coastal erosion," Journal of Coastal Development,2013,PP 135-146,16(2).

[3] M. Al-Agha," Access to the coast and erosion control: use of wastes on local engineering works in the coast of Gaza City", Environmental Geology, 39(3-4),2000, PP. 405-410.

[4] S. Azwar, E. Suganda, P. Tjiptoherijanto, H. Rahmayanti, "Model of Sustainable Urban Infrastructure at Coastal Reclamation of North Jakarta," Procedia Environmental Sciences,17, 2013, PP. 452 – 461.

[5] B. Callaert And j. Bogaert "The Taparura Project: Sustainable Coastal Remediation And Development At Sfax, Tunisia," 2016.

[6] M. Braja, "Principle of foundation Engineering 8th Edition."

[7] N. Cheng, "Investigation of opportunities for recycling inert construction and demolition material in Hong Kong," Technical Note 2/2000, Hong Kong: Civil Engineering and Development Department.

[8] Delft Hydraulics, "Port of Gaza, basic engineering study. Final report, part II, Coastal impact study prepared for the Palestinian national Authority and the Ministry of Economic Affairs," The Netherlands, Sep 1994.

[9] DEME, "Land Reclamation," retrieved from http://www.deme-group.com/expertises/land-reclamation.

[10] B. El dada and s. Jendia, " Use of Reclaimed Asphalt Pavement and Demolition Debris in Road Pavement Base Layers," M.S. thesis, IUG Univ., Gaza, Palestine, 2013.

[11] A. El Kharouby, " Post-war rubble removal and potential use of recycled construction rubble in Gaza governorates,". The Islamic University Journal, 19(1), 2011, pp.179-212.

[12] Environmental Council of Concrete Organization: Recycling Concrete and Masonry: Illinois, USA 1999.

[13] E. Mulder, " Closed Cycle Construction: A concept for the separation and reuse of C&D waste," TNO Science and industry Dept. Netherland, 2008.

[14] L. Feng,X. Zhu, and X. Sun, "Assessing coastal reclamation suitability based on a fuzzy-AHP comprehensive evaluation framework: A case study of Lianyungang, China," Marine Pollution Bulletin 89,2014, PP.102–111.

[15] R.Graaf and F. Hooimeijer, "Urban water in japan," Taylor & Francis Group: London, UK, 2008.

[16] P. Grand," http://www.china-steelpiling.com/product/z-type-sheet-pile-6.html"

[17] GERDAU, " Z-Profile Steel Sheet Piling",2016 retrieved from http://sheet-piling.com/pzc-z-profile/

[18] J. William, "Introduction to Coastal Engineering and Management," Advanced Series on Ocean Engineerig , World Scientific, Singapore , vol. 16, 2000., pp.437.

[19] B. Jorge and S. Nabajyoti, "Recycled Aggregate in Concrete, Green Energy and Technology," Springer-Verlag London, 2013, DOI, 978-1

[20] M. Jonathan and C. Scott, "Utilizing Concrete Rubble for Post-Disaster Reconstruction," Colorado State University. Colorado, 2009.

[21] F. Kevin, " Palm Islands, Dubai: Eighth Wonder of the World" 2011, retrieved from http://www.brighthub.com/education/homework-tips/articles/57707.aspx.

[22] J. Li, L. Pu, M. Zhu, J. Zhang, P. Li,X. Dai, Y. Xu and L. Liu, , "Evolution of soil properties following reclamation in coastal areas: A review," Geoderma, vol. 226–227,2014, pp.130–139.

[23] S. Lin , H. Khan and C. Loke , " The Coastal Environmental Profile of Singapore. Manila, Philippines," : International Center for living Aquatic Resources,1988.

[24] Malta Environment & Planning Authority (MEPA), " Land Reclamation Study," Project Identification Report, Malta 2005.

[25] N. Nadzir, M. Ibrahim and M. Mansor, "Impacts of Coastal Reclamation to the Quality of Life: Tanjung Tokong community, Penang," Procedia - Social and Behavioral Sciences, vol. 153,2014, pp.159 – 168.

[26] PCBS. (2016). Retrieved from http://www.pcbs.gov.ps/

[27] PilePro. (2016). Retrieved from http://www.lbfosterpiling.com/

[28] A. Qreaq and S. Jendia, "Reuse of Recycled Aggregates of Demolition Building Debris as an Asphalt Binder Course in Road Pavements," M.S. thesis, IUG Univ., Gaza, Palestine,2011

[29] R. Rustom, S. Taha,A. Badarnah and H. Barahma, "Properties of Recycled Aggregate in Concrete and Road Pavement Applications." The Islamic University Journal (Series of Natural Studies and Engineering), vol,15(2), 2014, pp.247-264.

[30] Tianjin Yichengtong Steel Trade Co., Ltd., " Q295 JIS Standard Steel Sheet Pile 400X170X16mm. Retrieved fromhttp://yctsteel.en.made-in china.com/product/SBHJLgDyZbcr/China-Q295-JIS-Standard-Steel-Sheet-Pile-400X170X16mm.html, 2014.

[31] T. Jagadeesh and M. Jayaram, "Design of Bridge structures, second edition, 2009.

[32] United Nation Industrial Development Programme (UNIDO), "Testing Program to Investigate the Application of Construction and Demolition Wastes in Construction Industry in Gaza Strip," Analysis Report, Gaza ,2005.

[33] United Nation Development Programme (UNDP), "Examining Potential Use of Recycled Construction Wastes," Analysis Report, Gaza, 2007.

[34] Wikipedia , retrieved November 7, 2014, from http://en.wikipedia.org/wiki/Gaza_Strip.

[35] WIKI. "Sheet piles",2016, retrieved from https://www.designingbuildings.co.uk/wiki/Sheet_piles

[36] World Business Council for Sustainable Development – WBCSD, " The cement Sustainability Initiative, Recycling Concrete," Geneva, July 2009.

[37] Xinhua, "Bridge connects China's first artificial offshore island with mainland", 2016 retrieved from http://www.globaltimes.cn/content/985582.shtml

[38] H. Yan, , N. Wang, T. Yu, Q. Fu and C. Liang, "Comparing effects of land reclamation techniques on water pollution and fishery loss for a large-scale offshore airport island in Jinzhou Bay, Bohai Sea, China, "Marine Pollution Bulletin 71,2014, PP. 29-40.

[39] P. Yin, "A Sea Besieged, Land reclamation poses great challenges to the country's ecosystems"2014, retrieved from http://www.bjreview.com.cn/nation/txt/2014-11/02/content_648513.htm.

[40] A. Zuhud, M. Arafa, and J. Hamad, " Performance of Recycled Aggregate Concrete" M.S. thesis, IUG Univ., Gaza, Palestine, 2008.

[41] D. Zviely and M Klein, "The environmental impact of the Gaza Strip coastal constructions," J. Coast. Res., vol, 19(4) ,2008, PP.1122-1127.