Evaluating the impact of irregular wave transmission energy on floating structures performance

Samar Hassan Abu-Ameereh

Civil Engineer, Faculty of Engineering Technology, Al-Balqaa Applied University

E-mail: Samar_3maireh91@outlook.com

Abstract

The response brought about by different floating structures in terms of the performance has been investigated in the manner that will help define the wave transmission. The effectiveness of the floating structures through the breakwater with the various configurations has the reducing effects on the waves which are both transmitted as well as reflected. This has been reported based on the various waves which have different heights also steepness. The magnitude as well as the timing and also the frequency of the various forces which are exerted by the breakwater units that are restraining the piles are examined as per the measured motions of the various floating kind of the floating structures .These ones have the configurations as well as energy dissipation. This paper thus focuses on the various techniques that are used on investigating the impact of wave transmission on the floating structures. This was done by using the appropriate model that measured the wave height reduction. The numerical model was thus used in determining wave transmission through the act of floating by various structures which vary due to the wave conditions. The transmission was then obtained from one of the model known as MIKE21BW which compared the results obtained from the simpler model that was based on the incorporation of the wave energy flux. The conclusion made is that a simplified technique gives the results alike to the diffusion obtained from an arithmetical model.

Keywords: floating structures, wave transmission, irregular wave.

1. Introduction

Floating structures are normally used to offer protection of the small craft kind of the marinas that are located at the place where the wind as well as the boot waves are in most case restricted. The restriction was made up to the height and to the period which is less than that of 1.5 meters. The floating structures are usually very easy to install since they have the small footprint which offers the ongoing kind of the flexibility (Babarit, A., 2010.p720). The floating structures normally are of different configurations that usually vary in terms of the levels of the performance. From the studies done, the inventory kind of the typical floating structures was presented. In having to predict the level of movement of the floating structures, the numerical model was used and it was based on the linear kind of the diffraction theory. This theory was then extend to have the following included, the impacts of the moorings also the damping as well the obliquely kind of the incident as well as random kind of the waves.

There were limited solutions made from the numerical model while having the simplifying kind of the assumptions that were necessary made of the case of the establishment. These ones were little bit kind inappropriate for the case of the conditions that seemed to be very high thus having the energy losses through the turbulence as well as the wave that is able to break through the water bodies (Kofoed, 2013.p420). These were part of the conditions which were recorded in that those which were able to occur through the design case of the storm waves that seems to be having some impact on the floating structures. The flexible as well as mooring kind of the systems have been realized to be used in securing floating thriu8gh the floating structures that are located in various locations. Based on the reports given by various researchers, that is the laboratory report, the behavior of such systems is evidenced out of the conclusions given when the study was done. Most of the reporting given the research paper about the floating structures which shows the performance done on the water bodies has been exposed to the sea water. The work that is done in the laboratory has been to report the case of the laboratory wave kind of the flume with the given research that may have been reported by some authors as per the studies

done. This was based on the attenuation performance as well as pile loadings for the broad range of the floating structures. The level at which protection was offered was provided by the structures and this was measured by using the coefficient KT. This indicated the ratio of the transmitted wave having the HT kind of height with the given incident of the wave height HI. In that (KT=HT/HI). Based on the discoveries made by the researchers from the previous studies, the floating structures are quite effective in having the reduction of the short period kind of the wave energy via the given energy through the various processes of the wave reflection as well as energy dissipation (Gironella, 2005.p25). The wave transmission is one of the frequently reported cases of the wave reflection kind of the coefficient. It is hence useful in any given research which may be done either in future to show the effectiveness of the floating structures which the wave transmission, the wave reflection as well the energy dissipation can successfully be well measured to conclusively give the required results as per the aims of study.

1.1 Statement problem

The performance of the floating structures is usually affected by the irregular transmission of the wave energy. Floating structures seem to offer protection against any cases of the undesirable wave heights. Based on the previous research work on the floating structures, it has be shown that the wave transmission brings some impact on them. There is need to have the designed method which will aid in eliminating the effects on the effective performance of the floating structures. The overestimation on the effectiveness of the floating structures needs to have the effective method that can predict the nature of the wave transmission that impacts its performance. The effectiveness of the floating structure is influenced by the occurrence wave period as well as the dimensions of a given structure that makes it quite complex (Babarit, A., 2013. p70). My research paper therefore seeks to deal with the following as the evaluation of the impact of the transmission wave energy on the performance of the floating structures. To determine the impact of irregular wave transmission energy on floating structures performance and also

to identify the steps that can be undertaken during the various design process, to help in predicting the effectiveness of the floating structures.

1.2 Research questions

This study questions can be summarised as follow:

1. What are the steps that can be executed throughout the design procedure permitted to estimate the effectiveness of the floating structures more accurately? ’

2. What is the simplified project formula for the wave transmission that is applicable for the design of the floating structures?

3. Which methods are omitted in the current design approaches which cause the given overestimation on the efficiency of the floating structures?

1.3 Objectives

The main objectives of this study are as follow:

1. To determine the impact of irregular wave transmission energy on floating structures performance

2. To identify the steps that can be undertaken during the various design process, to help in predicting the effectiveness of the floating structures

3. To identify the simplified project formula for the wave transmission that is applicable for the design of the floating structures

1.4 Hypothesis

1. There are no impacts of irregular wave transmission on the floating structures performance.

1.5 Justification

The performance of the floating structures is impacted with different types of waves. The transmission nature of the wave especially the irregular wave brings some difficulties to the floating structures. When such is caused on the structures, then their performance is

impacted. In that connection this study seeks to evaluate the effects of the irregular wave transport power on the floating structures (Gironella, 2005.p25). It will also focus on how the performance of these particular structures is affected. The usefulness of my study will help identify the nature of the irregular waves whose transmission affects the floating structures. This will help in giving the recommendation on how the same effect should be avoided by using the applicable approaches.

1.6 Scope and limitations

This scientific research paper focus on the investigation of the irregular transport waves of the power energy that affects the floating structures. In this regard, there are the current activities also methodologies that have been used, in that they have been assess to bring some improvement having some of the more compliments that have more detailed specification (Babarit, A., 2010.p720). Overall, there has been some advancement made from the past with detailed description of the assessment made on the procedures used in having to evaluate the impact of irregular transmission of wave on the performance of the floating structures. There is little bit lacking of the relevant publications that regard the performance of the floating structures as well as also the methodologies which have been greatly applied. The main aim of the project has been involved in the act of having the performance of the floating structures while using the right methodology to have it done. The knowledge which is gained needs to be used when dealing with the best methodology that will be used in the respective manner. This will thus, be done while having the contributions made to help the whole society in shari8ng all the knowledge that is gained as well results in a form which is publicized and also collaborated.

2. LITERATURE REVIEW

2.1 Introduction

This section introduces the critical literature assessment of the whole areas of concern in the entire project. It gives in detail what is all about the waves as well as the floating structures without leaving the nature of the performance floating structures. Some of the transmission wave theory is also given to help understand the mechanisms of the impacts of the irregular wave on the floating structures. The chapter finishes with the summery of all that needs to be addressed on the literature review.

2.2 Physics of the waves as well as floating structures

2.2.1 Wave transmission

This is a phenomenon where the wave energy seems to be passing over as well as under or rather through the breakwater thus creating the reduced kind of the wave that is the transmitted wave, this takes places on the lee side of the structure (Babarit, A., 2013. p70). The amount of the wave which is transmitted is expressed with the transmission coefficient that is well defined as a ratio of the wave that is transmitted in terms of the wave height, that is (Ht) as well as the incident kind of the wave with the specific wave height Hi thus,

$$Hi),\ Ct = Ht/Hi$$

In many situations the wave transmission that takes place through the breakwater is always very possible as long as the waves as well as the structures are very permeable. The wave transmission normally occurs in the case of the floating structure under the breakwater. Again the case of the wave transmission which is over the breakwater tends to occur at the low crested kind of the breakwaters which are always very overtopping as it may over at times.

2.2.2 Irregular waves

If one can manage to look at the surface of water, he or she will see that it is continuously changing without having to undergo repetition itself. If the surface of the water elevations is then measured, then the resulting signal is normally seen to be like the irregular kind of the wave

signal. This one can be displayed by using the sum of the large sum of the harmonic kind of the wave components. That is

$$\eta (t) = X\ N\ i=1\ ai \cos (2\pi fit + \alpha i) \quad (4.12)$$

In this case, N is the large number of the frequencies αi = phase ai = amplitude fi = wave frequency. Each of the wave has the component with the regular which has the description of the given elevation (Kofoed, 2013.p420).. From this case which is given, it is told that the irregular wave will always describe the given surface elevation which can be in a given manner be decomposed by having the four with the series in the applicable number of the harmonic kind of the waves. The above given model is useful in determining which directions in many times affects the transmission of the energy that leads to impact on the floating structures. There it then needs to have some modifications which will simplify all the work towards having to achieve the expected results of the whole given work. This will at the end of be possible in having the best methodology working well towards achieving the aims of the whole given project.

2.2.3 Dynamics of the floating structures in the irregular waves

The modification of the density spectrum tries to give the description of the surface elevation with the water waves which are generated from the wind while having the statistical sense. From this kind of the variance, the density uses the elevation kind of the spectrum that is obtained in the form of motion (Gironella, 2005.p25). Any system that is linear as well cosnst9inat within a given time. Using the amplitude that is two dimensional will be very applicable, thus the following equation will be

$$(f, \theta) = X\hat{}(f, \theta)\ x\hat{}(f, \theta) \quad (4.23)$$

In that: Xˆ (f, θ) = shows the breadth of a reply wave xˆ (f, θ) = labels breadth of an excitation that (harmonic wave). The reply of the variety that is EX (f, θ) is then defined as the excitation of a range Ex (f, θ) that is times a square of size reply of the function Rˆ (f, θ): EX (f, θ) = Ex (f, θ) h Rˆ (f, θ) i2 (4.24). From here then the existing kind of the harmonic wave will have the route of the propagation (Gironella, 2005.p25). The given response with the other floating structure will

not be the propagating wave having the certain direction. Based on the system that is in motion that is usually used, it will help in giving what it takes to gain some bit of the best results all through.

2.3 Performance of the floating structures

The performance of the floating structures are always defined by the given amount of the wave that attenuates in that it is strongly dependent upon the given amount of energy with the given reflection that is (Er), also energy transmission (Et) as well as energy dissipation (Ed). The majority of the theories which have the interrelationship about the wave power transport, are usually derived from the linear kind of wave theory (Babarit, A., 2013. p70).For any effective attenuation to be there on the short waves, the blockage of all the upper given water needs to be there with the focusing on the differences on the water columns, this will determine the amount of the wave energy. For the case of the longer kind of the wave energy, there is always the largest blockage that forms part of the water blockage, this makes it hard to regulate the manner in which the floating structure are affected in terms of their performance. Due to this, there is need of having the optimization which will have to exist between the draft as well as the wave attenuation so that it will be easy to have the design that is very economical in having the project done successfully.

In many cases, the commonly types which deal with the floating structures seem to have the effectiveness that is defined by the nature of the transmission of the coefficient. This kind of the coefficient will thus have it well defined in that it will be good to attain all it takes to meet the nature of all that will have to be done.

In conclusion, the paper part has given the overview of the wave transmission as well other aspects related to performance of the floating water. All these have been given in detail in attempt to help in achieving what it takes to have the very best done within the short given time. The chapter has open all that will be looked at in detail in the nest chapter which will be all about

the methodology (Kofoed, 2013.p420). Then it will be easy to make various discussions as well conclusions on the same given aspects.

3. METHODOLOGY

3.1 Introduction

This chapter gives the methodology that was used in having the whole project completed having the main aims achieved. It will use the relevant methods that will help in evaluating of the irregular transmission transport which exposes some impacts on the floating structures. It will then give out some discussions which will later help in achieving the expected results. There will then be the summery giving out what the main topic has been all about.

3.2 Method

The numerical model was thus used in determining the wave transmission through the act of floating by various structures which vary due to the wave conditions. The transmission was then obtained from one of the model known as MIKE21BW which compared the results obtained from the simpler model that was based on the integration of the wave energy flux. From the study done on the floating structures, it shows the relationship between different structures that needs to get done in the manner which will give out what it takes to meet the right results (Babarit, A., 2010.p720). The conditions that face the structures to float on water are also defined to help have the applicable work done. It will as well be done in future based on all that will help find out the steps which will be taken to have the entire project be applicable I the really situations. With this kind of methodology, it is quite possible to manage making various comparison that stand to give out all that will be made possible from the impacts arrived at on the performance of the floating structures.

2.1 OpenFOAM

The main software used in this work is release version

2.1.1 of the open source software OpenFOA

2.1 OpenFOAM

The main software used in this work is release version

2.1.1 of the open source software OpenFOAM

3.3 The description of the numerical model

An open FOAM kind of the software was used to help in analyzing of the data received from the monitored progress made on the behavior of the floating structures. All the detailed about the floating objects has been given in the manner that will be done as it may be taken. With the right programs under the given software, it was easy to give substandard work on the behavior of wave transmission. This was able to be done with the attempt giving the detailed analysis on the same. The specific problems were done in the only applicable way that will give out the results of the whole project at the end.

3.3.1 NUMERICAL MODEL VALIDATION

The validation was done by using two simple tests. One of the tests was the basic kind of the numerical wave that had the flat bottom, in this case that was the surface kind of the elevations that had some bit of the series that were little bit of kind complicated thus helping to give out the right analytical formulation. This test gave the ability that the numerical model was able to generate as well as absorbed the transmission waves which affected the performance of the floating structures. Another test had the case of the reproducing of the well kind of known experiment study from one of the researchers that represented the wave transform with the motion on the submerged bar (Kofoed, 2013.p420). This was as results of the highest kind of the linearity procedure of the wave transmitted as well energy that was exchanged when the performance of the floating structures was affected. This is the test which was used as the benchmark for the numerical model that was favorably used. In this kind of the research paper, then the Cartesian coordinated which were the x direction as well that was parallel to a given flume kind of the length was chosen. The y coordinate as well as the z coordinate were chosen as well that were parallel to the floating structure under study, this helped to give the remarks on all that was to be done basically to get the right way of dealing with the same. The origin was shown as indicated at the left side of the domain with the surface that was facing the impact of the transmission on the performance it was expected to do.

This part is all about the main methodology which was used in the research of the topic. It was able to give out the expected results asper the plans that were under study. All the given were focusing on all it takes to have the right manner to deal with what it takes to have the best. Thus, all that was doe is well given in the above chapter.

4. RESULTS

4.1 Introduction

This part gives all the results that were received after the study was done at the filed. After having the successful evaluation of all the irregular waves that had the impact on the performance of the floating structures is show in this chapter. Also the step for any person to take when coming across the given devices is easy for them to make a decision. Here all the relevant outcomes and the results which were expected from the beginning of the research are given here.

4.2 Discussion

The outcomes of the case which were tested from the study are given presented. From the first case of the study that was submerged, with the floating object. This was used to evaluate the case of the irregular object which impacted the performance of the floating objects. There was several of the wave transmission with deterrence's in the power energy that showed how the floating devices were affected. Their performance was not working on well, but from the analysis in as per the fort test, it was shown out that, it possible to have the devices managed to avoid the case of the floating structures being affected. The analysis was therefore valid and legible to be done in the manner which was reliable as a way of getting the results that were later presentable and also applicable. Another case which was tested was that one of the floating device that was full submerged (Babarit, A., and 2013. p70). This is the one that was used in studying the manner in which wave was transmitted along the given flume. It was kind of applicable in having the most applicable work done in the expected way as it will give out what it takes to give the results that were expected at the end of the whole work.

4.2.1 Half-submerged floating structure

The evaluating nature of the wave transmission as well as the wave transmission of the structures that are floating was the main concern of study under this particular section. The study also focused on the hydro-dynamics that was as well done in the manner that was giving out what it was expected. The wave kind of the reflection had the ratio which showed all it takes to meet the nature of the irregular waves and the effects they have on the floating structures.

4.2.2 Performance of the floating structures

Structures that float on water were as well affected by the irregular structures. The nature of performance of the floating structures will not as well give what it takes to meet the required solutions (Babarit, A., 2010.p720). In that connection, there is need to have some modifications done on the floating structures so that they can evade the irregular transmission waves which move at a terrific speed that at the end gives some bit of the challenges. The performance of the floating structure can be made effective if they are modified in the manner that will help avoid the waves which impact them in the manner that they operate.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter, some facts about the whole project will be concluded and some recommendations made on some sections. Here all that was done will be concluded while giving out what it takes to be meeting the required results. All this will have to be done as it will give the required detailed assumptions made and conclusion reached at.

5.2 Conclusions

The floating structures are quite suitable applicable on the deep waters that have the combination of the short waves. The wave transmission period is useful in having to determine the case on effectiveness of the breakwaters (Gironella, 2005.p25). This will again have to be concluded that the various experiments which were done as well as the numerical data which was obtained shows how the effectiveness nature of the structures are affected. To manage having the waves

that are attenuated and are not having any impact on the floating structures, the devices need to have the large kind of the width as well as the draft which is very draft.

The formulas that define the wave transmission come from the given structures that seem to be little bit deep in water. If all the given formulas are well compared with the other, then it will at the end be concluded that the linear given wave will easily be valid (Babarit, A., 2010.p720). The case of energy which has different and various connection on the same has the transmitted waves that are impacting the performance of the same devices. This brings some considering that needs to have the right way of dealing with the nature of performance of the same given work. This will be looking at how well the entire job can be done in future.

5.3 Recommendations

The researcher recommended conducting further researches to this study topic according to its importance and the rare existed studies in this field. Below is the list some following studies that can be conducted:

- To investigate anchoring system in terms of the wave transmission.
- To conduct a similar study with the aim of having also the calibration as well as the validation of the numerical method done
- To investigate this study model with the full spectrum and also wave transmissions checked on the irregular waves.

References

Babarit, A., 2010. Impact of long separating distances on the energy production of two interacting wave energy converters. *Ocean Engineering*, *37*(8-9), pp.718-729.

Babarit, A., 2010. Impact of long separating distances on the energy production of two interacting wave energy converters. *Ocean Engineering*, *37*(8-9), pp.718-729.

Babarit, A., 2013. On the park effect in arrays of oscillating wave energy converters. *Renewable Energy*, *58*, pp.68-78.

Beels, C., Troch, P., De Visch, K., Kofoed, J.P. and De Backer, G., 2010. Application of the time-dependent mild-slope equations for the simulation of wake effects in the lee of a farm of Wave Dragon wave energy converters. *Renewable Energy*, *35*(8), pp.1644-1661.

Drew, B., Plummer, A.R. and Sahinkaya, M.N., 2009. A review of wave energy converter technology.

Faltinsen, O., 1993. *Sea loads on ships and offshore structures* (Vol. 1). Cambridge university press.

Koutandos, E., Prinos, P. and Gironella, X., 2005. Floating breakwaters under regular and irregular wave forcing: reflection and transmission characteristics. *Journal of Hydraulic Research*, *43*(2), pp.174-188.

Yamamoto, T., 1981. Moored floating breakwater response to regular and irregular waves. *Applied Ocean Research*, *3*(1), pp.27-36.

Yu, Y.H. and Li, Y., 2013. Reynolds-Averaged Navier–Stokes simulation of the heave performance of a two-body floating-point absorber wave energy system. *Computers & Fluids*, *73*, pp.104-114.

Zanuttigh, B., Angelelli, E. and Kofoed, J.P., 2013. Effects of mooring systems on the performance of a wave activated body energy converter. *Renewable energy*, *57*, pp.422-431.