WAMIT-MOSES Hydrodynamic Analysis Comparison Study

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Summary

The global motion analysis and related installation procedures are very important tasks for floating offshore platforms. As new deep-water oil and gas production systems such as a SPAR, FPSO and TLP are introduced these tasks have become more important since the performance of these floating platforms might be decided by them. For the global motion analysis WAMIT is the most widely used and well-proven 3-D diffraction and radiation computer program in the frequency domain. For the combined work such as a global motion analysis, installation simulation and fatigue analysis MOSES may be the most popular computer program in this area. Since MOSES has the same 3-D diffraction and radiation computer module one may use it as the tool for the global motion analysis. However, it may be necessary to examine the software performance before applying it to the floating production platforms.

In this study the hydrodynamic analysis using MOSES and WAMIT were carried out to investigate the performance of the two computer programs. Five models which can represent most of the floating platforms currently installed or under development were selected and the results were compared for a wide range of wave periods and wave heading angles.

The mathematical formulation and theoretical background for the two computer programs can be found in Ref [1] and Ref [2] or http://www.wamit.com and http://www.ultramarine.com.

1. Introduction

The use of MOSES to analyze the global motion and related installation procedures for floating platforms has increased since installation engineering and related work has become more complicated as new hull forms are introduced.

The object of this study is to compare the hydrodynamic analysis results from MOSES and WAMIT. WAMIT is the most widely used 3-D computer program for the diffraction and radiation problem and is a well-proven computer program. MOSES also has the same capability and since both programs use conventional 3-D constant panel method and mathematical formulation one should have the same results. However, MOSES results have never been systematically compared with WAMIT results. In order to compare the results one must choose various offshore floating structures and a wide range of wave periods. Different wave heading angles should also be considered to investigate the performance of both programs.

In this study two simple geometries (rectangular box and vertical cylinder) and three offshore floating structures (ship, TLP, semi-submersible) are chosen with the proper number of panels. These five models can represent or simulate most offshore floating structures currently installed or under development such as a FPSO, SPAR, TLP and Semi-submersible.
Using MOSES and WAMIT, added mass and damping coefficients, wave exciting forces and moments and motions were calculated for the wide range of wave periods and heading angles.

The version of each program used in this study was WAMIT 5.4PC and MOSES 5.09.027

2. Test Models

In order to compare the effectiveness of the programs, five models were selected to cover most of the floating structures used for oil and gas production. By selecting the rectangular box, vertical cylinder, general ship form, TLP and semi-submersible type of structures one can examine the performance of the two computer programs for most floating structures currently installed or under development. For example, the box can represent a FPSO or Tanker that has a large block coefficient and the vertical cylinder can be regarded as a simplified SPAR platform. The TLP and MOB can represent a typical semi-submersible. The following table shows the basic dimension and characteristics of the five selected models, which were used in the numerical calculations.

TYPE	Length (meter)	Beam or Diameter (meter)	Draft (meter)	Displacement (Metric-Tons)	Center of Gravity (KG)	Number of Panels
Box	200.0	40.0	28.0	229,645.0	28.0	1264
Cylinder	200.0	40.0	200.0	256,011.0	200.0	1120
Ship	275.4	27.7	9.6	43,698.0	13.9	430
TLP	51.6	51.6	35.0	52,761.0	35.0	512
MOB	260.0	138.0	39.0	328,894.0	26.9	1120

Table 2.1 Geometry and number of panels

The three-dimensional mesh for each model used for both methods is shown in Figures 2.1-2.5.

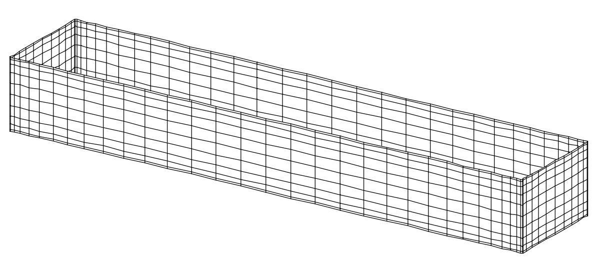


Figure 2.1 Simple box

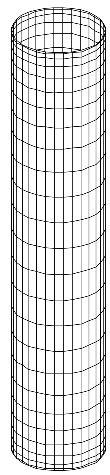


Figure 2.2 Simple Vertical cylinder

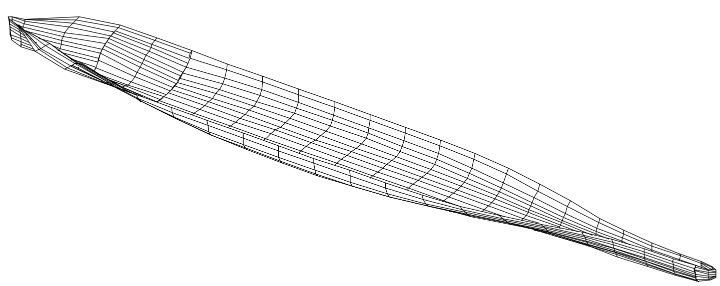


Figure 2.2 General ship form

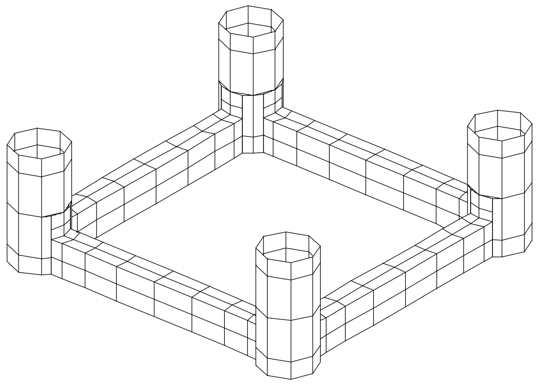


Figure 2.3 TLP

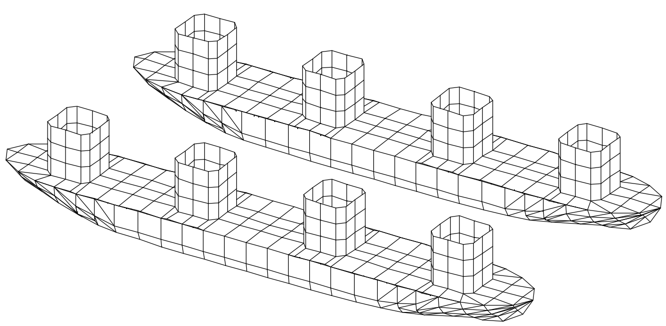


Figure 2.4 Semi-Submersible (MOB)

The nodal and panel input data used for both programs (WAMIT and MOSES) is actually the same since all MOSES geometry files were directly converted from WAMIT's geometry input files. Since definition of the normal vector on the panel for the two programs is different, care must be taken when converting the WAMIT geometry file to MOSES. By using the same number of panels and geometry more consistent comparison between the two programs is achieved.
The wave periods used in the numerical calculation were selected from 4 seconds to 42 seconds (total 20 periods by increments of 2 seconds) which covers a wide range of waves. Three wave-heading angles (head, quartering, and beam) were also studied.

3. Results and Discussion

Hydrodynamic coefficients (added mass and damping coefficients), wave exciting forces and all motion response amplitude (RAO) were extracted and compared from both numerical outputs. All outputs are normalized by mass, frequency and wave amplitude. Table 3.1 shows the normalization of each parameter. All units are based on the metric system.

Resulting components	**Units**	**Normalized variable**
Added mass coefficient	Mass	A_{ij}/Mass
Damping coefficient	Mass/Time	SQRT(B_{ij}/Mass)
Wave exciting forces	Tons	Tons/A
Wave exciting moments	Tons*Meter	Tons*Meter/A
Linear motion RAO	Meter	Meter/A
Angular motion RAO	Degree	Degree/A

* A : Wave amplitude

Table 3.1 Normalization

Hydrodynamic coefficients, wave exciting forces and motion RAOs for 45 degree wave heading are plotted in Figures 3.1-3.20. Although the other two wave direction computations were completed, the results are not presented here.

For all five models, results show very good agreement between two programss. This was expected since both programs use the same constant panel method.
From this study the following statements can be made.

1. Results show very good agreement between the two computer programs.
2. For the magnitude near the resonance period, there are some differences. These differences near the resonance wave period are known to be normal for the different numerical methods. Near the resonance period the RAO calculation is very sensitive so that the small numerical difference can cause relatively large differences. According to the results from this study the

differences are not that significant for the simple geometry like box, cylinder, ship and TLP. But complicate geometry like MOB has more pronounced difference than the simple geometry.

3. Both programs give very effective computing time when a moderate number of panels are used. But WAMIT is more effective in the computing time when one uses the symmetry option.

From this study we can conclude that the MOSES 3-D diffraction code can be used as a hydrodynamic analysis tool. The comparison with WAMIT, which is a widely used and well-proven code, shows good agreement. As a further study, it is suggested to use larger number of panels for both programs to get more accurate results.

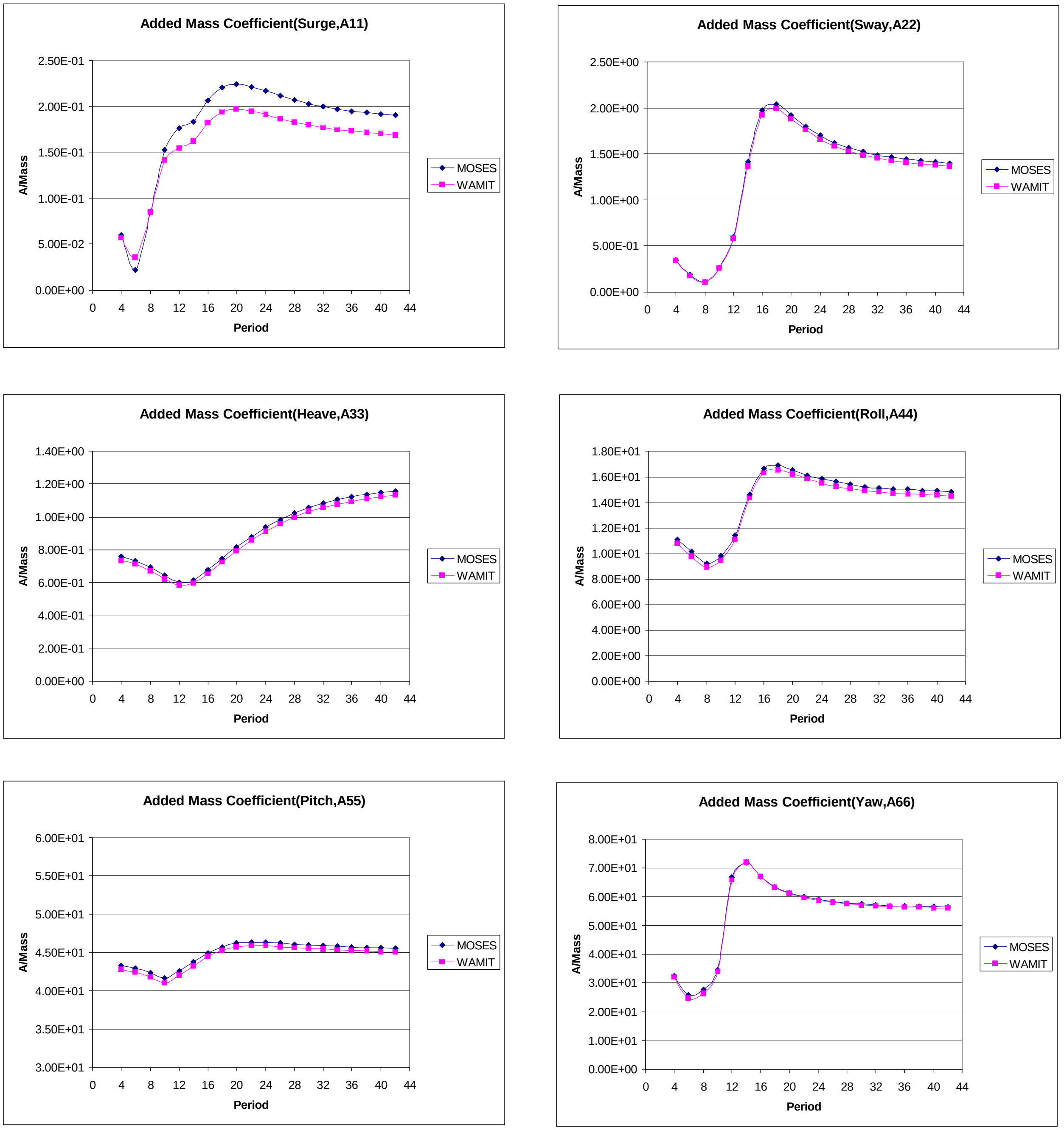


Figure 3.1 Added Mass Coefficients for BOX

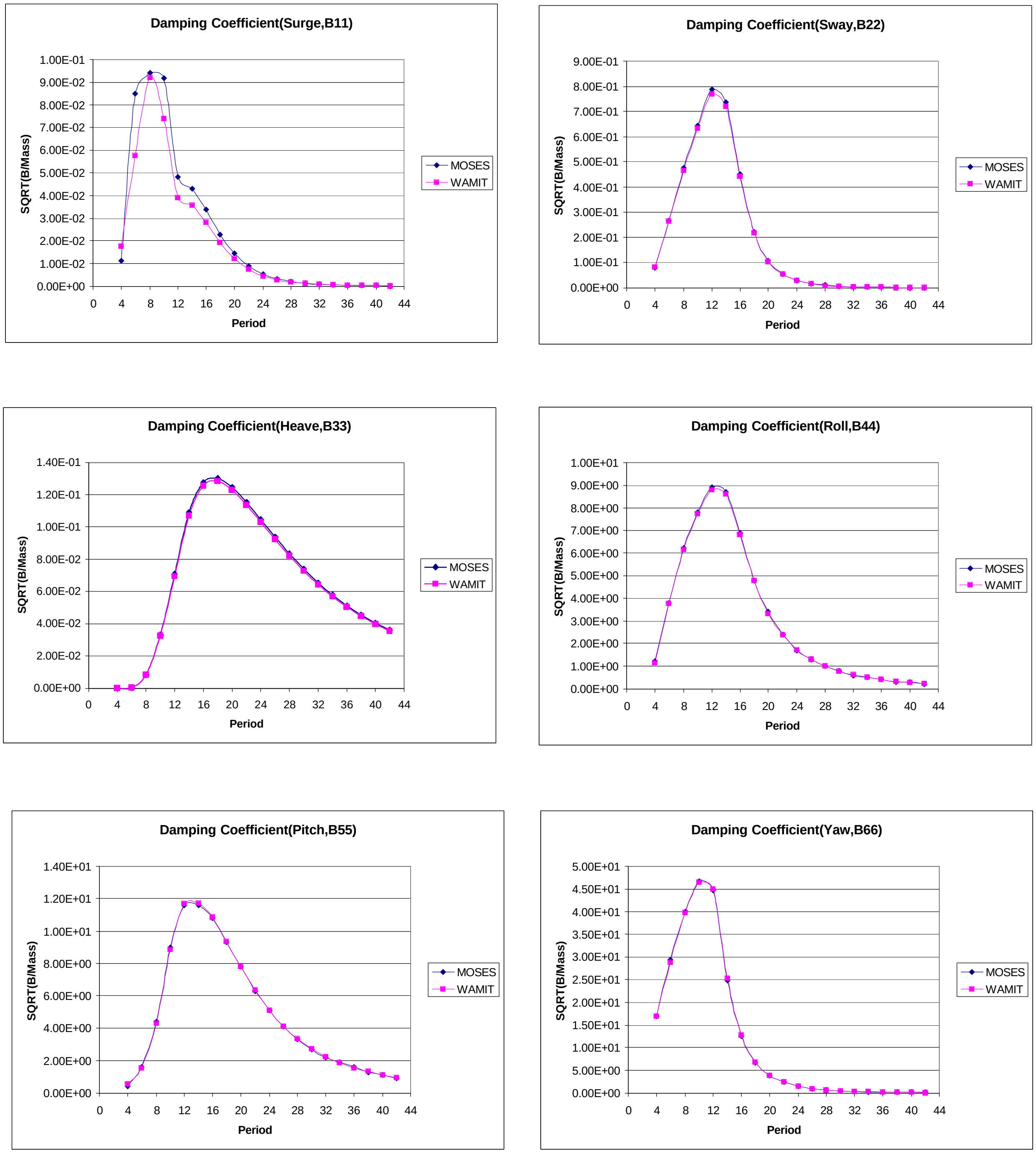


Figure 3.2 Damping Coefficients for BOX

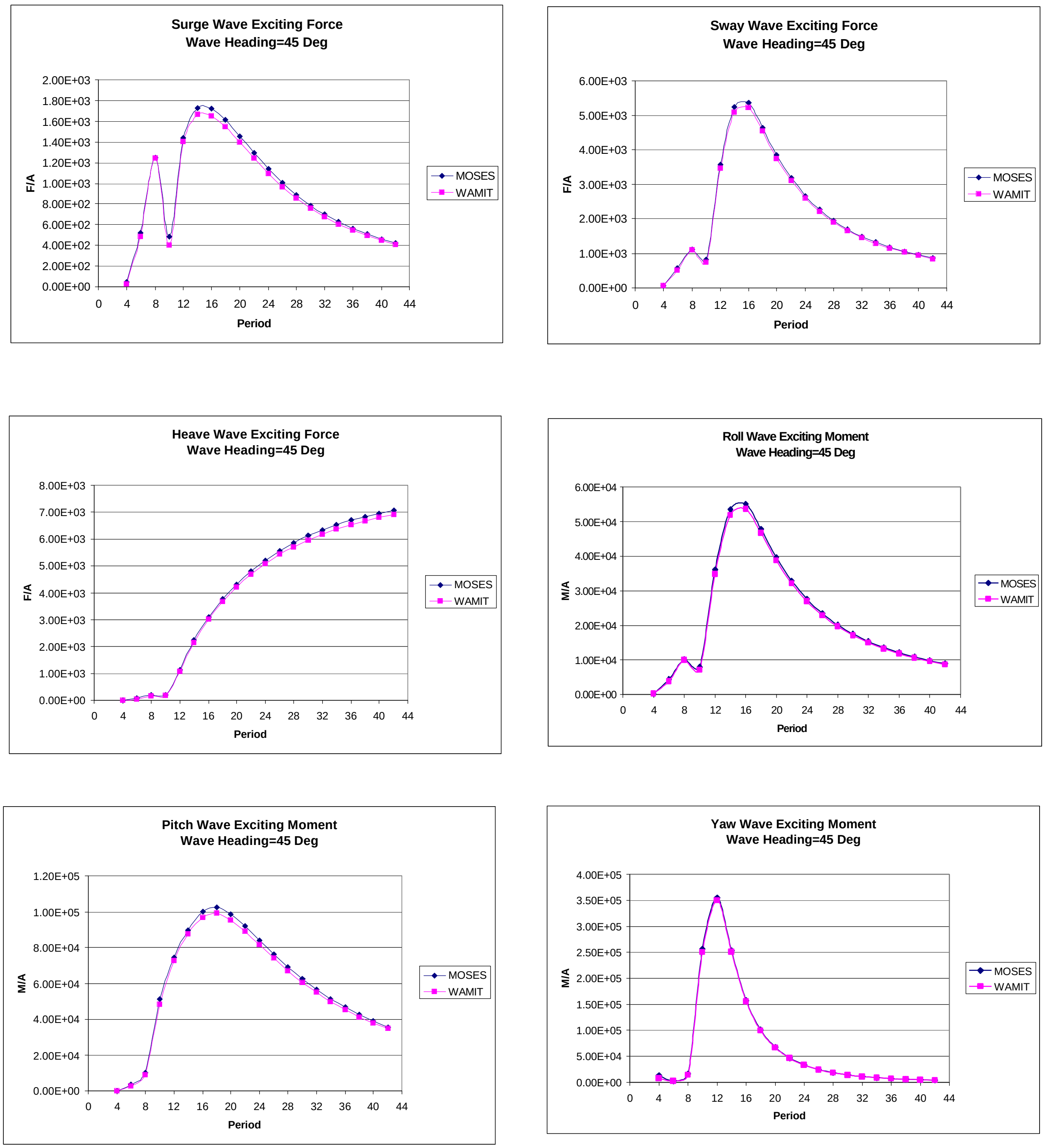
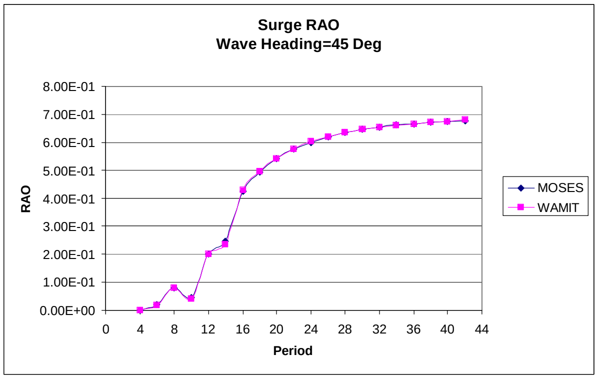
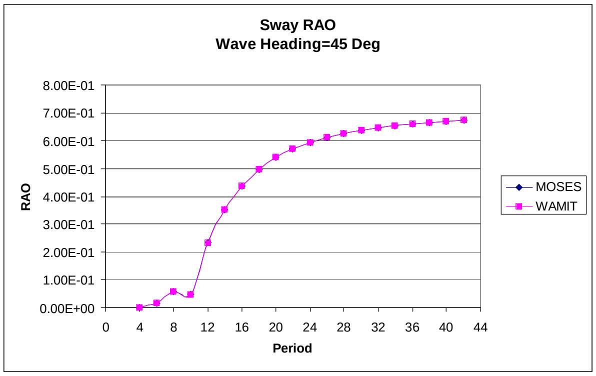
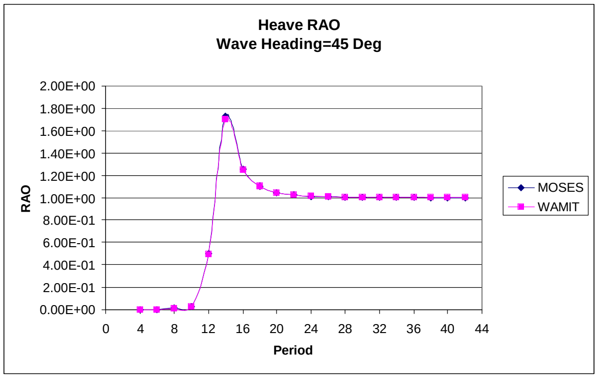
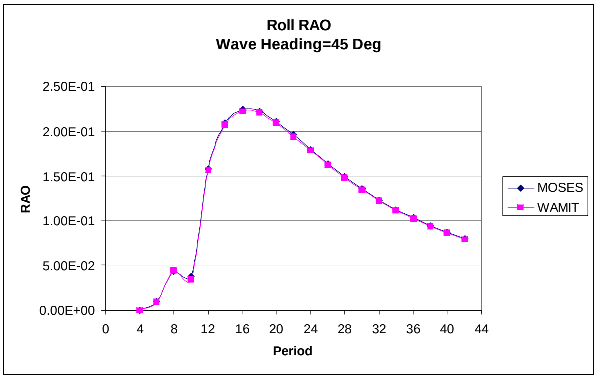


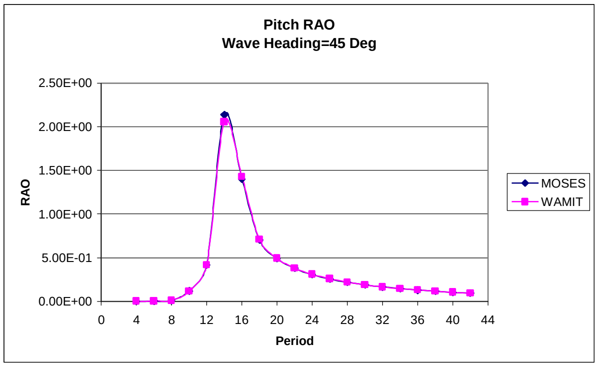
Figure 3.3 Wave exciting forces and moments for BOX











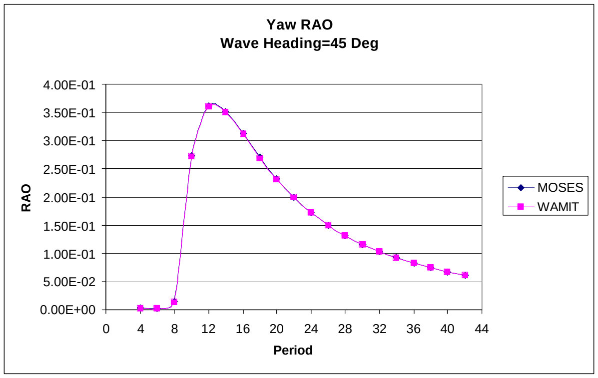


Figure 3.4 Motion RAO for BOX

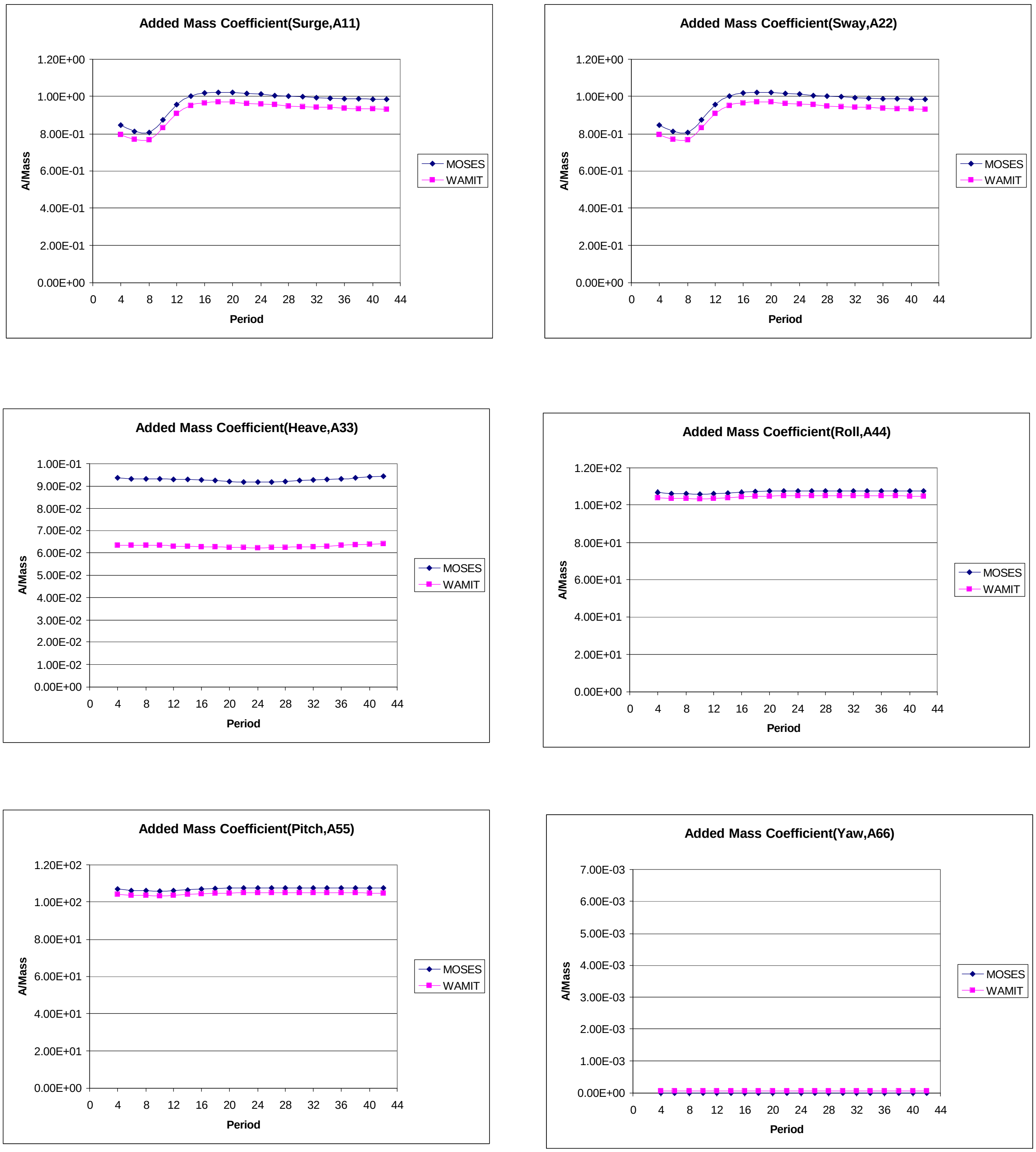


Figure 3.5 Added Mass Coefficients for CYLINDER

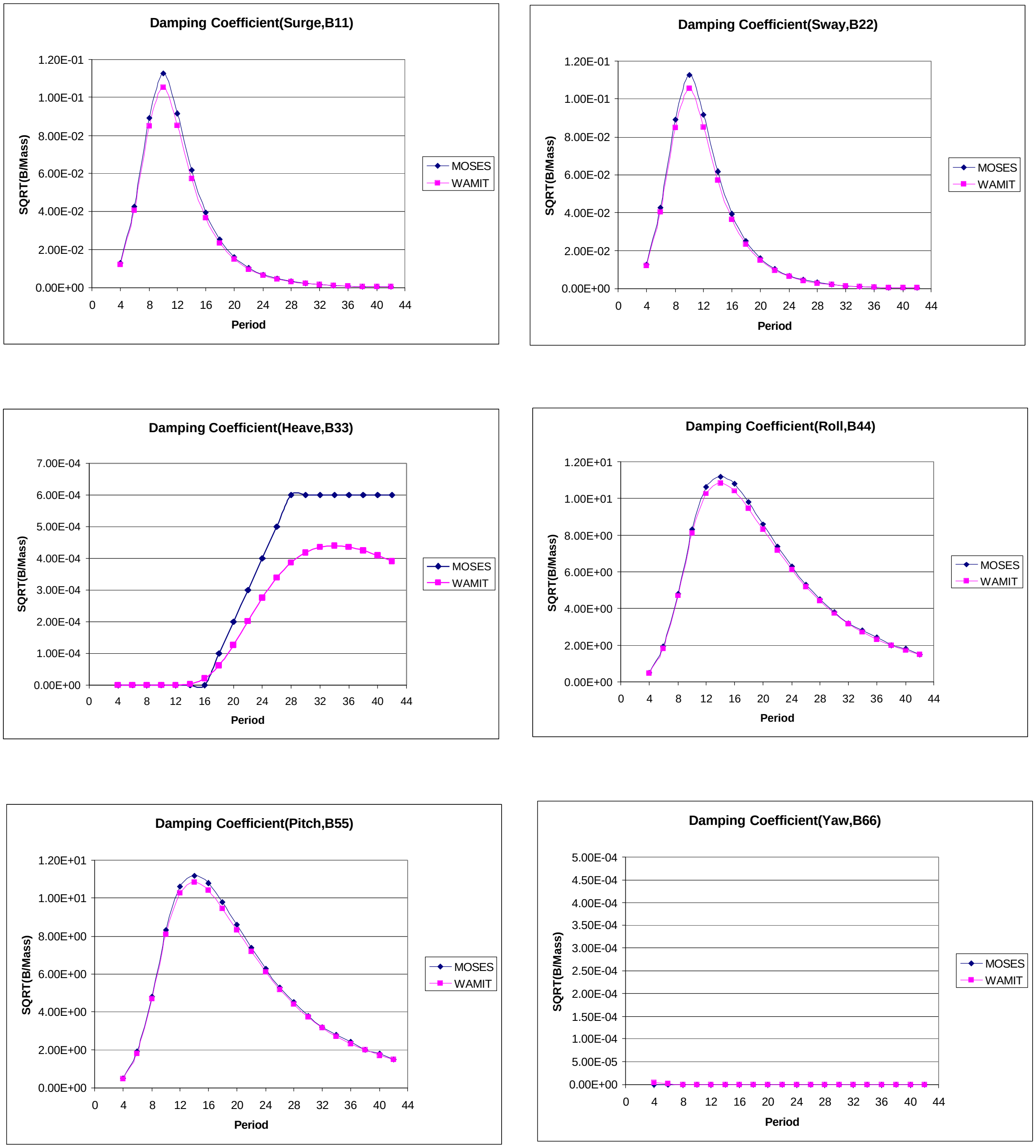


Figure 3.6 Damping Coefficients for CYLINDER

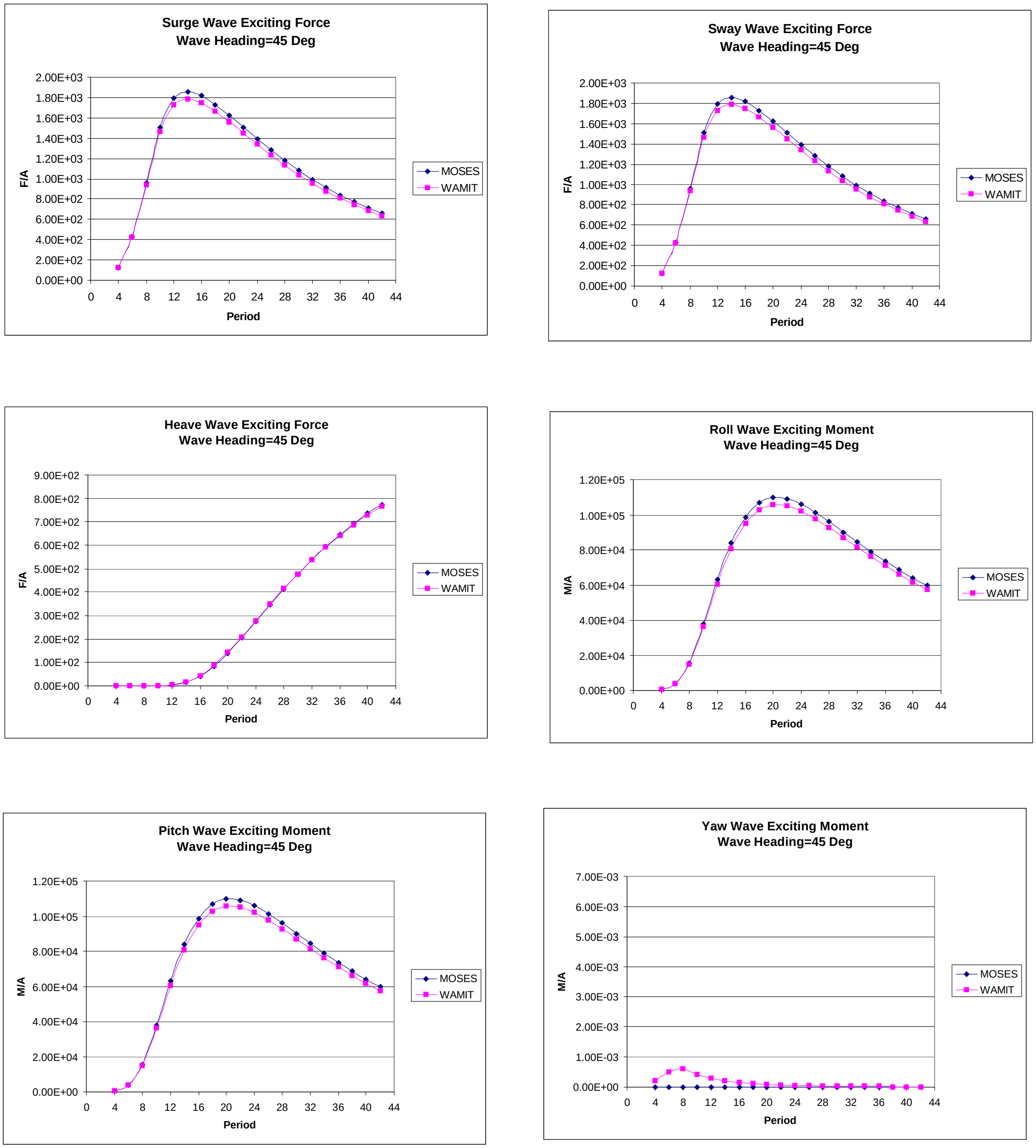


Figure 3.7 Wave exciting forces and moments for CYLINDER

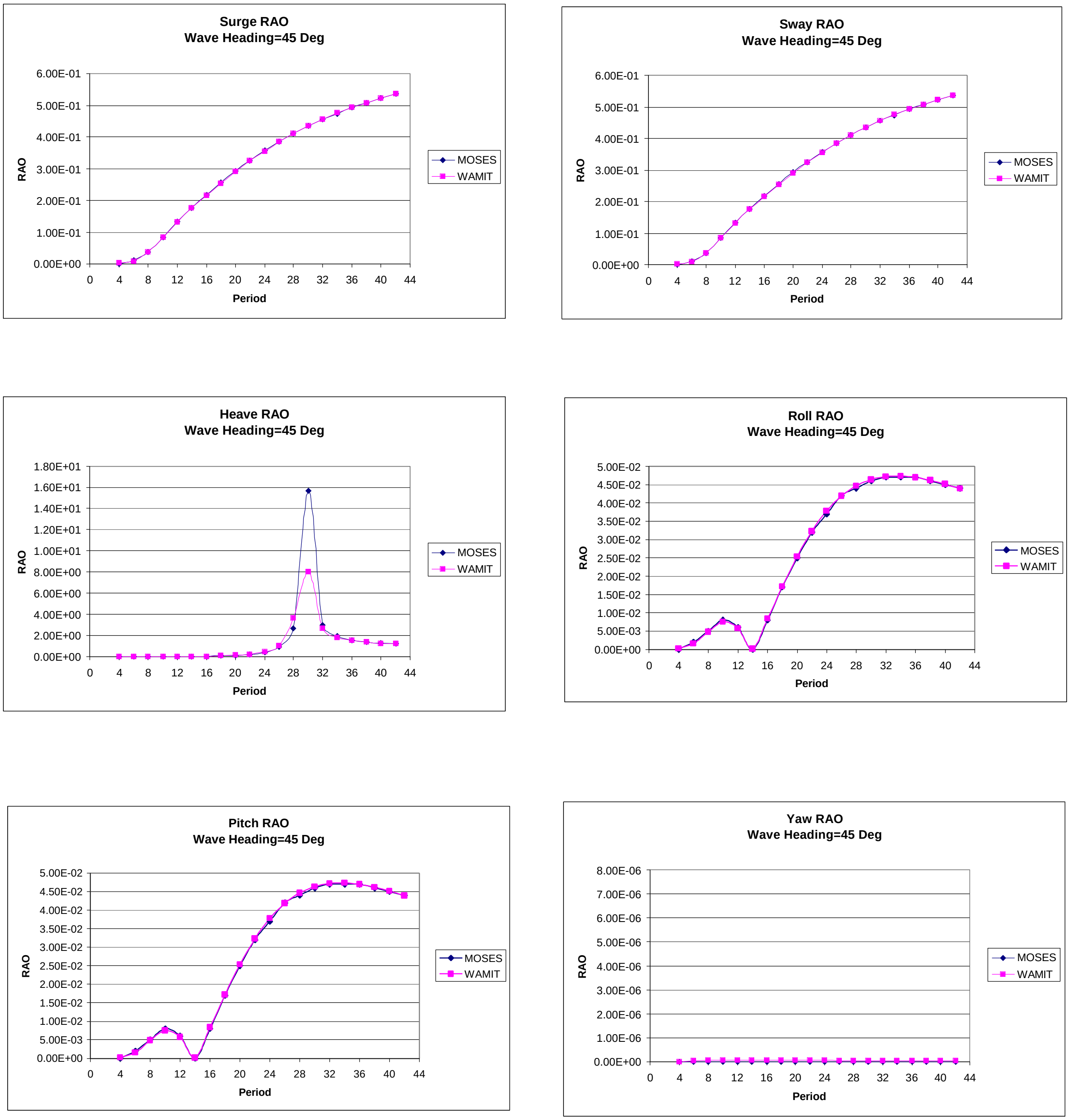
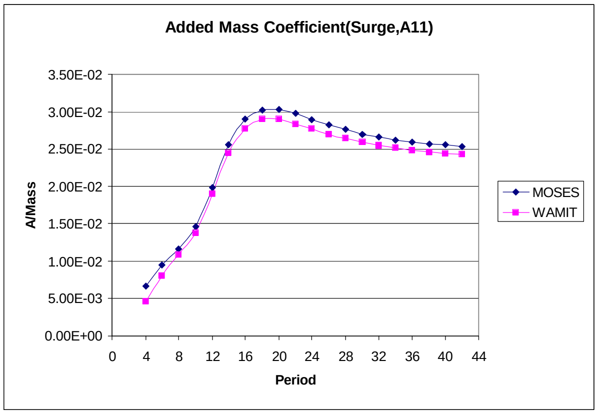
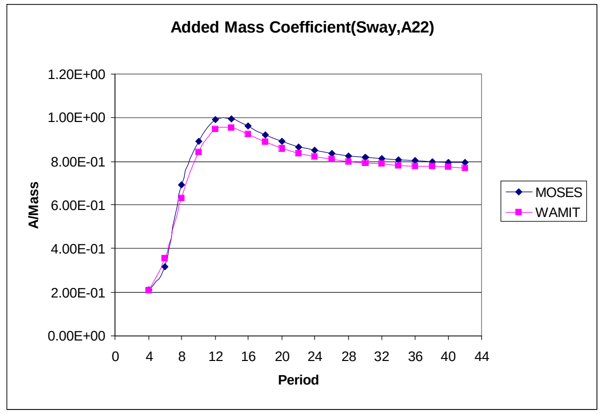
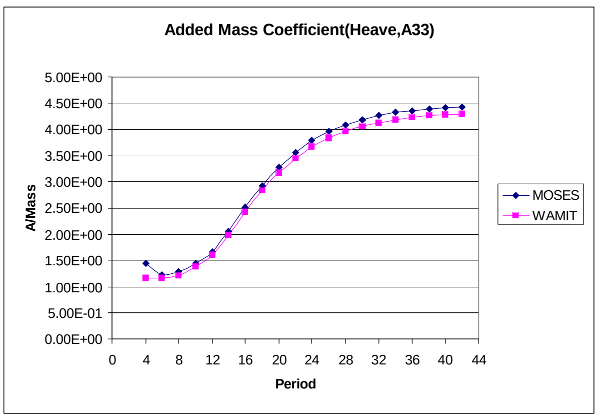
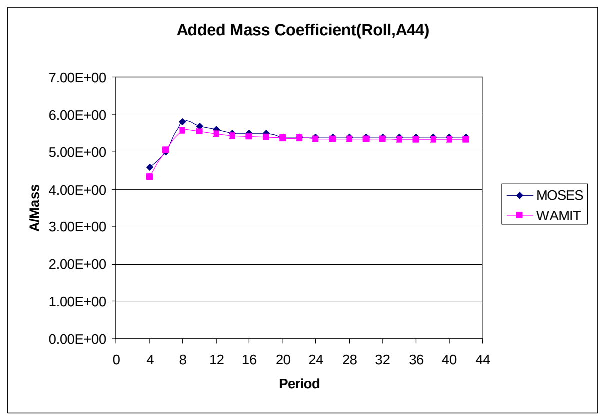


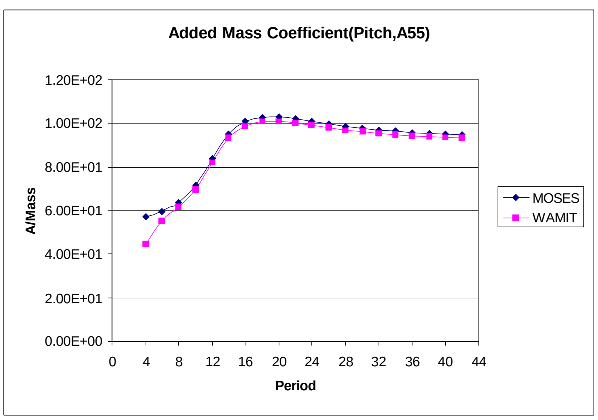
Figure 3.8 Motion RAO for CYLINDER











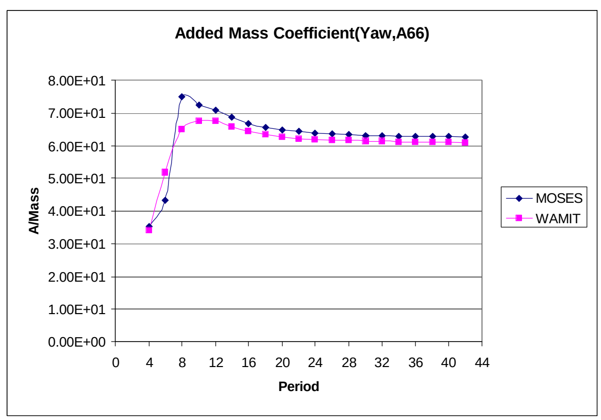


Figure 3.9 Added mass coefficients for SHIP

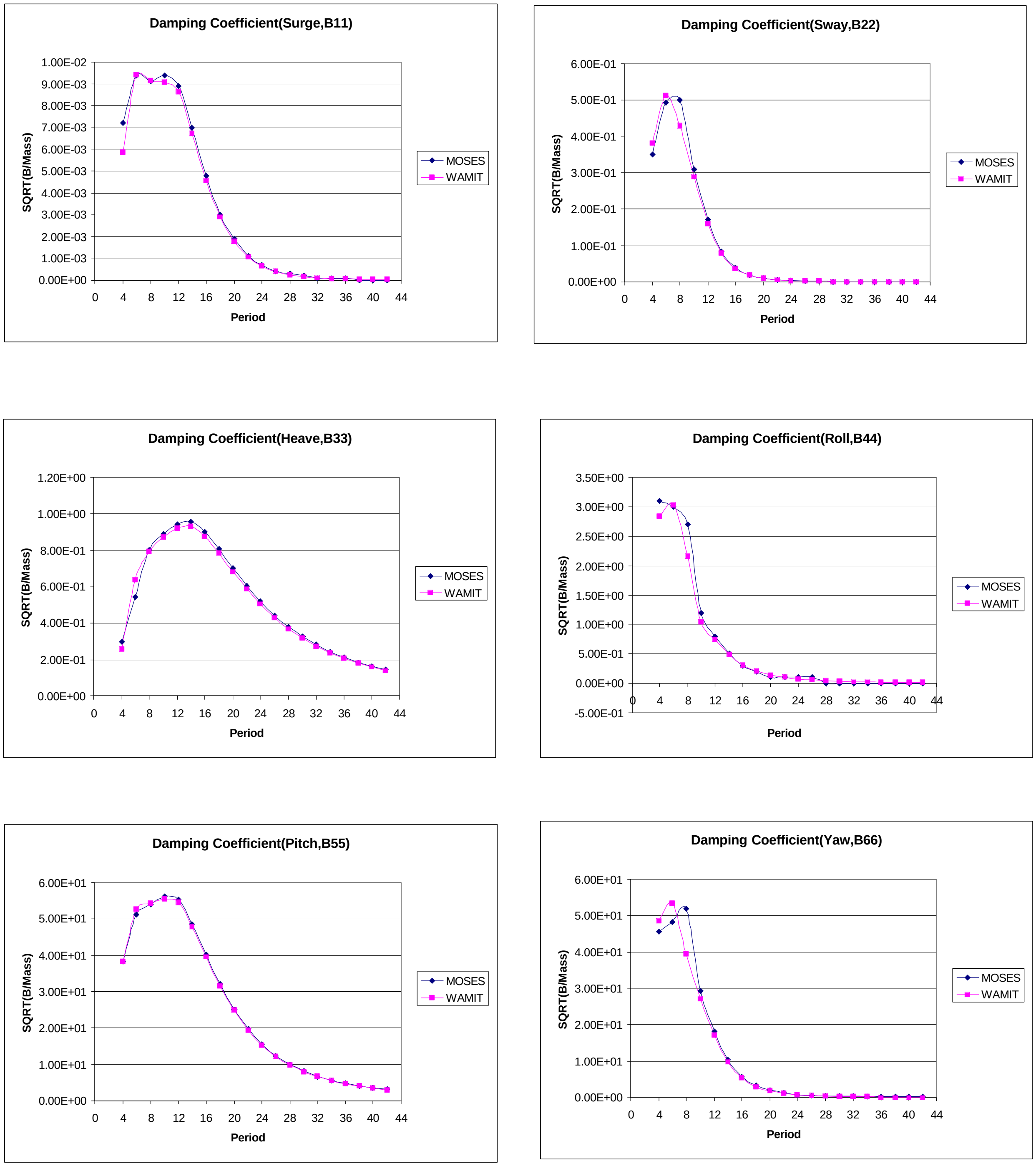


Figure 3.10 Damping coefficients for SHIP

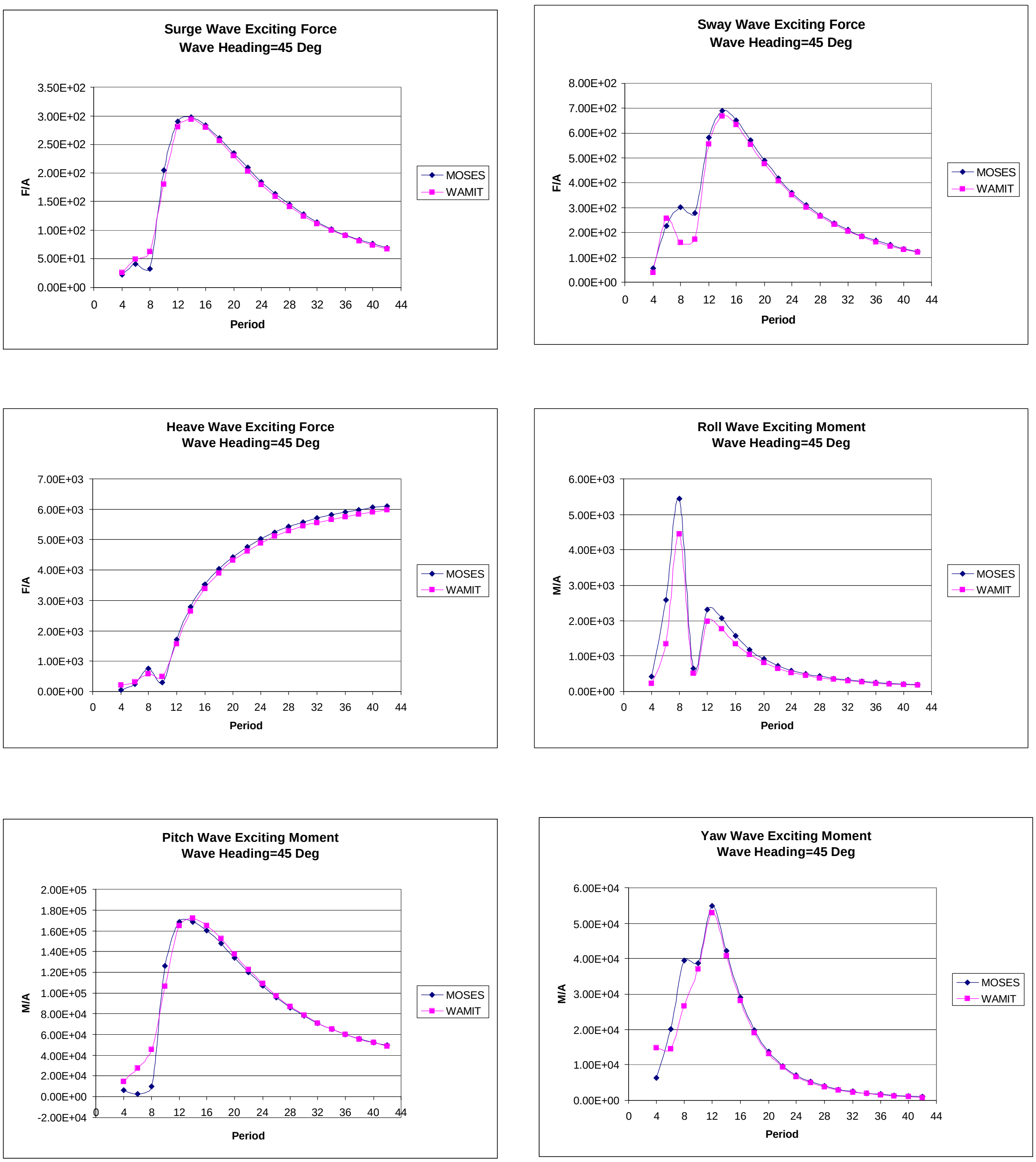


Figure 3.11 Wave exciting forces and moments for SHIP

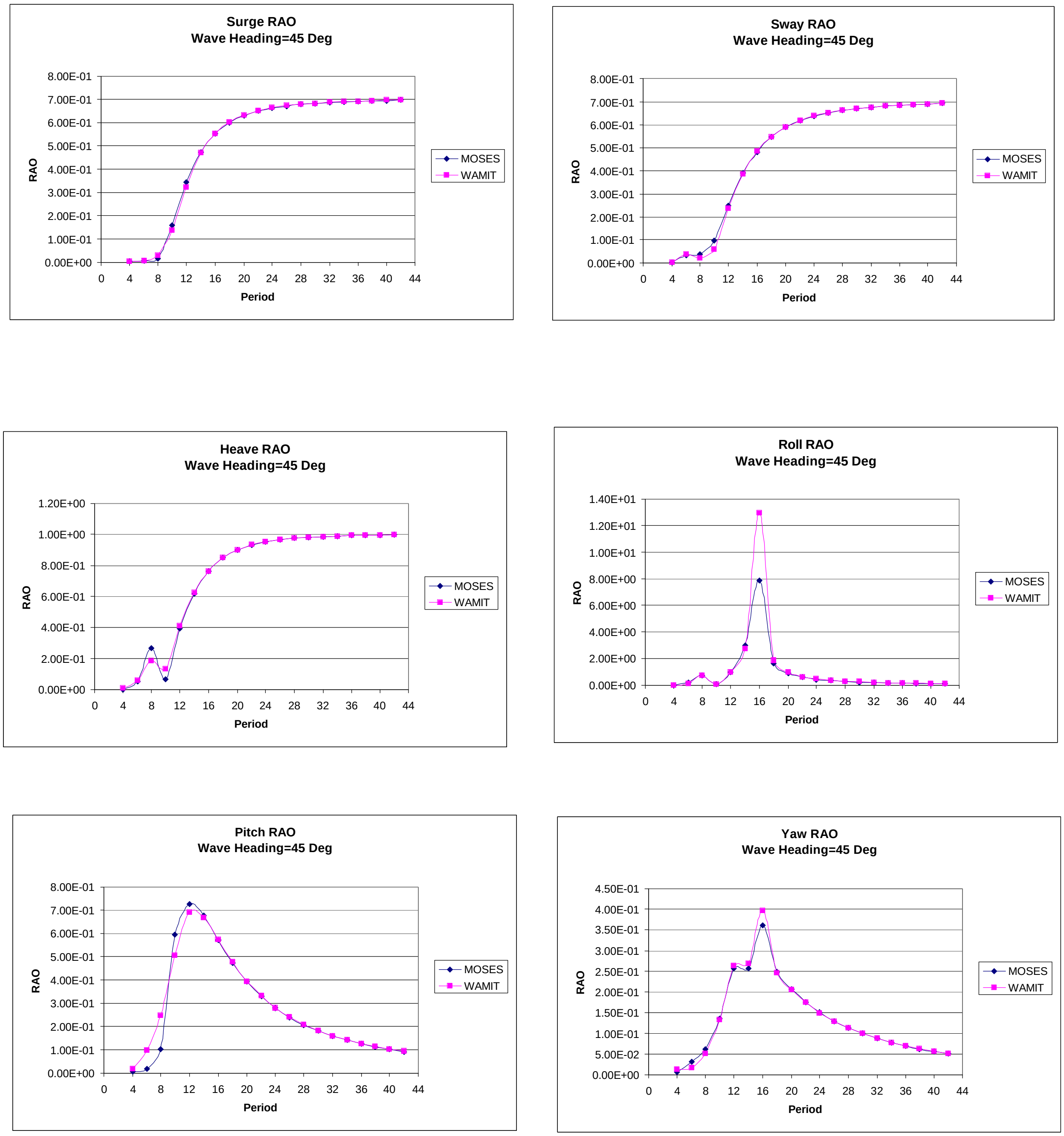


Figure 3.12 Motion RAO for SHIP

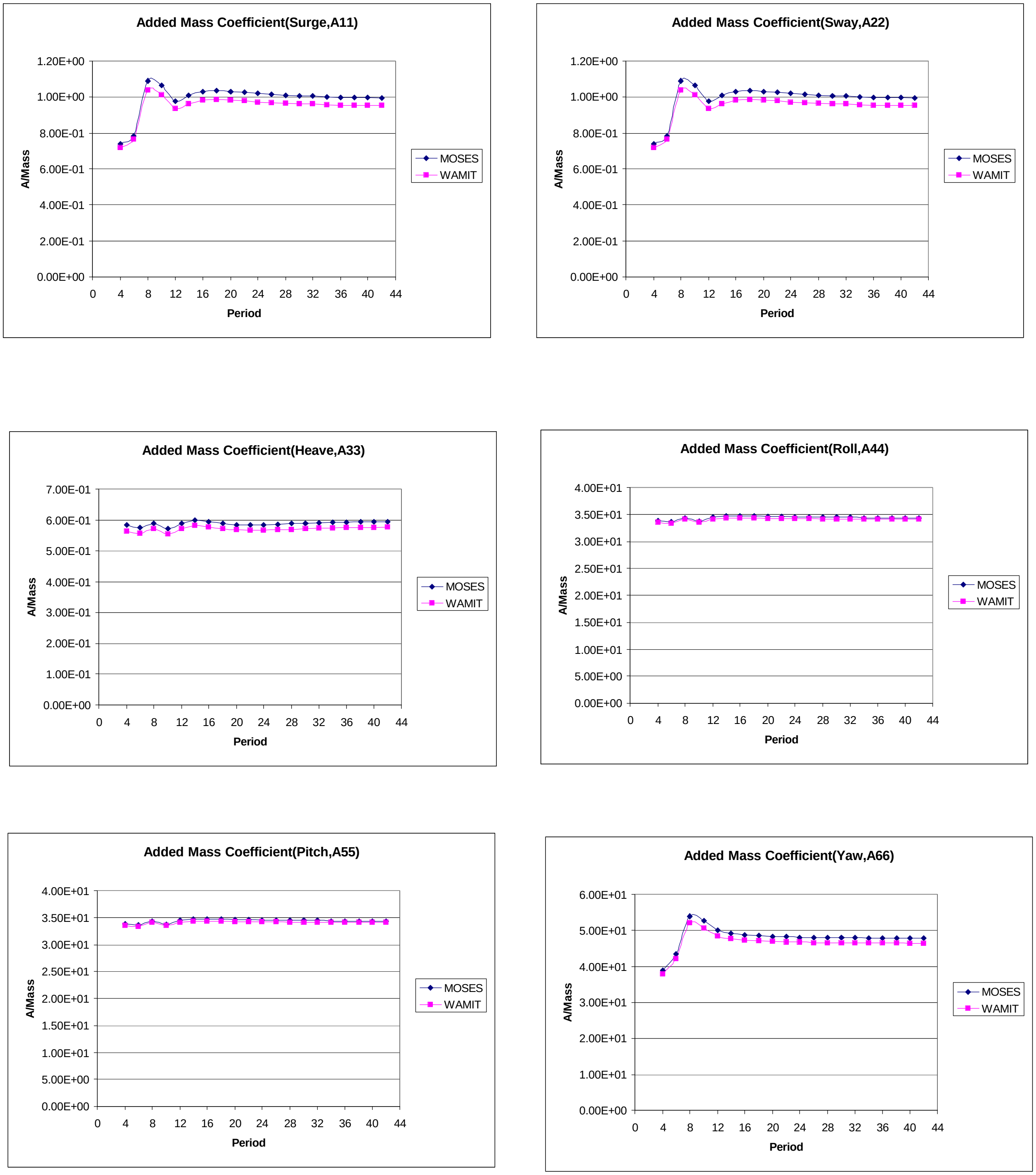


Figure 3.13 Added mass coefficients for TLP

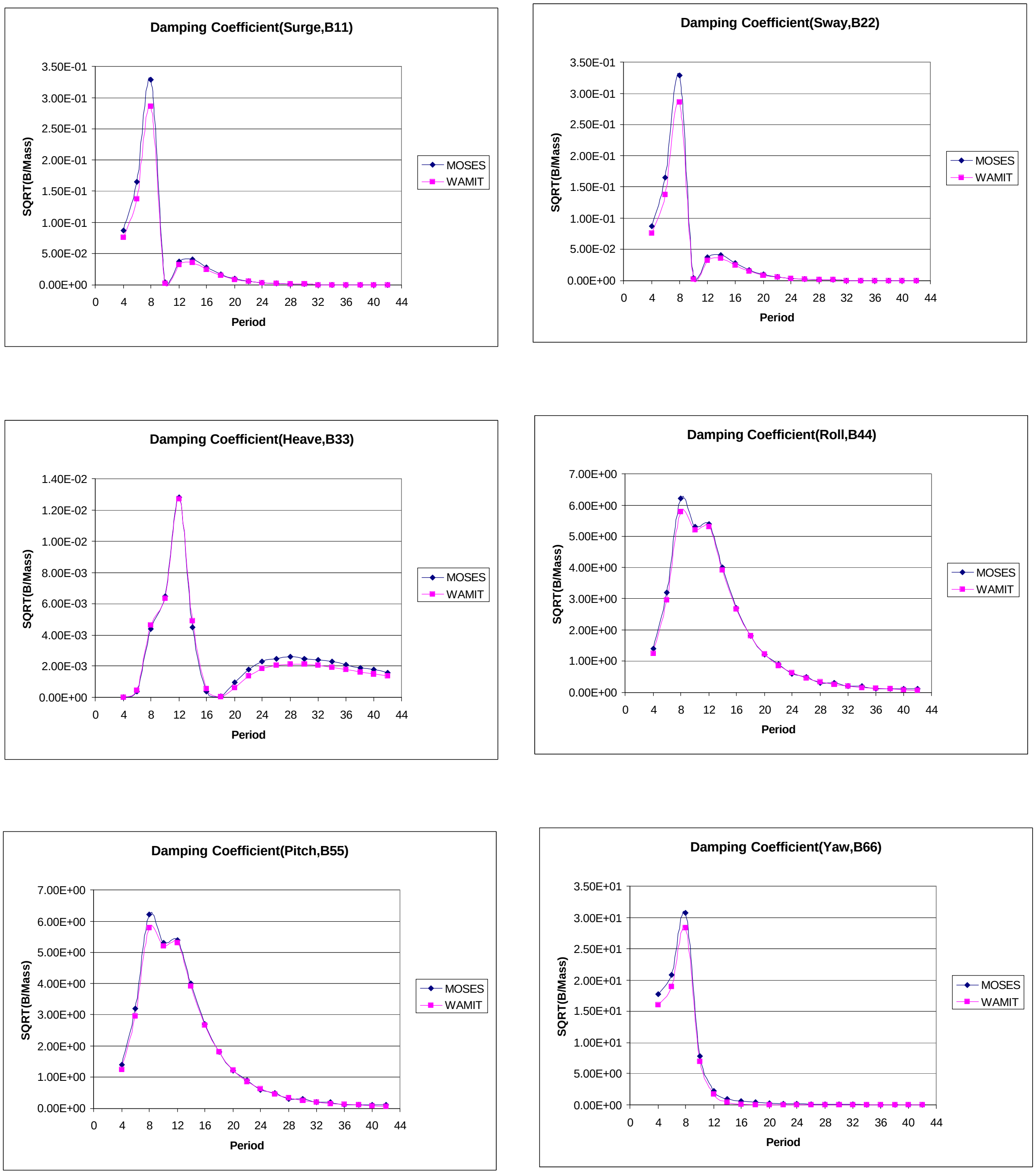


Figure 3.14 Damping coefficients for TLP

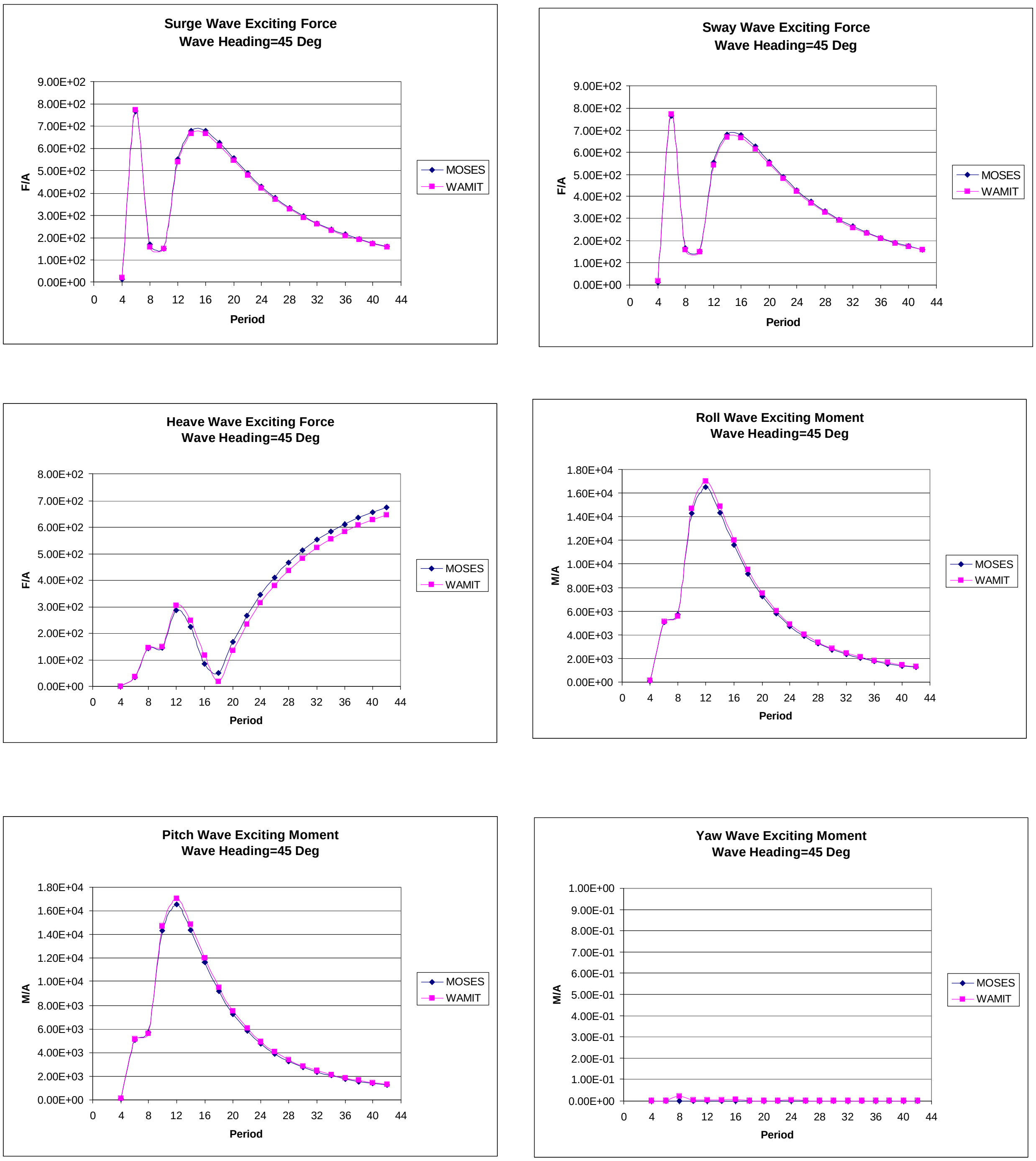


Figure 3.15 Wave exciting forces and moments for TLP

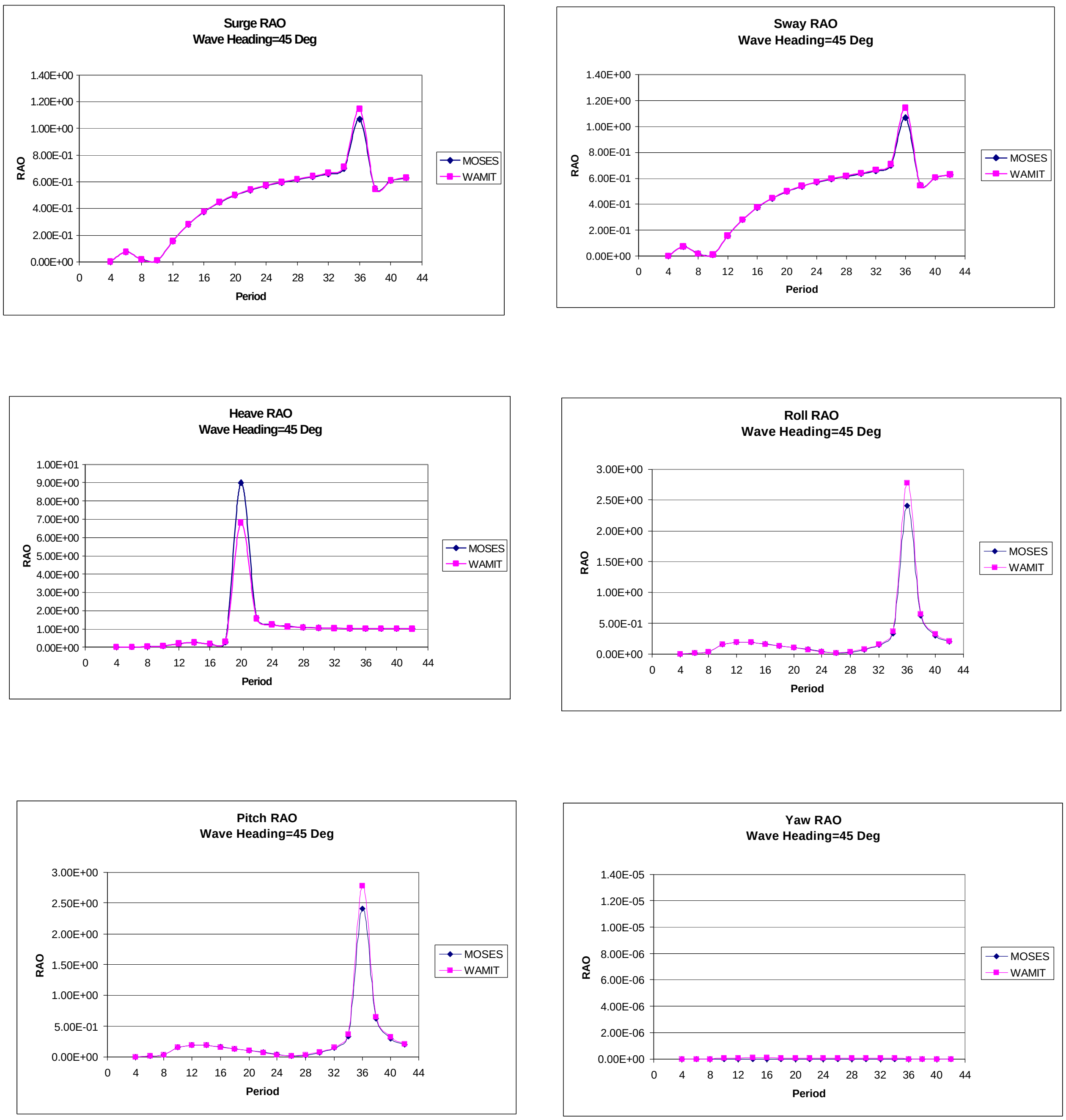


Figure 3.16 Motion RAO for TLP

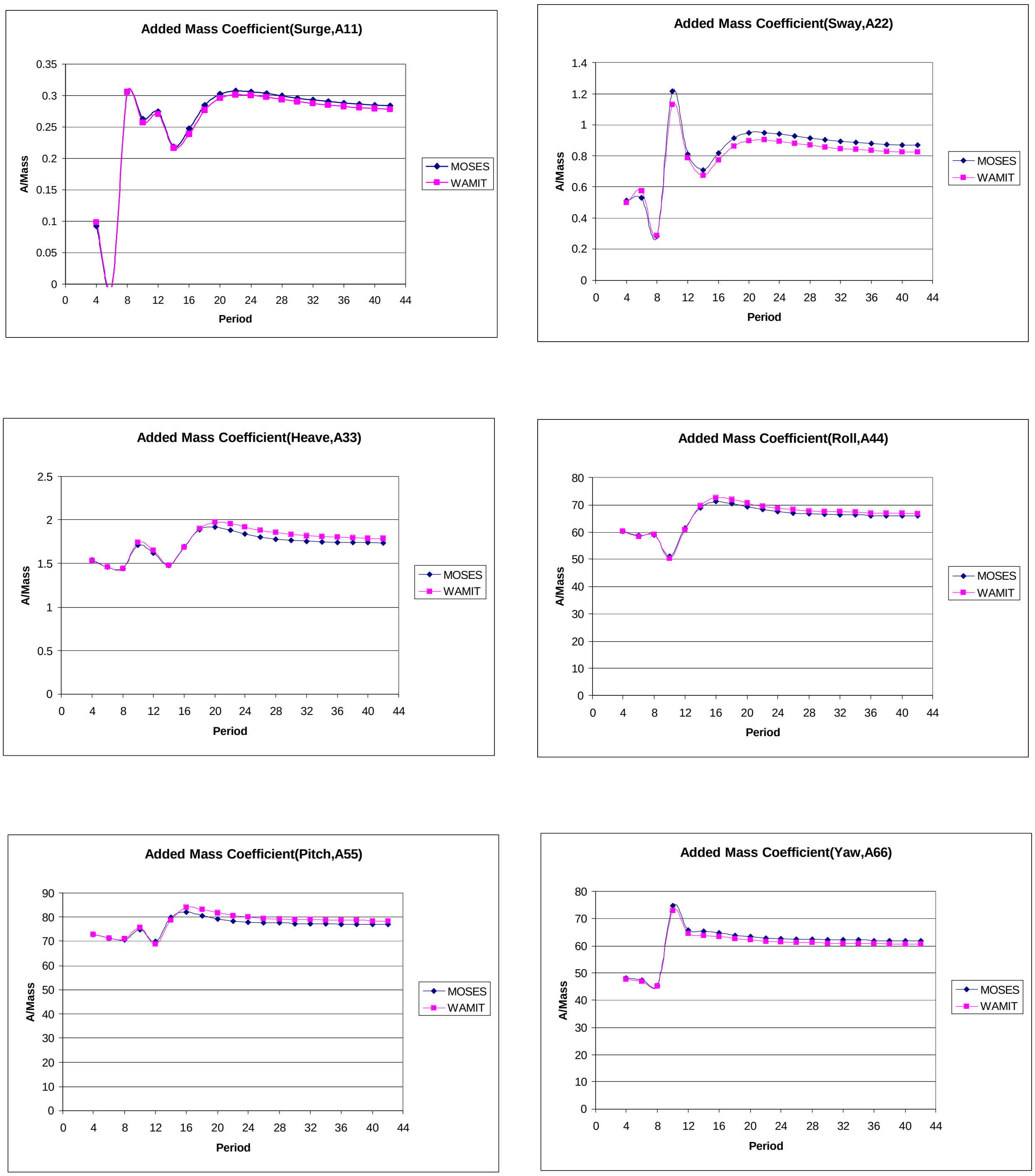


Figure 3.17 Added mass coefficients for MOB

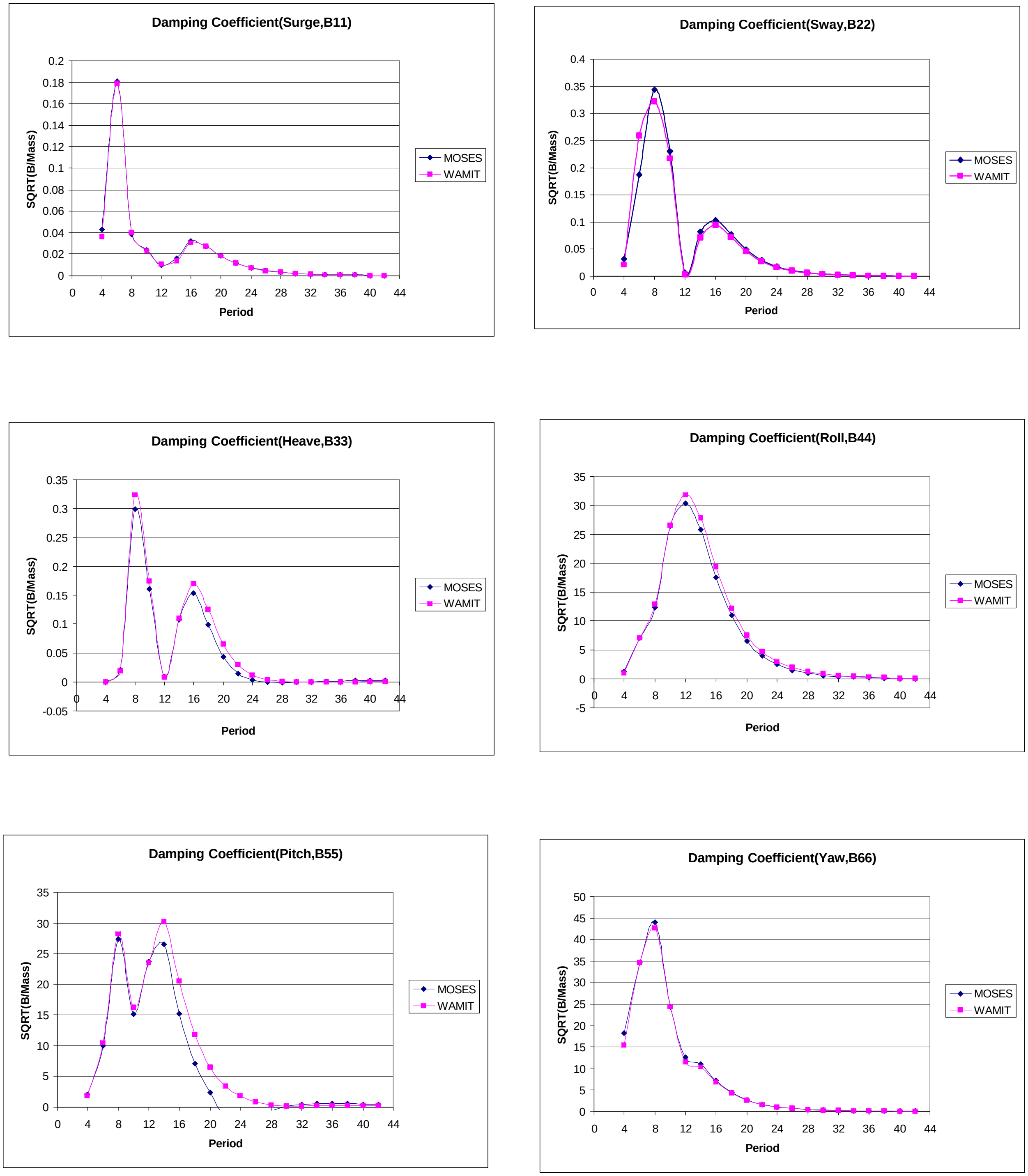


Figure 3.18 Damping coefficients for MOB

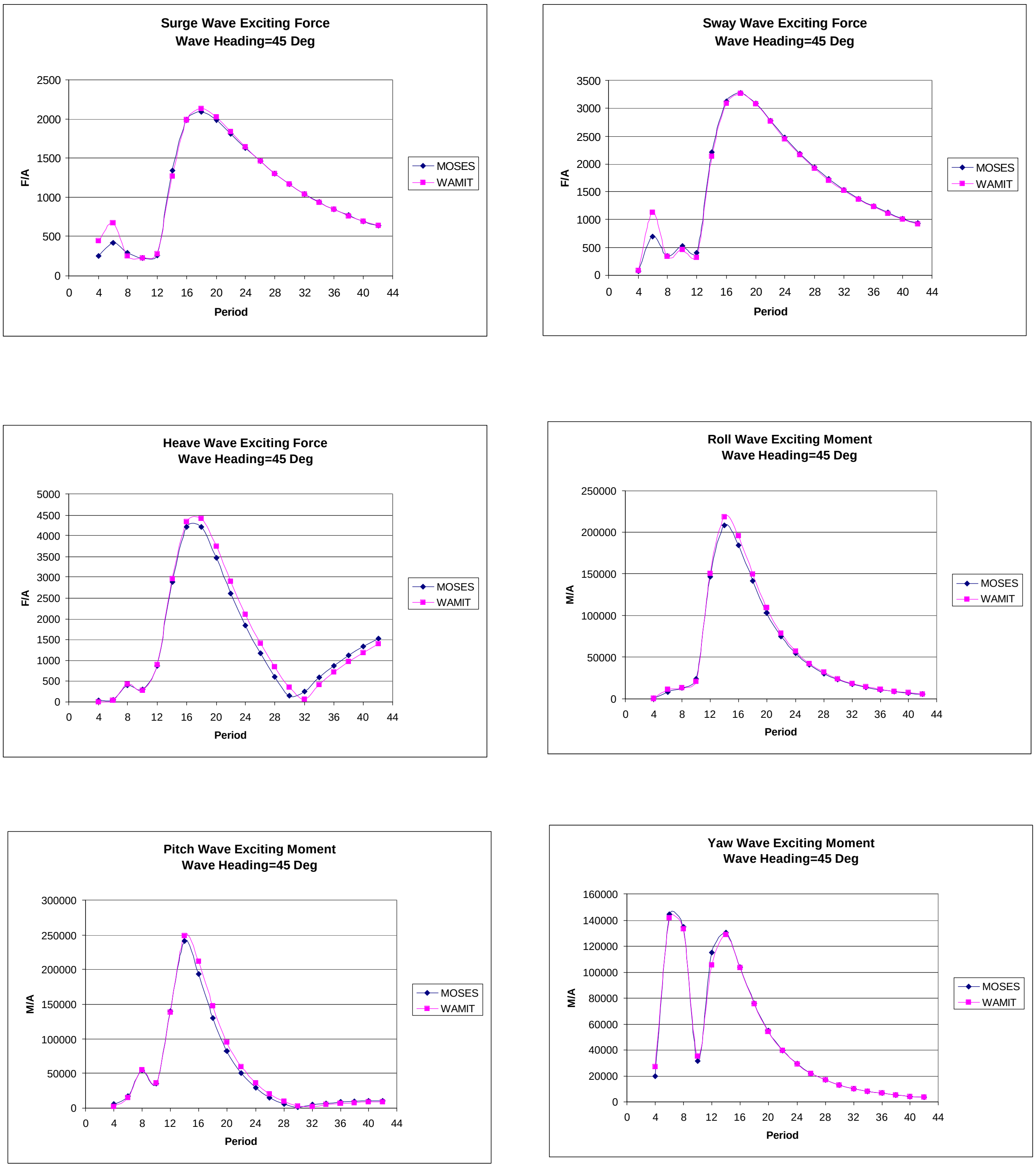


Figure 3.19 Wave exciting forces and moments for MOB

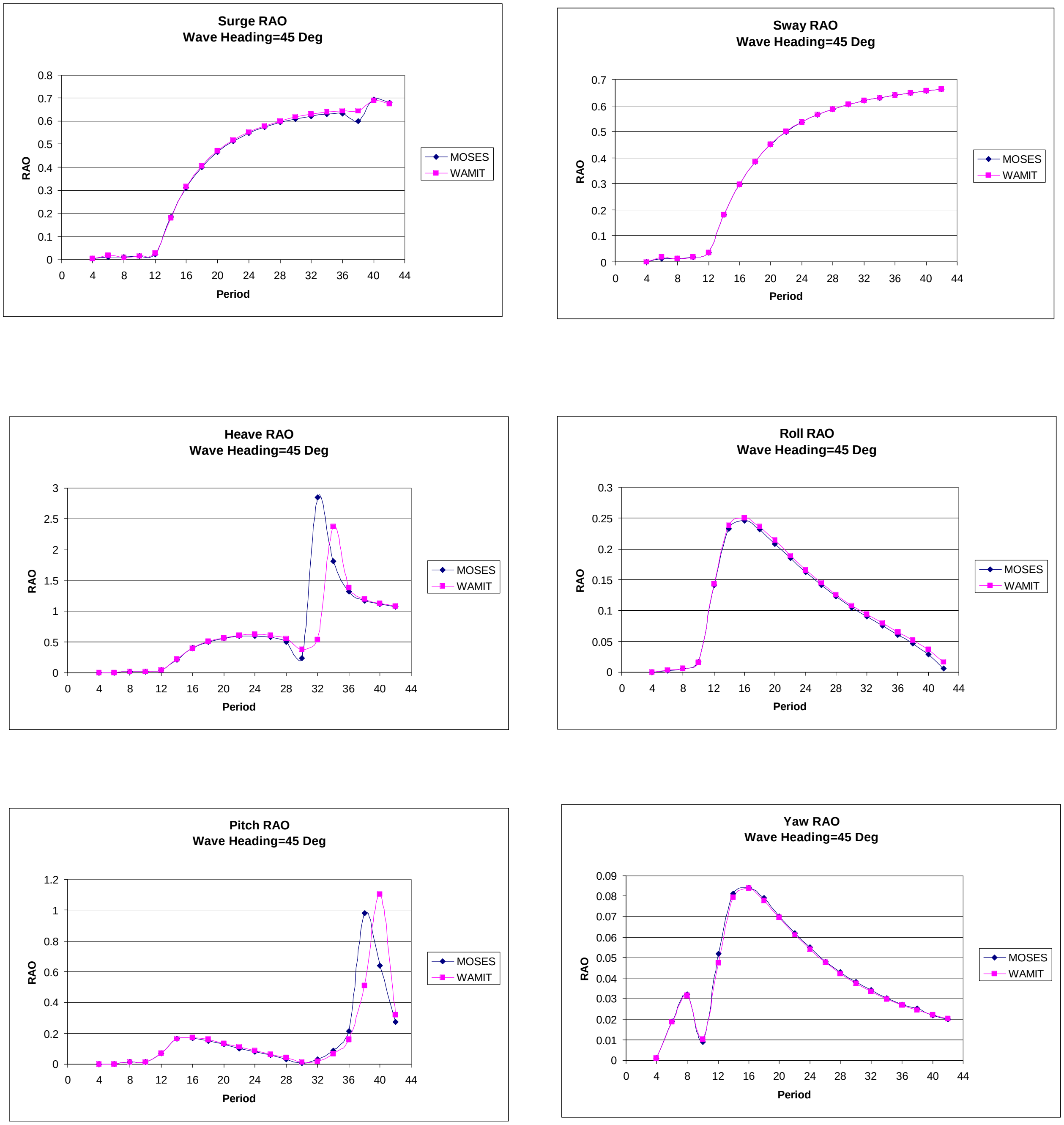


Figure 3.20 Motion RAO for MOB

4. References

1. WAMIT Version5.4 : A Radiation –Diffraction Panel program for Wave-Body Interaction , MIT, 1998.
2. MOSES Version 5.09.027 Reference Manual, Ultra Marine, 1999.