SESAM EXAMPLE

Jacket Earthquake Analysis

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1 Introduction

This example shows how to do a jacket earthquake analysis in Sesam. It is a subset, with some changes, of the example named ‘Comprehensive Analysis of Jacket’ and for this reason the model is superelement 7 and not the customary 1. The model shown in **Figure 1-1** below. The example is based on units kN and m.

The earthquake analysis is controlled by Sesam Manager, see **Figure 1-2** below. The example input is simplified for the purpose of illustrating the principles of this type of analysis.

The following programs and versions are used: Sesam Manager version 6.6, Sestra 10.15.

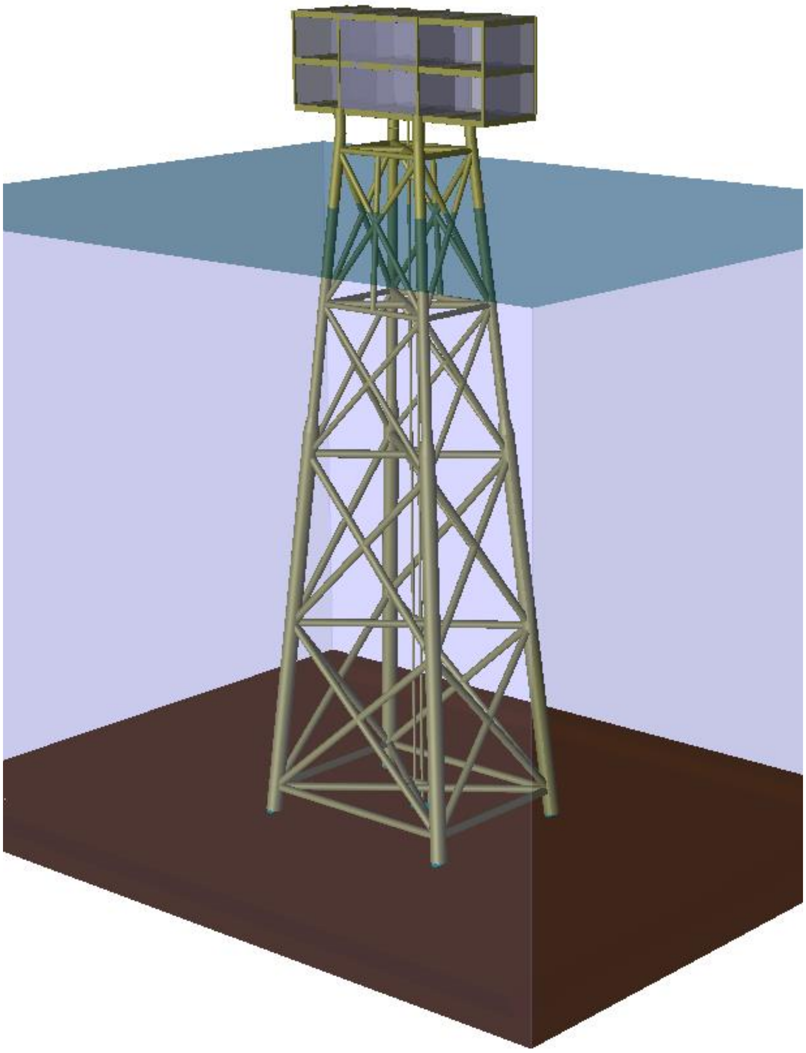

Figure 1-1 Jacket model

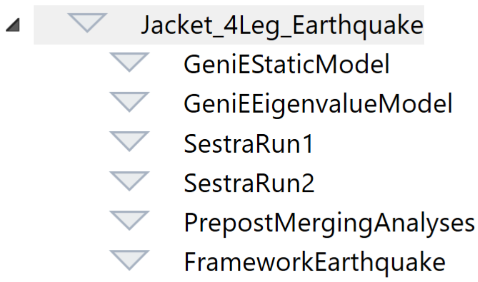

Figure 1-2 Sesam Manager workflow shown as ‘Tree View’

2 Establish the Workflow from Scratch

To create the workflow from scratch rather than establishing it by importing the ZIP file of this example do as follows:

- Create a new job based on the job template TwoAnalysesAndMerge:

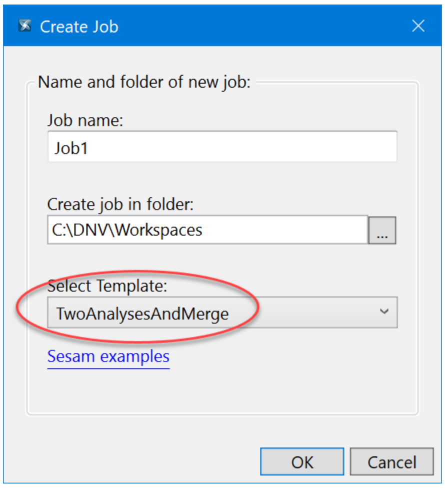

Figure 2-1 Create a Sesam Manager job based on a template

- This creates the workflow:

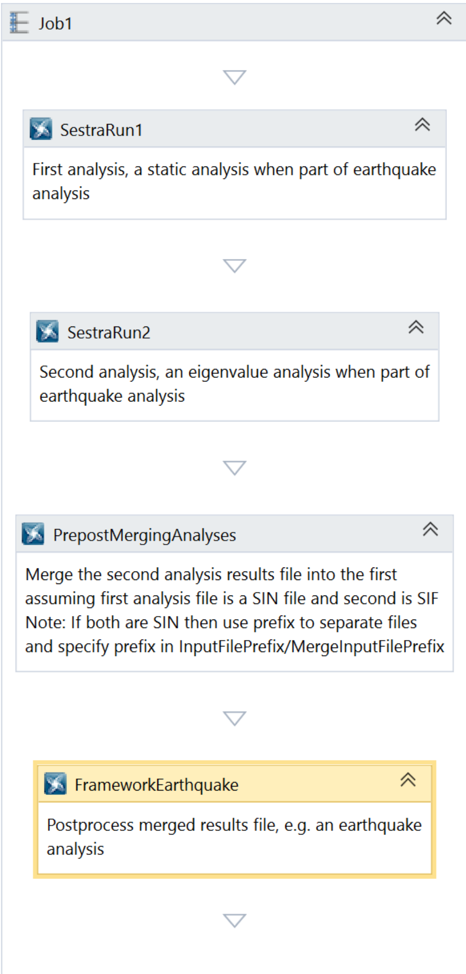

Figure 2-2 New Sesam Manager job based on template TwoAnalysesAndMerge

- Add one or two GeniE activities to the job above. Two models (T#.FEM files) are needed, one for static and one for eigenvalue analysis. These normally deviate slightly as the first model will have a gravity load case and the second model must have proper mass modelling, possibly with loads converted to mass, and hydrodynamic added mass. If both of these models are created from a single GeniE run then a single GeniE activity will suffice.

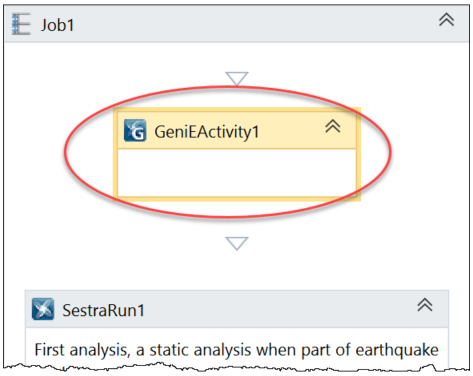

Figure 2-3 Add GeniE activity to the new Sesam Manager job based on template TwoAnalysesAndMerge

- For the first Sestra activity, SestraRun1, adjust the properties Description, SuperElementNumber, InputFilePrefix, LoadFilePrefix and OutputFilePrefix as required.
- The second Sestra activity, SestraRun2, must be modified from a static analysis to an eigenvalue analysis using the MultifrontLanczos solver and checking the EarthquakeAnalysis property so as to compute the modal earthquake excitation forces. Also adjust the properties Description, SuperElementNumber, InputFilePrefix, LoadFilePrefix and OutputFilePrefix as required.

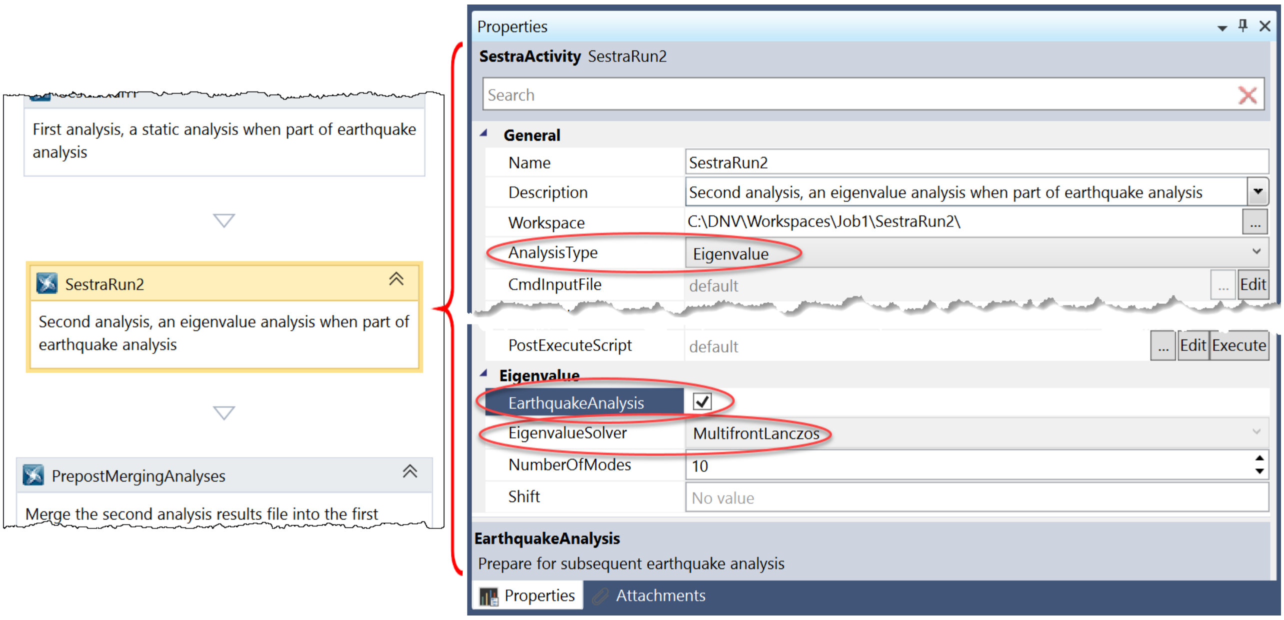

Figure 2-4 Modify second Sestra activity to an eigenvalue analysis computing modal excitation forces

- For the activity PrepostMergingAnalyses set the InputFilePrefix equal to the OutputFilePrefix of the eigenvalue analysis and the MergeInputFilePrefix equal to the OutputFilePrefix of the static analysis. This will merge the first analysis results (static) into the second analysis results (eigenvalue).
    - NOTE: The Description for the activity is misleading as it says, “Merge the second analysis results file into the first …”, correct is the other way around. You may want to adjust this text.

3 Earthquake Analysis by Importing Workflow

Create a new job with a preferred name. Do not select any template for this job. Import the ZIP file Jacket_4Leg_Earthquake.zip provided with this example. Your job should then contain the workflow shown in **Figure 1-2**. In addition to the workflow, the ZIP file contains a GeniE model of a four-legged jacket in the form of a gnx file as well as js input files with all necessary additional input.

An earthquake analysis is based on a merged results file from two analyses in Sestra:

- Static analysis
- Eigenvalue (free vibration) analysis

It is required that the two models are equal (same node numbering and coordinates and same element numbering).

The modelling for static analysis of gravity loading (including equipment) and buoyancy is activity **GeniEStaticModel**. To compute buoyancy Wajac is run under the control of GeniE. (Wajac may alternatively be run after GeniE and under the control of Sesam Manager.) Ensure that *StaticT7.FEM* and *StaticL7.FEM* are found in the repository after the GeniE run. StaticS7.FEM also produced is irrelevant in this case.

The free vibration model is created by activity **GeniEEigenvalueModel**. To compute added mass Wajac is run under the control of GeniE. Ensure that *EigenvalueT7.FEM* and *EigenvalueL7.FEM* are found in the repository after the GeniE run.

The static analysis in Sestra is performed by activity **SestraRun1**. Ensure that the results file *StaticR7.SIN* is found in the repository after the Sestra run.

The eigenvalue analysis in Sestra is performed by activity **SestraRun2**. Note that the free vibration analysis must include computation of modal earthquake excitation forces. This is achieved by checking the EarthquakeAnalysis property (that sets the MOLO parameter on the CMAS command to Sestra equal to 1). The MultifrontLanczos eigenvalue solver is used to compute 20 modes. Sestra produces the results file EigenvalueR7.SIN. Ensure that this file is found in the repository after running Sestra.

The merging of the two results files in Prepost is done by activity **PrepostMergingAnalyses**. The static analysis should preferably be merged into the eigenvalue analysis and not the other way around. (If the eigenvalue analysis is merged into the static analysis, then the resulting file will contain mass representation from the static analysis. The print of modal masses in Framework will in such case present incorrect modal mass as fraction of total mass. Otherwise the earthquake results will be correct.) Note that the property AnalysisType for the Prepost activity has been set to MergeResultFiles. This involves a default PreExecuteScript to be created that will copy EigenvalueR7.SIN to *MERGED_EigenvalueR7.SIN* so as to keep the original EigenvalueR7.SIN. Furthermore, the required input to Prepost is automatically created. Since the files to be merged in this example both are SIN formatted the StaticR7.SIN is first reformatted to SIF whereupon this is merged into MERGED_EigenvalueR7.SIN. Ensure that the file MERGED_EigenvalueR7.SIN is found in the repository after running Prepost. Notice that the file is larger than both of the merged results files.

Then run the earthquake analysis in Framework. This is activity **FrameworkEarthquake**. A screen dump of code check results (usage factors) is shown in **Figure 3-1** below.

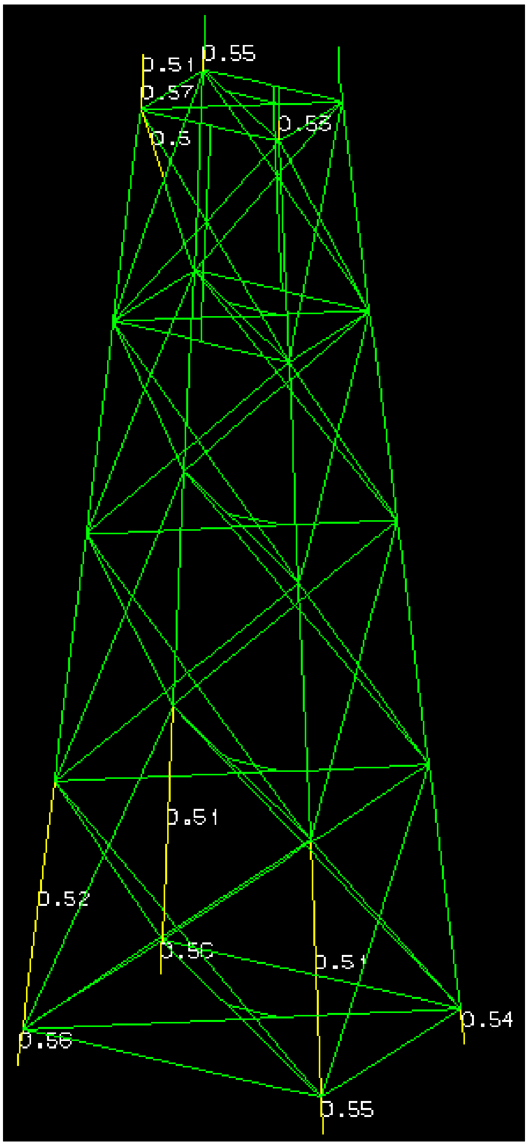

Figure 3-1 Code check results of earthquake loading computed by Framework

To verify the total mass participation (effective modal mass) the individual modal mass participation factors in Framework are printed to a file named *EarthquakeMass.LIS*. The table in **Figure 3-2** below is taken from this file.

The encircled columns to the right are the accumulated mass participations in the X, Y and Z directions as fractions of the total mass. The encircled values at bottom are the mass participations (effective modal masses) and the total masses.

```
                    Effective Modal Mass (EMM)
                    (modal load factors squared)


NOMENCLATURE:

Mode      Loadcase name of the mode shape
Period    Period of mode, T
EMM(X)    X-direction effective modal mass
EMM(Y)    Y-direction effective modal mass
EMM(Z)    Z-direction effective modal mass
DMM(X)    Fraction to total X mass
DMM(Y)    Fraction to total Y mass
DMM(Z)    Fraction to total Z mass
AMM(X)    X-direction acumulated mass fraction
AMM(Y)    Y-direction accumulated mass fraction
AMM(Z)    Z-direction accumulated mass fraction
```

Mode	Period	EMM(X)	EMM(Y)	EMM(Z)	DMM(X)	DMM(Y)	DMM(Z)	AMM(X)	AMM(Y)	AMM(Z)
1	2.966	4.43E-03	1.72E+04	9.76E-02	0.0000	0.7019	0.0000	0.0000	0.7019	0.0000
2	2.395	1.73E+04	8.49E-03	2.93E-01	0.7222	0.0000	0.0000	0.7222	0.7019	0.0000
3	1.294	1.01E+00	4.90E+01	1.43E-03	0.0000	0.0020	0.0000	0.7223	0.7039	0.0000
4	0.906	2.13E-02	6.50E+03	2.39E-02	0.0000	0.2652	0.0000	0.7223	0.9690	0.0000
5	0.841	6.17E+03	1.67E-02	2.35E+00	0.2579	0.0000	0.0001	0.9801	0.9690	0.0002
6	0.699	1.01E+00	5.21E+00	6.67E-03	0.0000	0.0002	0.0000	0.9802	0.9693	0.0002
7	0.555	3.62E-03	6.52E-04	6.98E+02	0.0000	0.0000	0.0398	0.9802	0.9693	0.0400
8	0.539	1.24E-04	3.65E-01	4.47E+00	0.0000	0.0000	0.0003	0.9802	0.9693	0.0402
9	0.529	2.01E-04	7.98E+01	1.22E+00	0.0000	0.0033	0.0001	0.9802	0.9725	0.0403
10	0.447	8.36E+01	2.86E-02	5.35E+03	0.0035	0.0000	0.3048	0.9837	0.9725	0.3451
11	0.442	5.17E+01	4.94E-02	6.79E+03	0.0022	0.0000	0.3869	0.9858	0.9725	0.7320
12	0.436	1.84E-01	2.70E+00	2.72E+02	0.0000	0.0001	0.0155	0.9858	0.9726	0.7475
13	0.428	9.88E-04	2.96E+02	1.09E+00	0.0000	0.0121	0.0001	0.9858	0.9847	0.7475
14	0.418	1.37E-03	1.26E+02	2.56E+01	0.0000	0.0051	0.0015	0.9858	0.9899	0.7490
15	0.414	2.35E-02	1.33E+00	9.81E+02	0.0000	0.0001	0.0559	0.9858	0.9899	0.8049
16	0.386	6.77E-05	5.09E-03	3.59E+00	0.0000	0.0000	0.0002	0.9858	0.9899	0.8051
17	0.369	9.34E-04	1.01E-01	1.88E-01	0.0000	0.0000	0.0000	0.9858	0.9899	0.8051
18	0.360	2.22E-03	3.52E+00	9.84E-04	0.0000	0.0001	0.0000	0.9858	0.9901	0.8051
19	0.356	1.17E+02	4.11E-05	8.98E+00	0.0049	0.0000	0.0005	0.9907	0.9901	0.8057
20	0.351	2.01E-02	5.70E-02	6.05E-01	0.0000	0.0000	0.0000	0.9907	0.9901	0.8057

Direction	X	Y	Z
Sum of EMM	2.3718E+04	2.4256E+04	1.4134E+04
Total Mass	2.3940E+04	2.4499E+04	1.7542E+04

Figure 3-2 Accumulated mass participations in the X, Y and Z directions as fractions of the total mass

For this example we find that the mass participation is 99.07%, 99.01% and 80.57% for the X-, Y- and Z-directions, respectively.

The accumulated mass participations in the X, Y and Z directions as fractions of the total mass may be taken into Excel and graphed, see **Figure 3-3** below. As seen, rather few modes contribute with nearly all mass participation. This is typical for jacket structures. The contribution to the Z-direction is, as can be expected, from the higher modes. To achieve a high percentage contribution for the vertical direction a high number of modes must be included.

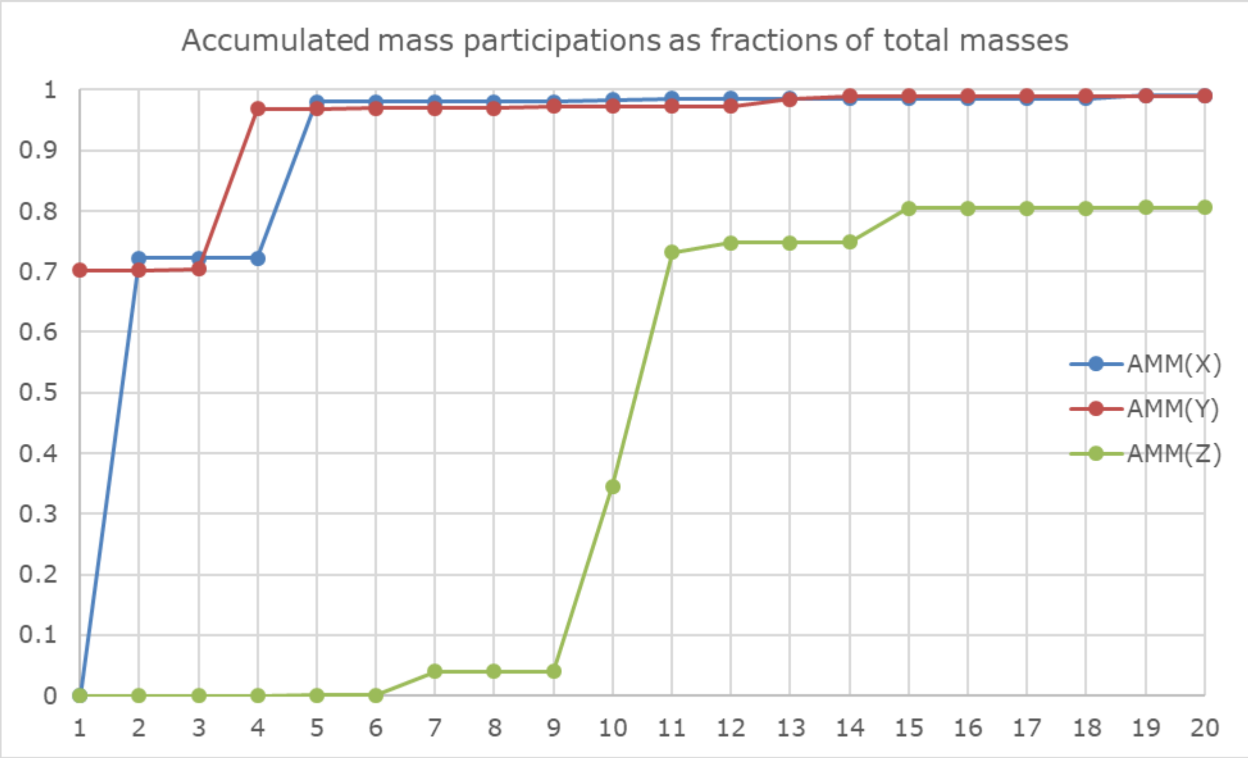

Figure 3-3 Accumulated mass participations graphed against mode number

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