SDLS140 – Wave propagation in a semicircular canyon

Summary:

The purpose of this test is to study the transitory answer of a semicircular model 2D of canyon subjected to a movement of plane wave of vertical propagation according to the directions P (vertical direction of propagation) and S (normal horizontal direction with the propagation). The imposed movement is a sinusoidal displacement in times of pulsation 8.15 Hz.
The surface structure is with a grid in triangles and one affects on his edges inferior and side elements of absorbing border allowing to apply the loading by plane wave.
One compares for each request the maximum ones of horizontal and vertical displacement along the edge higher of the canyon than those obtained by an analytical study provided by the reference [bib1].
The comparison on the space paces and amplitudes along the higher edge is rather satisfactory.

1 Description

1.1 Geometry

The model of study is a semicircular canyon of ray $R0=100\mathrm{m}$, prolonged horizontally on both sides of same dimension and of vertical depth $H=200\mathrm{m}$ (cf Figure 1.1).

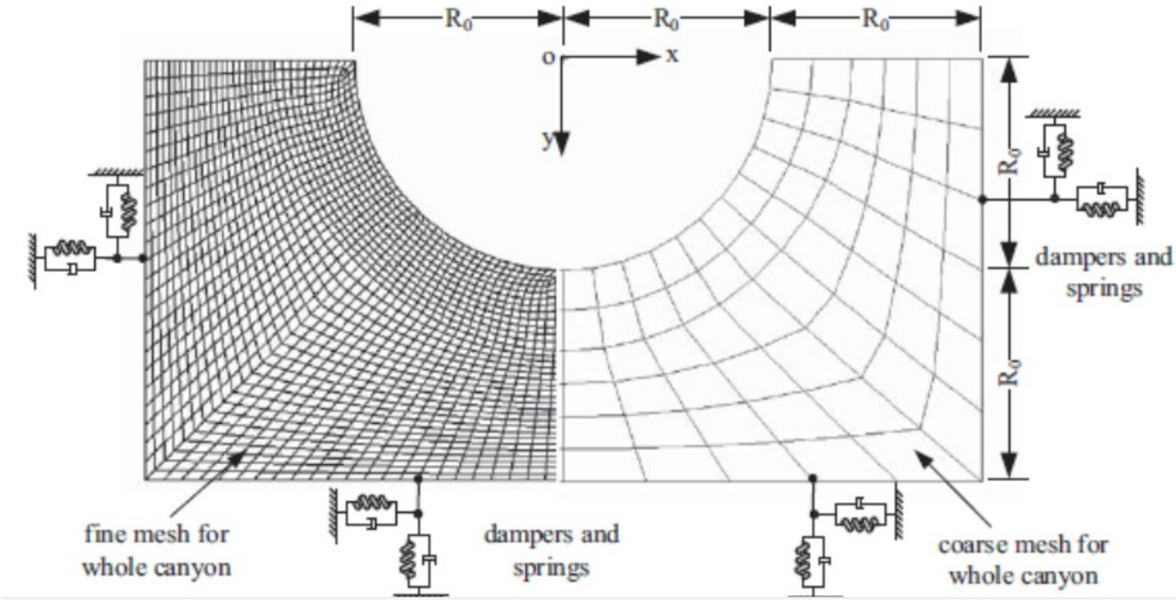

Figure 1.1: geometry and dimensions of the canyon

1.2 Properties of materials

The properties of the ground for the structure of the canyon are given in the following table.

Material	Ground
Young modulus	$1.885 10^{10}\ Pa$
Poisson's ratio	0.33
Density	$2650\ kg/m^3$

1.3 Boundary conditions and loadings

1.3.1 Boundary conditions

The lateral sides and inferior do not have blocking but present a condition of border absorbing by the assignment of linear elements absorbents.

1.3.2 Loading:

The loading consists in applying one imposed movement of plane wave in the form of sinusoidal displacement in times of pulsation 8.15 Hz (cf Figure 1.3.2).

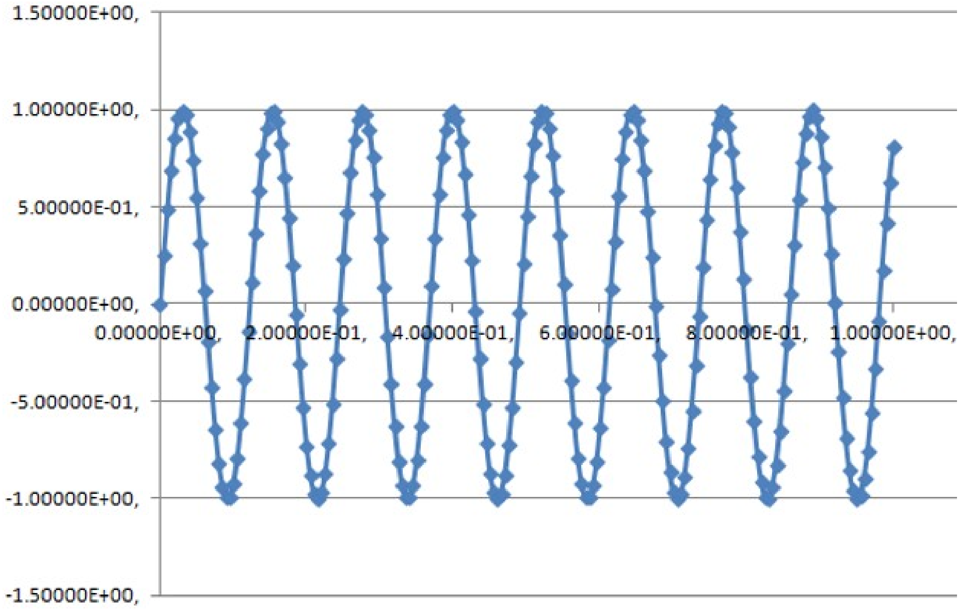

Figure 1.3.2: movement of displacement imposed of the plane wave

2 Reference solution

The reference solution is given by an analytical approach extracted the reference [bib1] and represented on the figure below respectively like amplitudes of the answers to a wave P and a sinusoidal wave S of frequencies 8.15 Hz along the higher edge of the canyon according to the horizontal X-coordinate (cf Figure 2).

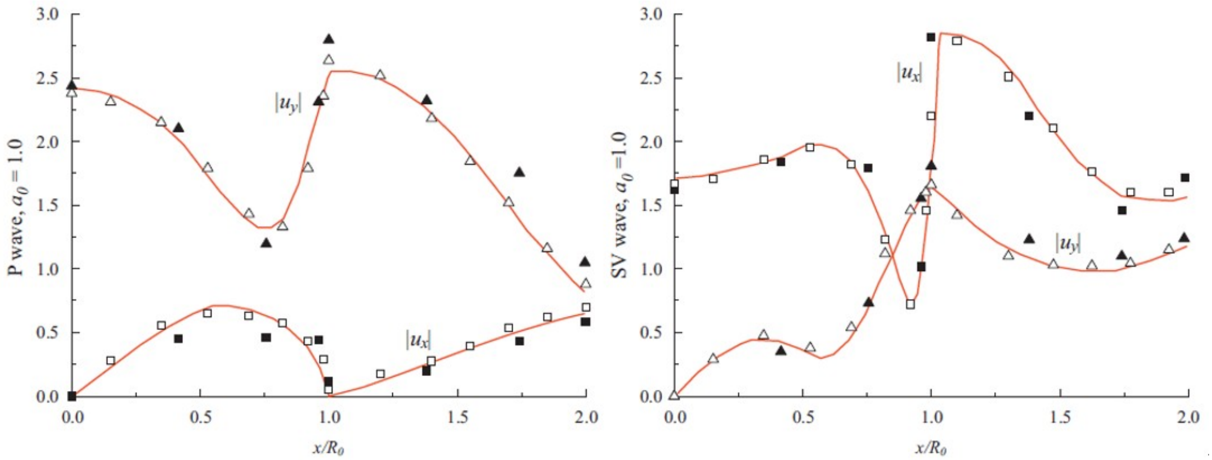

Figure 2: maximum analytical answers in X and Y to the wave P (left) and the wave S (right)

3 Modeling A

3.1 Characteristics of modeling

The structure is modelled by 1496 surface meshs of type TRIA3 modelled in D_PLAN, like by 80 meshs of edge of the type SEG2 modelled in D_PLAN_ABSO (cf Figure 3.1)

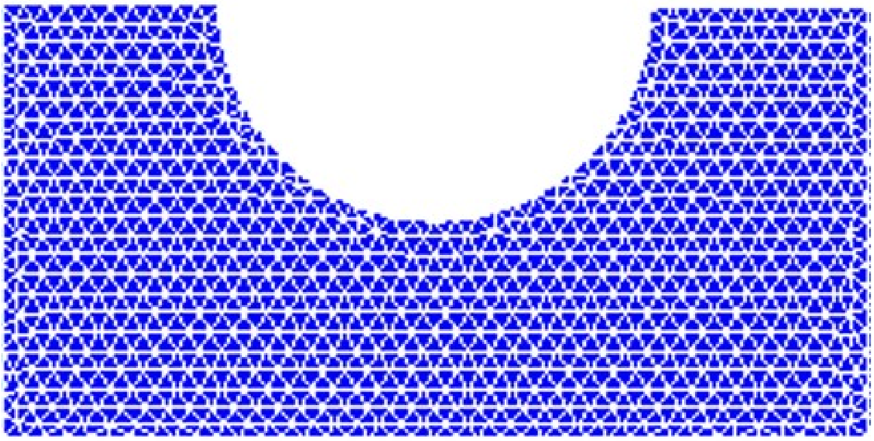

Figure 3.1: grid of the model of canyon

3.2 Comparisons and results

3.2.1 Comparisons

One compares for each request the maximum ones of horizontal displacement DX and vertical DY along the higher edge of the canyon according to the horizontal X-coordinate, with those obtained by an analytical study provided by the reference [bib1].
The following figure (Figure 3.2.1) synthesizes the 4 answers (2 directions of request, 2 directions of answer) to compare with those of Figure 2.

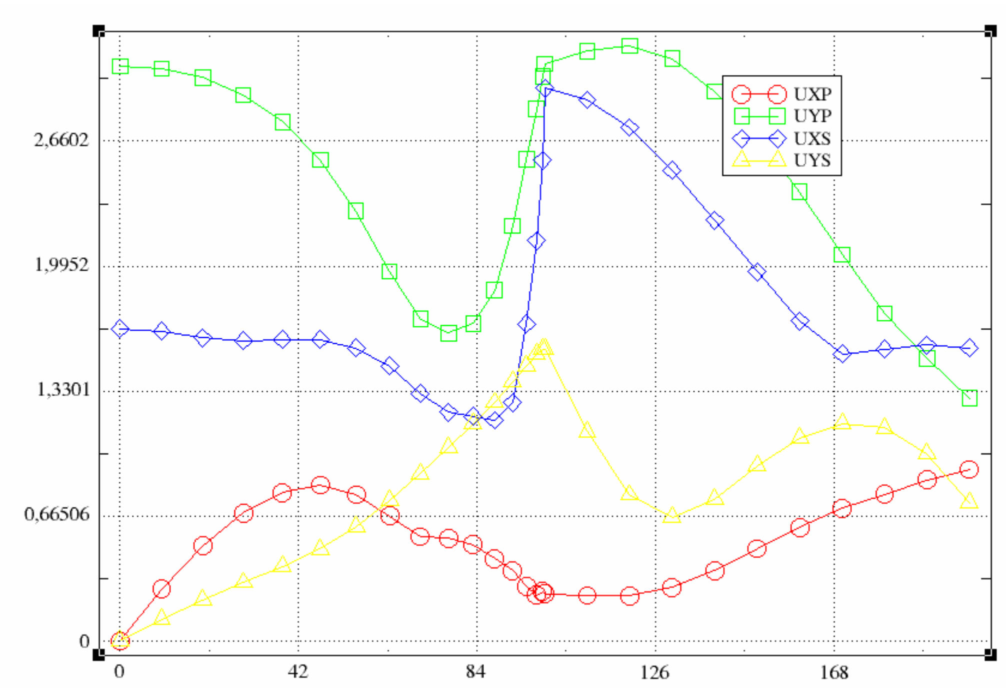

Figure 3.2.1: maximum digital answers in X and Y to the wave P and the wave S

3.2.2 Results tested

The results tested are of not-regression and correspond to the computed values for each direction of request S and P and according to the components L DX and vertical DY with the nodes of horizontal X-coordinate 0 (center of the canyon), 100 (edge of the canyon) and 200 (flat rim of the foundation).

Node	Direction	Component	Absc.	Value (m)	Precision	Reference
$N23$	P	DY	0	3.0587E+0	1.0E−6	NON_REGRESSION
$N2$	P	DX	100	2.4651E−1	1.0E−6	NON_REGRESSION
$N2$	P	DY	100	3.0730E+0	1.0E−6	NON_REGRESSION
$N3$	P	DX	200	9.2335E−1	1.0E−6	NON_REGRESSION
$N3$	P	DY	200	1.2948E+0	1.0E−6	NON_REGRESSION
$N23$	S	DX	0	1.6592E+0	1.0E−6	NON_REGRESSION
$N2$	S	DX	100	2.9364E+0	1.0E−6	NON_REGRESSION
$N2$	S	DY	100	1.5502E+0	1.0E−6	NON_REGRESSION
$N3$	S	DX	200	1.5625E+0	1.0E−6	NON_REGRESSION
$N3$	S	DY	200	7.3559E−1	1.0E−6	NON_REGRESSION

4 Synthesis

The qualitative and quantitative comparison on the space paces and amplitudes along the higher edge is rather satisfactory taking into account the low horizontal dimension of the modelled structure.
An adjustment of the parameter material LONG_CARA representative of a dimension structural feature would undoubtedly allow, by generating stiffnesses added on the elements of absorbing edge, to still improve the agreement between the analytical and calculated values.

5 References

[bib1] " Influence of seismic input mechanisms and radiation damping one arch prejudice answer ". Zhang Chuhan , Pan Jianwen, Wang Jinting . Soil Dynamics and Earthquake Engineering 2009 pp 1282-1293