NUMERICAL MODELLING OF TIME-HARMONIC SEISMIC WAVE FIELDS IN SIMPLE STRUCTURES BY THE GAUSSIAN BEAM METHOD. PART II.

JANA KONOPÁSKOVÁ
Geophysical Institute, Czechosl. Acad. Sci., Prague*)

VLASTISLAV ČERVENÝ
Institute of Geophysics, Charles University, Prague**)

1. INTRODUCTION

In [1], the method of Gaussian beams was used to compute the time-harmonic waves reflected from a plane interface between two homogeneous half-spaces. The purpose of these computations was to test the accuracy of the Gaussian beam method by comparing its results with those of exact solutions.

It was shown in [1] that, in this case, the method of Gaussian beams yields satisfactory results not only in the regular-ray regions, but also in the critical region, which is singular from the point of view of the ray method. In both regions, the method of Gaussian beams yields the results predicted by exact methods. Moreover, in the overcritical region, head waves were automatically obtained by superimposing reflected Gaussian beams.

Gaussian beam computations, however, are influenced by certain auxiliary computation parameters. The most important of them are the initial parameters of the Gaussian beams (such

*) Address: Boční II, 141 31 Praha 4-Spořilov.
**) Address: Ke Karlovu 3, 121 16 Praha 2.
as the initial halfwidth of the beam and initial curvature of the phase front of the beam), followed
by the parameters of the expansion of the wave field into Gaussian beams, etc. In [1], the com-
parison of the results obtained by the Gaussian beam method with the exact solutions was
presented only for one particular group of these parameters. It is, therefore, necessary to investi-
gate the sensitivity of the results obtained by the method of Gaussian beams to these computation
parameters.

This paper is a continuation of [1] which will be referred to as Paper I. The main aim of this
paper is to investigate the influence of the computation parameters on the amplitude-distance
curves of $PP$ waves reflected from a plane interface. It will be shown that the results are generally
stable with respect to these parameters. Only the initial width of the Gaussian beam has a certain
smoothing influence on the amplitudes of reflected waves in the critical and overcritical regions.
For comparison with the amplitude-distance curves of $PP$ reflected waves, also other types
of reflected waves are considered in Sec. 6, particularly the converted $PS$ and $SP$ reflected waves,
and the $SS$ reflected waves. The main conclusions drawn from our investigations are listed
in Sec. 7.

We shall again consider the same model of the medium as in Paper I, i.e. two homogeneous
isotropic perfectly elastic halfspaces in a welded contact along a plane interface. The method
of Gaussian beams used for computations is explained in Paper I, where all the necessary equa-
tions are given. For a more detailed description of the propagation of Gaussian beams in general
two-dimensional laterally smoothly inhomogeneous media see [2, 3] and for Gaussian beams
in laterally varying layered structures see [4]. For many other references on Gaussian beams we
refer the reader to the above-mentioned papers.

Note that the results presented here were computed using the program written by the first
named author as a part of her Diploma Thesis at the Charles University, Prague [5].

2. PARAMETERS OF COMPUTATION

There are two groups of computation parameters of reflected and transmitted
waves in the Gaussian beam method in the simple model described in the introduction.
The first group of parameters specifies the model, the source, the receiver and the
type of wave. The results of the computations, of course, depend considerably
on these parameters. The second group of parameters consists of auxiliary para-
eters which control the computation, such as the initial parameters of Gaussian
beams, parameters of the expansion of the wave field into Gaussian beams, etc.
In principle, the results of computations should not be influenced by the auxiliary
parameters of the second group. However, some influence is to be expected and
we must learn how to choose the parameters to obtain sufficiently accurate results.
For example, it is clear that for higher frequencies it will be necessary to consider
a denser system of rays.

Let us now specify in more detail the individual parameters in both groups.

The first group consists of the following parameters:

a) The parameters of the model: $\alpha_1$, $\beta_1$, $\varrho_1$ for the first halfspace (in which the
source is situated), $\alpha_2$, $\beta_2$, $\varrho_2$ for the second halfspace. The quantities $\alpha_i$ and $\beta_i$
denote the velocities of compressional and shear waves, respectively, $\varrho_i$ the densities.