ON THE STRESSES ACTING AT THE FOCI OF EARTHQUAKES NEAR THE BEND OF THE CARPATHIAN ARC

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INTRODUCTION

The main Carpathian epicentral region is situated near the bend of the Carpathian arc (region of Vrancea). The foci are at a depth of 100—150 km under the Earth’s crust [1]. With a view to investigating the inner forces acting at the foci we selected some strong earthquakes of this zone [12]. There are the shocks of 29.3.1934 \((M = 6\frac{1}{2})\), 24. 6. 1940 \((M = 6)\), 22. 10. 1940 \((M = 6\frac{1}{2})\), 10. 11. 1940 \((M = 7\frac{1}{2} - 7\frac{1}{2})\); for these earthquakes a sufficient number of observations were available. Their parameters are given in Tab. 1.

<table>
<thead>
<tr>
<th>Earthquake No.</th>
<th>Date</th>
<th>Time of origin</th>
<th>Epicentre</th>
<th>Depth of focus</th>
<th>Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29. 3. 1934</td>
<td>20 06 43</td>
<td>45.7</td>
<td>26.5</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>24. 6. 1940</td>
<td>09 57 23</td>
<td>45.8</td>
<td>26.5</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>22. 10. 1940</td>
<td>06 37 00</td>
<td>45.9</td>
<td>26.5</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>10. 11. 1940</td>
<td>01 39 07</td>
<td>45.7</td>
<td>26.8</td>
<td>130</td>
</tr>
</tbody>
</table>

The theoretical basis of investigation is Volterra’s theory of dislocations [2, 3]. In order to utilize the apparatus of the theory of elasticity, the theory of dislocations substitutes a rupture in the elastic medium (with the known displacement of the faces) by a force system distributed on the crack surface. The force system is selected so as to excite in the elastic medium the same field of displacements as the given crack. In this way the problems of the theory of dislocations are reduced to the usual problems solved by the theory of elasticity of continuous media.

We propose as a model of an earthquake focus a crack area, the faces of which are displaced in opposite directions on the slip plane [4]. In accordance with the theory of dislocations the field of displacements excited by such a source of disturbances is the same as the field caused by a force system uniformly distributed on the limited area;

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the forces are equalized and form a tensor-deviator at each element of area. Such
a force system will be called the force model of the focus [5].

An analogous model was suggested at first by Honda [6]. The idea of a rupture
connected with a slip as the most probable model of focus is accepted generally.
Opinions differ only on the question of the force system which can excite the same
field of displacements as a fault [7]. V. I. Keilis-Borok [8] proposes a double force
with a moment as a force model of focus. Without going into particulars, we mention
only that our model, i.e. two perpendicular double forces with a moment, agrees with
the laws of mechanics according to which the inner forces within a rigid body are
always balanced.

1. SOME GENERAL CONCEPTIONS

Before illustrating the method used for the investigation of stresses acting at the
foci of the Carpathian earthquakes, brief mention will be made of some of the princi-
pal conceptions connected with the action of stresses at foci.

We consider the focal region to be a limited body of finite volume. Stresses acting
on the surface of the body are transformed to outer forces distributed on this surface.

Fig. 1. Force systems modelling the source: a) two perpendicular force couples with moment; b) two perpendicular double forces without moment.

Fig. 2. Orientation in space of the breach area and the compression (i) and dilatation (k) axes.

Because a rupture connected with a slip is the most probable form of displacement in
the focus, we can determine the area of the rupture in a body as a set of points lying in
one of the planes of maximum tangential stresses. If the size of the outer forces reaches
a certain value, the tangential stresses approach the limit of solidity and a breach in the
continuity of the medium occurs. The effect of the origin of a rupture is that the stres-
ses on the area of rupture are removed, and the faces of the rupture displaced.

In the case of an abrupt occurrence of a rupture on the limited area and a displace-
ment of its faces we can, according to the theory of dislocations, reduce the rupture
to a system of forces operating instantaneously and distributed on the crack area. In
a particular case of a crack connected with a slip the force system can be represented
by two perpendicular force couples with a moment. The moments of the forces are
situated on the crack plane perpendicularly to the displacement and in opposite direc-
tions; the forces of the couple parallel to the crack plane have the same direction as the
displacement along the crack (Fig. 1a).