# KALININGRAD EARTHQUAKE OF SEPTEMBER 21, 2004, DAMAGE

**Aptikaev F.F.[1], Nikonov A.A.[1], Alyoshin A.S.[1], Assinovskaya B.A.[2], Pogrebchenko V.V.[1] and Erteleva O.O. [1]**

[1] *Institute of Physics of the Earth, Russian Academy of Sc., Bolshaya Gruzinskaya street, 10, Moscow, Russia, 123995*

[2]*Seismological Branch of Astronomical Observatory, Russian Academy of Sciences, Saint-Petersburg, Russia, 196140*


## ABSTRACT

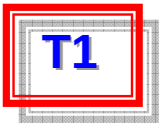
The problem contains an estimation of seismic hazard in areas of the low seismic activity. The maximal seismic intensity in Kaliningrad district is $I \leq 5$ according to the General Seismic Zoning Map of Russia (1997). The Kaliningrad earthquake of September 21, 2004, covered all the Baltic region turned out to be unexpected. There were 7 felt shocks. Three of them were recorded by seismic station arrays. The main shock ($m_b$ = 5) was stronger than any recorded instrumentally formerly within the Eastern European Platform. The shocks caused anxiety, disorder, and damage. One man died as a result of heart attack, 20 persons were seriously injured (fractures of legs and spine; head trauma with fall tile and fragments of damaged chimneys). About 2100 buildings including schools and kindergartens were damaged within this region. Total loss has been estimated not less than 5.500.000 $. The authors have succeeded to gather macroseismic data in more than 60 points within near and mesoseismal zone. The descriptions of the observed damages are presented.

**Keywords:** *Seismic hazard, Seismic intensity, Damage, Ground cracks*

## 1. PARAMETERS OF KALININGRAD EARTHQUAKES

Only three first shocks have been recorded instrumentally. The times of occurrence (GMT) and magnitudes of these events are 11-05-03.3, $M_S$ = 3.9, $m_b$ = 4.9; 13-32-29.3, $M_S$ = 4.1, $m_b$ = 5.0; 13-36-00, $M_S$ = 3.0 correspondingly. Our estimations of mean seismic intensity for 7 strongest shocks are 5.5; 6.0; 4.0; 4.0; 4.0; 3.0; and 3.0 MSK-intensity units (in the order of occurrence). On the basis of macroseismic data the epicenters of all these shocks were located under a sea bottom; those of the first and third shocks were near west coast of Sambian Peninsula, the second shock epicenters were near its north coast.

The seismic intensity maps for three shocks were drawn. Special investigations have been provided to estimate epicenter positions for each of three main shocks. The isoseismals for the main shock see on Fig. 1.1. The frequency of sound during earthquakes was very high. Somebody felt this sound as an explosion or as large cannon shot. Some people felt as if an airplane squadron flew underground. Therefore the frequency of the ground motion was at least 20 Hz. There are damages of single objects formally related up to intensity 8 on places with the bad ground conditions. For example, serious damages were observed in Kaliningrad harbour, where some construction were placed on water saturated fill.



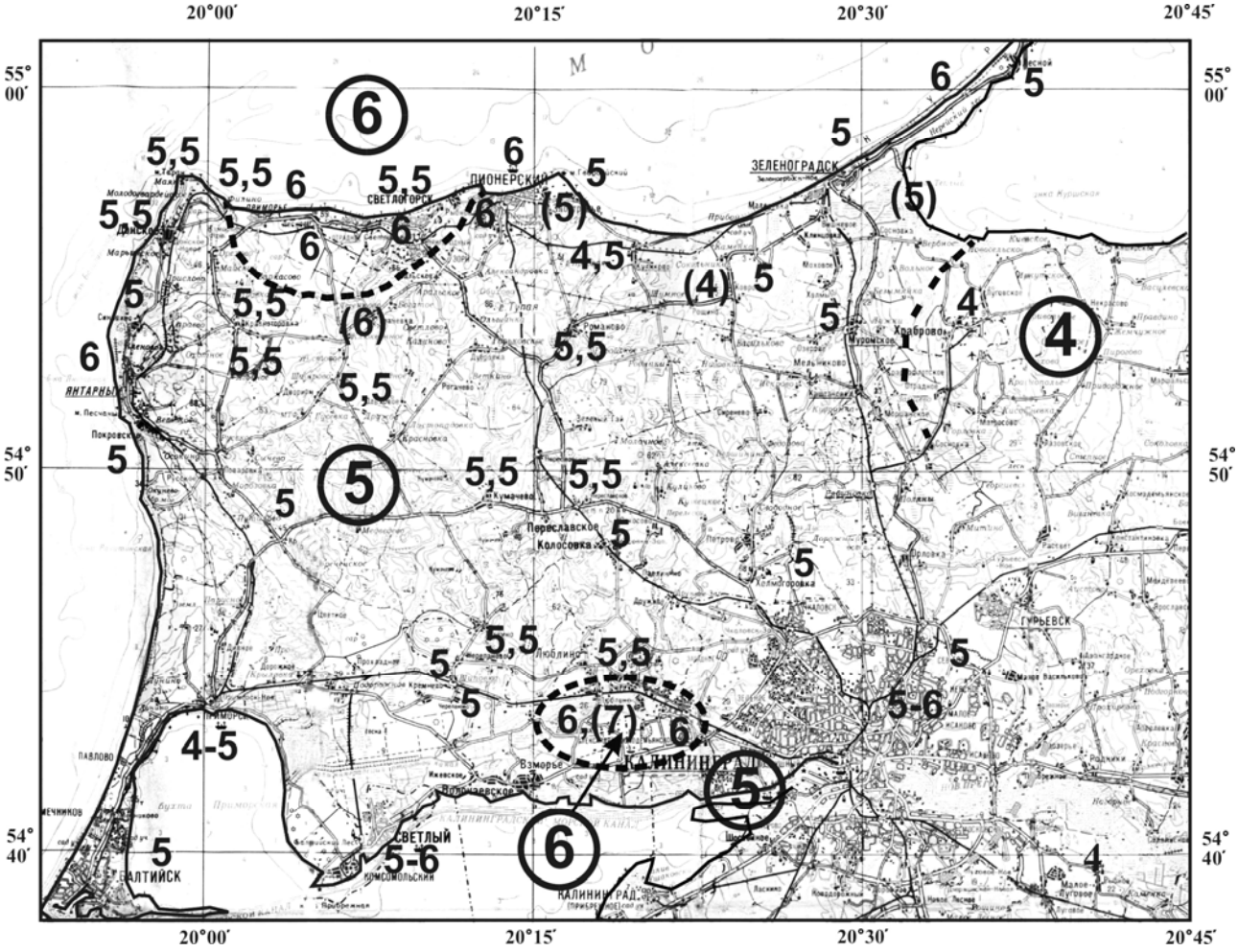



Fig. 1 The main shock isoseismals. in the circles are given the mean intensity for the areas.

### 1.1. Ground Failure

The railway embankment near Svetlogorsk town slid to the sea side; the embankment material was very wet because of strong rains; see Fig. 1.2 - 1.3. The crack system occurred along the borders of the pond near Veselovka village during the first shock, the cracks are enlarged after second shock. The main crack has the length about 100 m, opening – about 20 cm, vertical offset 20 cm and displacement along the fault about 20 cm; see Fig. 1.4. The crack in perpendicular direction occur along another border. On hill slopes somewhere the cracks and ground slide occurred.

### 1.2. Building Damage

The wall of three - storey maternity house in Kaliningrad city has large vertical crack at the edge. This crack ran through the semi-basement and two stories. The crack crossing inside wall diagonally through all the three stories appeared in Children orthopedic sanatorium (brick building) in Pervomaisky town, see Fig. 1.5.


Fig. 1.2 The rail deformation. Zarembo from the newspaper “Komsomolskaya Pravda v Kaliningrade”.

Fig. 1.3 The railway embankment sliding near Svetlogorsk town. The ground mass slid to sea side and railway was hanging on 15 meters high. This point is about 50 m apart from the place shown on Fig. 1.2. Photo I. Zarembo.

Fig. 1.4 The ground crack was appearing during the foreshock along the borders of the pond near Veselovka village during the first shock, the cracks were enlarged after main shock

Fig. 1.5 The Children orthopedic sanatorium (3-storey brick building) in Pervomaisky town, first floor. The crack crossed inside wall through the entire three storeys diagonally.

Diagonal crack appeared in the wall of gymnastic hall of school in Primor'e town, see Fig. 1.6. The rack appeared in beam of three - storey frame of reinforced concrete school in Lublino town, see Fig. 1.7. This building was erected on the fill ground over peat. In every case the seismic intensity related to damages of surrounding buildings and people feelings is not so high. The main losses are due to oven and chimney damages, see Fig. 1.8 and 1.9. Pay attention how far are the bricks thrown aside. It should be noted, that as a rule the damaged buildings are very old, see Fig. 1.10.The seismic hazard in the Baltic region is higher, than it was believed before. The serious damages in this area as a rule connected with bad ground conditions and bad foundations.

Fig. 1.6 The wall crack in the gymnastic hall on second floor of school in Primor'e town.

Fig. 1.7 The through crack in the crossbeam.
The three - storey frame of reinforced concrete school in Lublino town.

Fig. 1.8 The damage of oven.

Fig. 1. 9 The damage of chimney. The bricks are thrown aside on distance larger than chimney height.

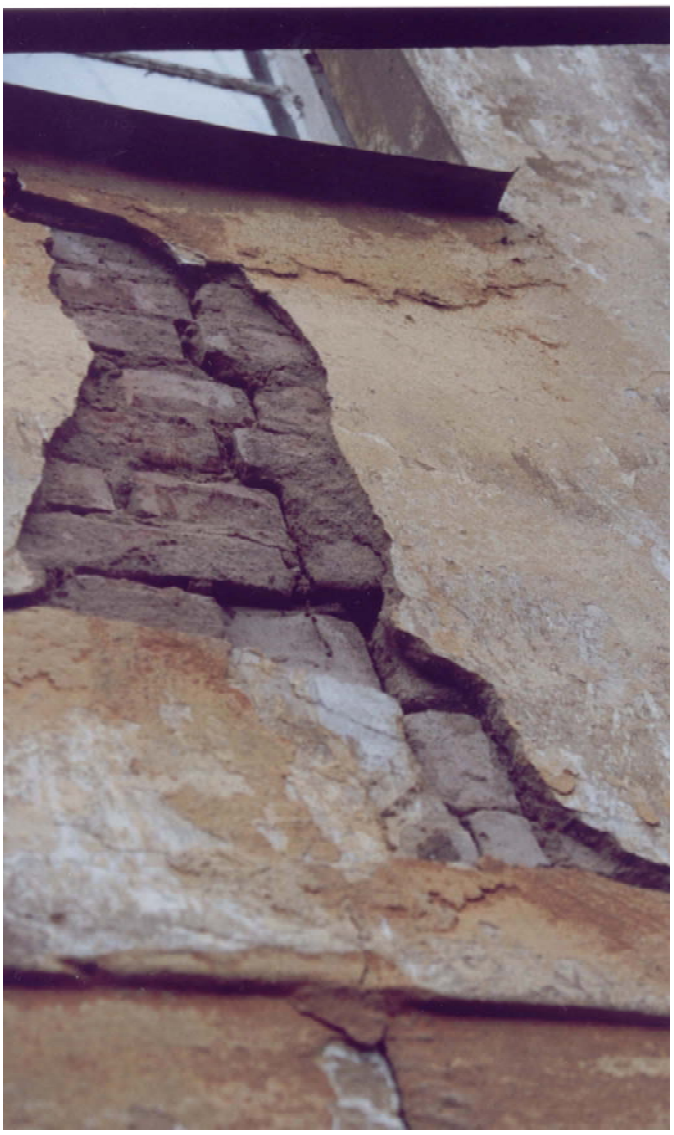


Fig. 1.10 The wall cracks in the brick house of pre-war construction.