INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING AND TECHNOLOGY (IRJET) E-ISSN: 2395-0056
VOLUME: 07, SPECIAL ISSUE | JUNE 2020 WWW.IRJET.NET P-ISSN: 2395-0072
International Conference on Recent Trends in Science & Technology-2020 (ICRTST - 2020)
Organised by: ATME College of Engineering, Mysuru, INDIA

Earthquake Disaster Mitigation and Management in Mysore District, Karnataka

Suresha. K.J[1], C.Srikantappa[2], Hema H.C[3]

[1]*Associate Professor, Department of Civil Engineering, ATME College of Engineering, Mysuru-570028*
[2]*UGC-Emeritus Scientist, Department of Earth Science, University of Mysore, Manasagangotri, Mysore, 570 006*
[3]*Associate Professor, Department of Civil Engineering, CMR Institute of Technology, Bengaluru, 560037*

Abstract- *Peninsular Gneiss of Archean age is the prominent rock type in Mysore District. Structural studies indicate the presence of four major fracture/shear zones in the area. Among them, NW-SE trending Chitradurga Mylonite Zone (CMZ) and N-S trending Kollegal Shear Zones (KSZ) are the structurally weak zones in the area. These are steeply dipping, deep seated fracture zone along which crustal disturbance is recorded. Movement of rocks along these fault/shear zones could be normal, reverse or thrust faulting which causes earthquakes. An earthquake of intensity around 2.5 to 4.5 in the Richters scale is predicted along these shear zones in Mysore district . So that buildings surrounding the shear zones should be constructed on a good concrete base and no stones filled with mud be used for the basement and no bricks filled with mud be used for the walls. Suggestion are recommended towards the reconstruction of old buildings constructed more than 100 years back like old city market buildings and Lansdowne buildings with modern engineering structures, maintaining the existing architecture . Hence there is a need in providing the temporary relocation for the old buildings.*

Keywords: Earthquake, Disaster Mitigation , Management

1. INTRODUCTION

Earthquake takes place when the outer layers of the Earth's crust move during tectonic activity. The outermost shell of the Earth's crust, called Lithosphere, Brocken into pieces will be in constant motion above the molten rock called Magma in the upper mantle. When the lithospheric plates move, the rocks are subjected to large forces causing deformation. During deformation of rocks, lot of stress will be built up within the crust and this stress will be released along weak zones causing earth tremors leading to earthquake. Epicentre of the earthquake generally lies along weak zones like fault plane or major shear zones in the Earth's crust. For these reasons, identification of major fault zones or shear zones in the earth's crust now exposed on the surface of the earth is significant in recording the possible earthquake prone areas, which are structurally weak and unstable areas [1]. Identification structurally weak planes like fault/shear planes in important since it is along these planes various rocks types move one against the other causing earth tremors. The rocks can move horizontally, sub-horizontally or vertically along fault/shear zones causing earthquake. Earthquake occurs suddenly without any warning and are difficult to predict. Though Earthquake occurs rarely, but once it occurs, the destruction it causes is enormous through the loss of life and property. Earthquake pre- diction is possible if proper scientific investigations are carried out including detailed geological mapping of the area, structural studies to identify fracture and shear zones, detailed petrological studies to record micro-textures combined with geophysical studies including DSS profiles along and across fracture zones.

The southern Peninsular India was considered until recently a stable land mass. However, the earthquake during 1993, in Maharastra and low intensity earthquake (2 to 3 on Richters scale) around Maddur and Mandya in Karnataka state in the years 1972, 1993 and 1998, mild earthquake (3.5 to 4.0 intensity) near Mysore city on 29th January 2001 and earthquake in Mercara and Kollegal region in the years 2007 and 2010 has indicated that the land mass around Mysore is becoming unstable [2]. The earthquakes are associated with major lineaments in the state[3]. The Though the intensity of Earth- quake in Mysore District may not be of higher magnitude like the one in Bhuj (6.8 magnitude), there is a possibility of lower magnitude Earthquake at the order of 2 to 4.5 magnitude in Mysore District. For these reasons, there is a need to carry out detailed scientific studies to mitigate earthquake and related disaster management in Mysore district. The Karnataka state represents one of the most important parts and largest Precambrian shield areas of the world, which is tectonically termed as shield region or intraplate region . The convergent movement of Indian plate towards Eurasian plate at the rate of 5 cm/year [4]. brings moderate to high deformations in the interior of the Indian plate and therefore, the peninsular India can no longer be considered as a stable landmass with low seismicity [5].

2. GEOLOGY OF MYSORE DISTRICT

The major rock types exposed in southern Karnataka and around Mysore are the white to grey coloured, medium to coarse grained rock type generally termed as Peninsular Gneiss (Fig.1), containing minerals like quartz+plag+K-feldspar+bio+hbl+gar. Numerous bands of metasedimentary rocks like pelitic, carbonate and quartzites associated with ultramafic and mafic rocks like dunite/proxenite gabbros occur as enclave within the Gneiss [6]. Presence of metasedimentary rocks in Mysore district suggest that there was a shallow water seen where these rocks were deposited several million year ago. Presence of numerous volcanic rocks have been identified near Mysore [7]. The age of these sedimentary rocks is around 3,300 m.y. and hence they belong the Precambrian age [8]. All these rock types are classified as belonging to Sargur Group, the oldest rock types in India. Coarse grained, pink, porphyritic granite exposed in Chamundi hill is the youngest rock types with ages of 700 m.y.

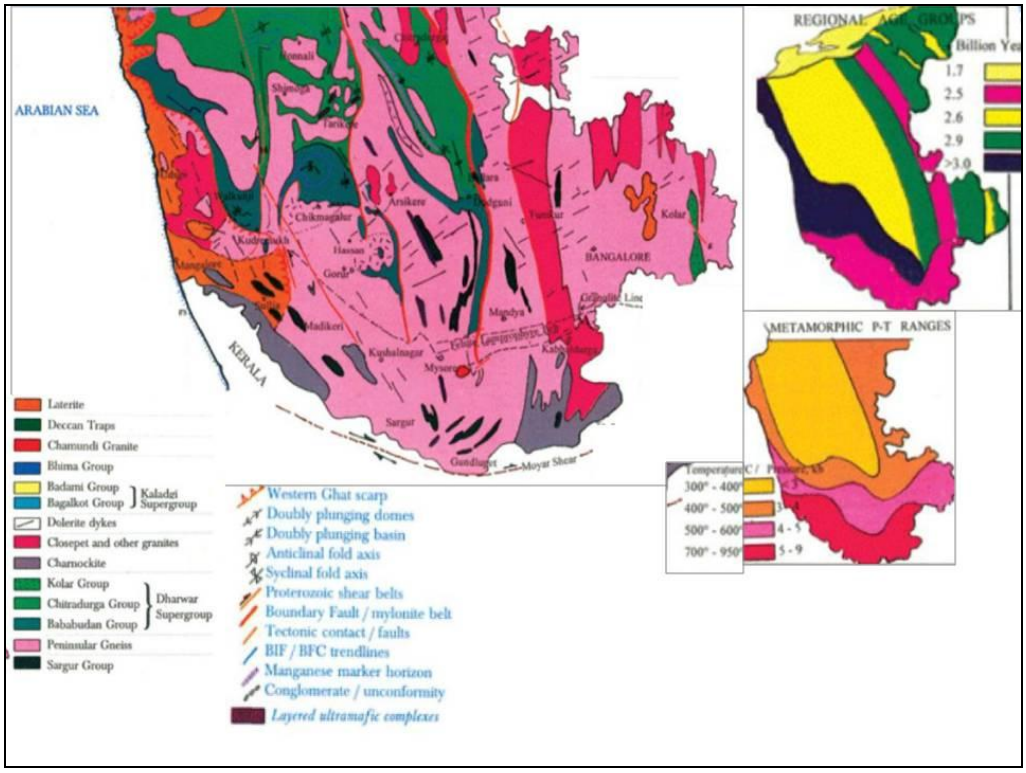

Fig.1: Geological map of southern Karnataka with major Shear /fault Zones around Mysore

All the rock types of Mysore district have been metamorphosed to upper amphibolite to granulite facies conditions (P=6 to 7 Kb and T = 600 to 760^{o}C) and regional metamorphism is dated around 2500 m.y. Based on paleo-pressure data, the present day crustal thickness is estimated around 35 km around in Mysore district. This gives the geological information that the molten rocks called magma exist at a depth of approximately 30km below Mysore city. If any deep seated fracture in the upper crust, particularly high angle fault/shear zone exist, this will intersect the upper mantle and will cause earthquake.

3. STRUCTURAL STUDIES

The rock types in Mysore District show various types of deformation with a regional N-S trending major structures, with steep dips of 80. The broad swerves of rock types, with fold axis trending NE-SW, is related to latest deformation. Numerous major fault zones have been identified in Mysore District with different orientation. The fault/shear zones are 10 to 30 km. in width, extending for about 50 to 200 km. with gentle to steep dips (60 to 80 degrees). Movement of rocks along these fault zones could be normal, reverse or thrust faulting which causes earthquakes.

Following major fault/shear zones have been identified in Mysore district, southern Karnataka (Fig.2).

1) N-S trending, steep dipping Kollegal Shear Zone passing through Chamarajanagar, Kollegal, Malavalli extending

further north to Maddur and Tumkur (Fig.3).

2) NW-SE to N-S trending Chitradurga mylonite zones extending from east of Chitradurga, west of Mandya up to Srirangapatna and Mysore city.

3) NW-SE trending, steep dipping Mercara Shear Zones passing through Virajpet, west of Kushalnagar and Madikeri (through abbey falls).

4) E-W trending Cauvery fracture zone along Holenarasipur and Srirangapatna.

5) NE-SW trending Kabbini fracture zone passing through HD Kote, Nanjangud.

Many fracture zones have been identified in Mysore District. Prominent among them are Kollegal shear zone (KSZ) [9] (Fig.2, Fig.4, Fig.5). The Chitradurga Mylonite Zone (CMZ) which passes through Eastern part of Mysore city is identified as a major zone of weakness which may trigger earthquake.

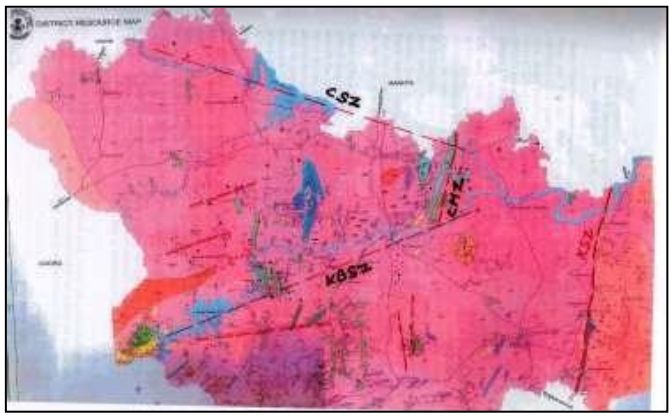

Fig.2: Geological map of with Shear /fault Zones in Mysore District

The recent minor earth tremors recorded near Kollegal and Mandya of 3.5 intensity is due to reactivation and crustal adjustments along KSZ and CMZ. Using Geographic Position System (GPS), we know that the crust in Mysore district is not stationary. The crust is moving at a very slow rate with estimated crustal movement of about 40 to 44 mm per year in a NE direction. This is related to movement of the whole Indian plate in a NE direction and collision of Indian plate with China, which is causing the raise of Himalayan mountains even today. Since the rigid Earth's upper crust in India is moving on a molten rocks (Magma) below, crustal adjustments are taking place on the surface of the earth triggering earthquake.

Fig. 3: Crustal melting of rocks along major shear zone, Kollegal.

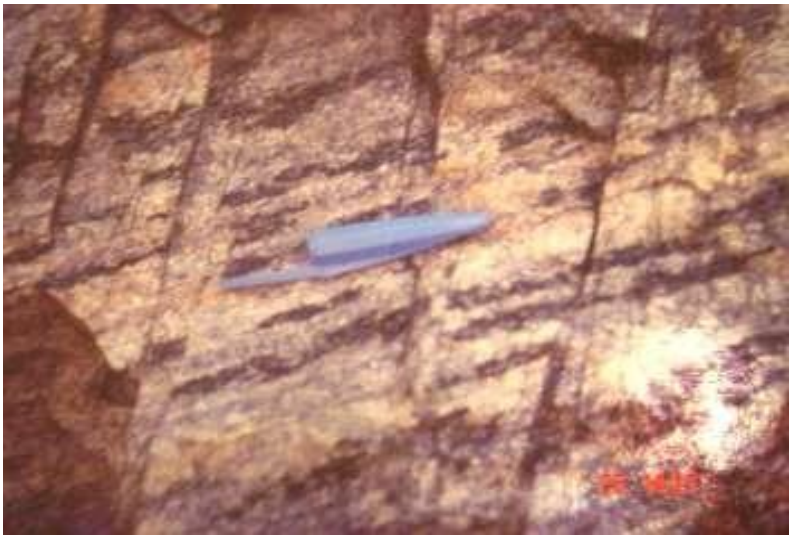

Fig.4: Brittle fractures Gneiss showing crustal movements.

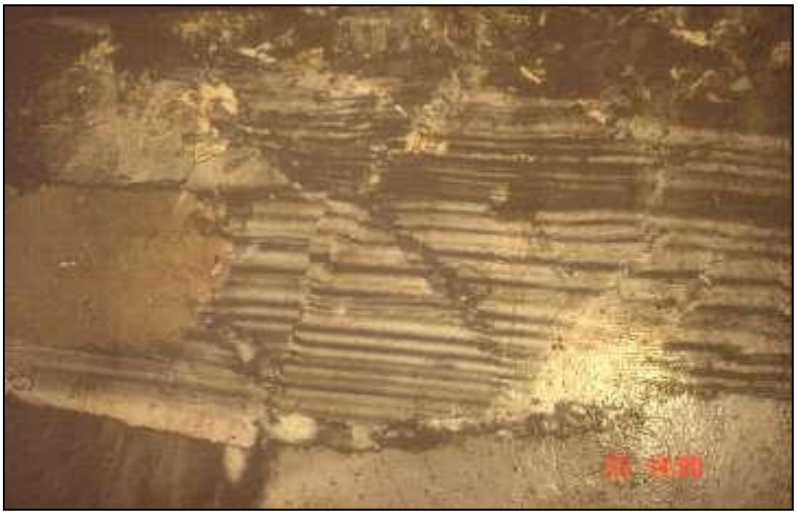

Fig.5. Microscopic studies show Fractured plagioclase grains

Some of the major fracture/shear zones are shown in Fig. 1 and Fig .2 may extend into deep crust, touching upper mantle. Deep Seismic Sounding (DSS) profile has to be undertaken to establish vertical extension of these fractures to upper mantle. Such studies done along Mercara Shear Zone has already shown that the fractures extend up to upper mantle. There is a need to study in detail some of these fracture zones in Mysore District and to trace their vertical extension to mantle. Study of rare gases like Helium analysis in soils, presence of Radan gas in groundwater along these shear zones will help in predicting earthquake prone areas.

Fig.6. Satellite photo of KRS dam site where water (dark areas) is filled along fracture zones.

An earthquake of intensity around 3.5 to 4.5 in the Richters scale may takes place along some of the shear zones around Mysore. There is a need to carry out detailed structural work around KRS dam site to record evidence of neotectonic movements in the area. The KRS dam is constructed across a NW-SE trending fracture zone which is being intruded by pink granite acting as a cementing material (Fig.6). Lineaments in the Mysore district is represents North-West or South-East direction . Fracture zones, shear zones and will comprise a fault-aligned valley, a series of fault or fold-aligned hills, an igneous intrusion like dykes [10] .Because of many fracture and shears passing though Mysore city, there is need to prepare first level seismic hazard micro zonation map of Mysore city to identify structurally weak and earthquake prone areas.

4. EARTHQUAKE MITIGATION AND MANAGEMENT

We do not have to worry too much on building a house in Mysore District as we are sitting on a stable landmass of Precambrian age where crustal disturbance is less. This is in contrast to structurally weak zones as in northern part of India like in Himalaya. However, there is a possibility of earthquake of low intensity (2 to 4.5) occurring in Mysore District. The district administration and public can take note of some of the following suggestions.

1. Building should be constructed on a good concrete base.
2. No stones filled with mud be used for the basement
3. No bricks filled with mud be used for walls
4. Rectangular and square type buildings are most suitable as being done now.
5. Heavy roofing with cuddapha/stone slabs must be avoided
6. Many old govt. buildings particularly old schools, old government offices needs to be demolished.
7. The old city market buildings and lansdown buildings need to be reconstructed with modern engineering

structures, maintaining the existing architecture.

8. Slum dwellers should be avoided who generally build their houses on mud walls and thatched roof tops.

5. CONCLUSIONS

The major rock types in Mysore district are the white to grey colored, medium to coarse grained rock types generally termed as Peninsular Gneiss of Achaean age. Various types of met sedimentary rocks and igneous occur as enclave within the Gneiss. The rock types have been subjected to various types of deformation with a regional N-S trending major structures, with steep dips. Numerous major fault/shear zones cross cut the lithologies with a width of 10 to 30 km., extending for about 50 to 200 km. with gentle to steep dips (60 to 80 degrees). Movement of rocks along these fault zones could be normal, reverse or thrust faulting which causes earthquakes. Four major shear zones viz., 1) N-S trending, steep dipping Kollegal Shear Zone passing through Chamarajanagar, Kollegal and Malavalli 2) NW-SE to N-S trending Chitradurga mylonite zones extending from east of Chitradurga, west of Mandya upto Srirangapatna and Mysore city, 3) NW-SE tending, steep dipping Mercara Shear Zones passing through Virajpet, west of Kushalnagar and Madikeri (through abbey falls) and 4) E-W trending Cauvery fracture zone along Holenarasipur and Srirangapatna.

Among four fracture/shear zones, N-S trending Kollegal Shear Zone and NW-SE trending Chitradurga Mylonite Zones are deep seated fracture zones in Mysore District. An earthquake of intensity around 2.5 to 4.5 in the Richters scale is predicted along these shear zones. Some suggestions have been given to the district administration and to public with regard to construction of earthquake resistant buildings and demolition of old buildings in Mysore District.

References:

[1] Arun Katiyar, Soutik Biswas and N.K. Singh Latur earthquake: Latest quake raises questions about stability of Indian peninsula October 31, 1993 Issue date: October 31, 1993.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[2] T.G.Sitharam,P.Anbazhagan,G.U.Mahesh,K.Bharathi and P.Nischala Reddy,Seismic hazard studies using geotechnical borehole data and gis, Symposium on Seismic Hazard Analysis and Microzonation, September 23-24, 2005, Roorkee

[3] K. Ganesh Raj and R. Nijagunappa, 2004, Major lineaments of Karnataka state and their relation to seismicity: A Remote Sensing based analysis. Journal geological society of India Vol.63, pp. 430-439

[4] Kumar P, Yuan X, Kumar M R, Kind R, Li X and Chadha, R K 2007 The rapid drift of the Indian tectonic plate; Nature 449 894–897

[5] T G Sitharam, Naveen James, K S Vipin1 and K Ganesha Raj, A study on seismicity and seismic hazard for Karnataka State,J. Earth Syst. Sci. 121, No.2, April 2012, pp. 475–490 , Indian Academy of Sciences

[6] Radhakrishna.B.P,and Vaidyanadhan.R.(1997),"Geology of Karnataka" Geological Society of India, Bangalore.

[7] C. Srikantappa, B. N. Shankar, V. N. Vasudev -1992 Spinifex-Textured Peridotitic Komatiite from Karighatta, Chitradurga Schist Belt, Karnataka JGSI Volume 40, Issue 2

[8] C Srikantappa and G R Ravindra Kumar-1994 Gneiss-Charnockite relation around Ponmudi, southern Kerala: evidences and implications of prograde Charnockite formation in southern India Proe. Indian Acad. Sci. (Earth Planet. Sci)

[9] Basavarajappa, H.T., and Srikantappa, c., 1999, Retrograde charnockite-gneiss relations in the Kollegal shear zone, Karnataka, India. The Indian Mineralogist, vol.33, No.2, pp.70-80

[10] Basavarajappa H.T, Balasubramanian A, Pushpavathi K.N and Manjunatha M.C (2012). Mapping and Integration of Geological and Geomorphological Landforms of Mysore District, Karnataka, India using Remote Sensing and GIS Techniques, Frontiers of Earth Science Research, Central University of Karnataka, Gulbarga University, Edited Vol.1, pp: 164-175