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# Bibliometric Analysis of Publications in India on Earthquake Engineering from 2010 to 2016

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## Abstract

This paper surveys Earthquake engineering studies using bibliometric analysis from 2010 to 2016 in India with topic as “Earthquake engineering” in SCOPUS database. The bibliometric analytical technique is used to examine the topic in SCOPUS publications from 2010 to 2016; which found 151 articles with Earthquake engineering. This paper studies Earthquake engineering literatures using the eight categories as: publication year, citation, country/territory, institute name, document type, research area, source title, and International collaboration, explores how Earthquake engineering studies trends have developed during this period.

Keywords : Earthquake engineering, Bibliometrics, Publications.

## 1. Introduction

Earthquake engineering is an interdisciplinary branch of engineering that designs and analyzes structures, such as buildings and bridges, with earthquakes in mind. Its overall goal is to make such structures more resistant to earthquakes. An earthquake (or seismic) engineer aims to construct structures that will not be damaged in minor shaking and will avoid serious damage or collapse in a major earthquake. Earthquake engineering is the scientific field concerned with protecting society, the natural environment, and the man-made environment from earthquakes by limiting the seismic risk to socio-economically acceptable levels Bozorgnia & Bertero, (2004). It has been narrowly defined as the study of the behaviour of structures and geo-structures subject to seismic loading; it is considered as a subset of structural engineering, geotechnical engineering, mechanical engineering, chemical engineering, applied physics, etc. However, the tremendous costs experienced in recent earthquakes have led to an expansion of its scope to encompass disciplines from the wider field of civil engineering, mechanical engineering and from the social sciences, especially sociology, political science, economics and finance (“Planetary System”, n.d.). Bibliometric analysis of publications is a research approach which has been receiving growing attention in engineering education research (EER) in recent years (Jesiek et al., 2011). Berg (1983) reports that

- Foresee the potential consequences of strong earthquakes on urban areas and civil infrastructure.
- Design, construct and maintain structures to perform at earthquake exposure up to the expectations and in compliance with building codes.

## 2. Literature Review

A literature review was conducted on earthquake engineering research papers published during 2010 to 2016 using the bibliometrics research. Trifunac (2006) analyzed the works of 51 academics with the aim of finding influential researchers on earthquake engineering. He used ISI's HighlyCited.com and tried to find out why there are no earthquake engineers in the category of engineering. As a result, the earthquake engineering was absent in the engineering category of ISI's HighlyCited.com. Trifunac (2006) also compared female and male academics in earthquake engineering by using citation analysis methods. X Liu et al (2012) provided a supplement evaluation on the global research trends in earthquake studies, by summarizing the patterns of authorship, journal and subject categories, geographic and institutional distributions, and temporal evolutions of keyword frequencies. Their analysis suggested that there has been steady growth in the scientific outputs in earthquake research and confirms the dynamic collaborations in this field.. The present study analyzes the evolution of research activity carried out in the field of earthquake engineering. With this objective in mind, all the articles published in the category "Earthquake Engineering" from the Scopus from 2010 to 2016 have been analyzed using bibliometric methods.

## 3. Objectives of the Study

The main objective of the present study is to analyze the studies on Earthquake engineering in India from 2010 to 2016, based on the publications output as indexed in Scopus database. In particular, the study focuses on the following aspects:

- (1) To study the research output on earthquake engineering, alongwith its growth.
- (2) To identify the distribution of Indian research output by broad subject areas in earthquake Engineering.
- (3) To study the international collaborative publications.
- (4) To discover the contribution of the top most-productive institutions in India.
- (5) To identify the publication productivity of leading authors of earthquake engineering studies in India.

## 4. Methodology

Several electronic databases can be used to carry out bibliometric studies. Scopus database has been selected to perform this study because it has several advantages over other databases (Bakkalbasi et al., 2006). Scopus includes larger number of journals than either Web of Science. Furthermore, Scopus allows a wide range and more accurate data analysis than Google scholar (Falagas et al., 2008).

The data were collected using the SCOPUS database at the beginning of January 2017. Publications in the field of earthquake engineering studies in India from 2010 to 2016 were retrieved. The keyword earthquake engineering in the "title" and "keyword" fields was used for searching the main publication data used in the study and became the main search string. Different search strategies were developed that were later combined with the main search string to generate the data for analyzing institutions, authors, and journal outputs.

## 5. Analysis

### 5.1 Annual Publications Pattern

There is growth in publications on Earthquake engineering. The number of publications grew by 27 publications in 2016 significantly, with the year preceding 17 publications.

Last year witnessed a large number of publications in the field of earthquake engineering, displaying ten more publications growth in one year. Table 1 & Figure 1 shows the annual publication pattern in earthquake engineering in India from 2010 to 2016.

Table 1  
Annual Publications Pattern

Year	Publications
2016	27
2015	17
2014	18
2013	18
2012	25
2011	21
2010	25

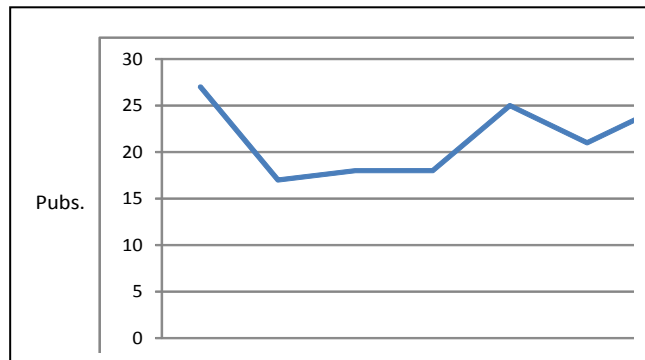


Figure 1: Annual Publications Pattern

### 5.2 Citations Pattern

There was a growth in citations of publications from 2010 to 2016. The number of citations grew with 3 in 2010, with 96 in the year 2016. Table 2 & Figure 2 shows the annual citations pattern in earthquake engineering in India from 2010 to 2017.

Table 2  
Citations Pattern

Year	Citations
2016	96
2015	95
2014	92
2013	64
2012	41
2011	12
2010	3

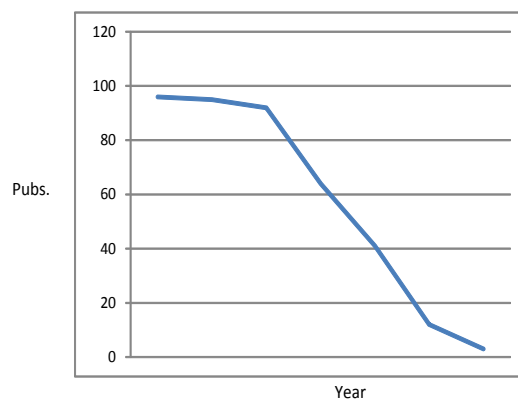


Figure 2: Citations Pattern

### 5.3 Document Type

Based on the Scopus database entries, it was found that a total of 151 papers were published in India on earthquake engineering from 2010 to 2016. A majority of the articles of periodicals (120, 79.5%), followed by article appeared in Conference proceedings (22, 14.6%), Books (4, 2.6 %), Book chapter (2, 1.3 %), article in press (2, 1.3 %) and Review (1, 0.7%). Table 3 & diagram 3 shows the distribution of publications by document type in the field of earthquake engineering from 2010 to 2016.

Table 3  
Document Type

Type	Publications	Percent
Article	120	79.5
Conference Paper	22	14.6
Book	4	2.6
Book Chapter	2	1.3
Article in Press	2	1.3
Review	1	0.7
Total	151	100

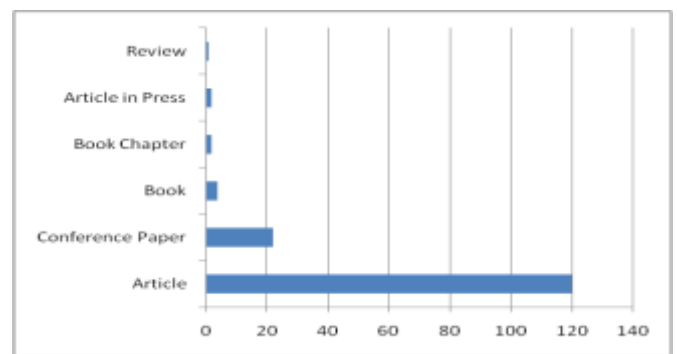


Figure 3: Document Type

### 5.4 Broad Subject Distribution

A subject analysis of the papers was done on the basis of the subject categories that were provided by the Scopus database. Studies on Earthquake engineering in India from 2010 to 2016 were published in the context of several broad subjects. The highest publication output came from top five subjects Earth & Planetary Science (93 papers, 36.3%). This was followed by: Engineering (90 publications, 35.2%); Environmental Science (41, 16%); Agriculture & Biological Science (22 publications, 8.6 %); Social Sciences (10, 3.9 %). Table 4 & diagram 4 shows the subject distribution of publications in Earthquake engineering from 2010 to 2016.

Table 4  
Broad Subject Distribution

<b>Subjects</b>	<b>Publications</b>	<b>Percent</b>
Earth and Planetary Sciences	93	36.3
Engineering	90	35.2
Environmental Science	41	16.0
Agricultural and Biological Sciences	22	8.6
Social Sciences	10	3.9

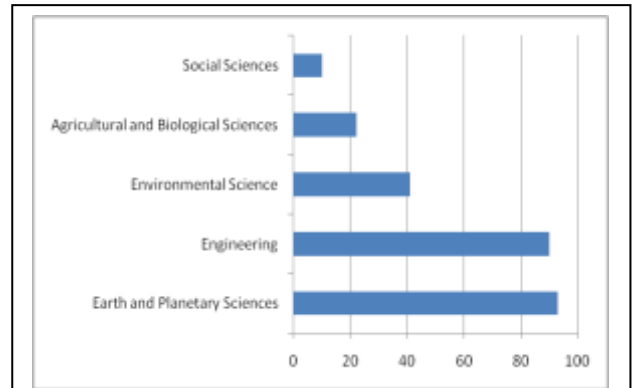


Figure 4: Broad Subject Distribution

### 5.5 Distribution of Publications by Source Title

The number of publications per source title reveals a common source for publishing articles in the area of Earthquake engineering. Table 5 & Figure 5 shows of top seven sources and the related number of publications. The numbers indicate that articles are published by a wide variety of scientific publications, emphasizing various theoretical roots. It can be seen that among the top seven source titles the majority are articles in periodicals, indicating the preference of the researchers in the field of Earthquake engineering to publish in journals.

Table 5  
Publications by Source Title

<b>Source</b>	<b>Publications</b>
International Journal Of Earth Sciences And Engineering	15
Earthquake Spectra	14
Soil Dynamics And Earthquake Engineering	11
Disaster Advances	8
Geotechnical And Geological Engineering	6
Natural Hazards	6
Engineering Structures	5

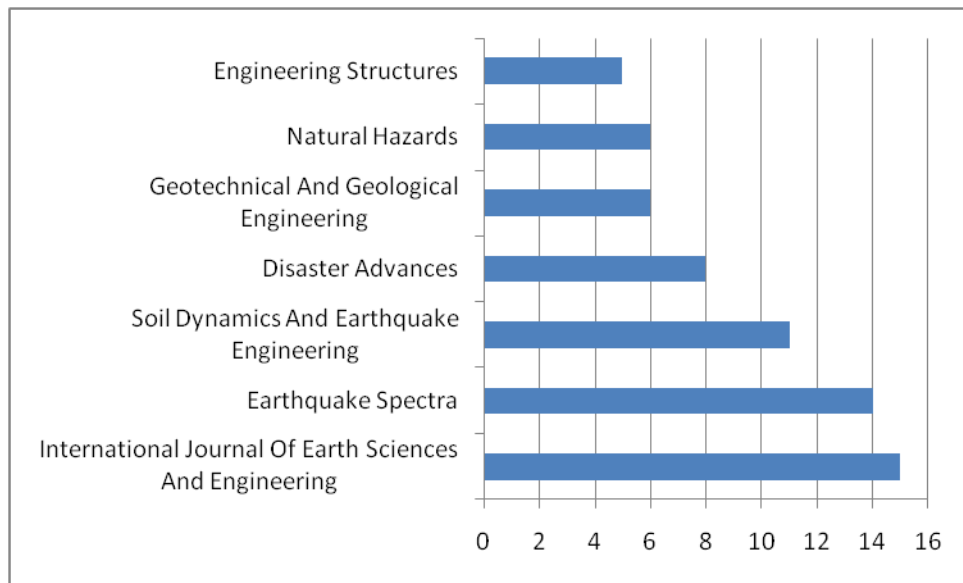


Figure 5: Publications by Source Title

### 5.6 International Collaboration

During the analysis, it was found that a total of the 46 papers from India have been written in collaboration with authors from other countries, resulting in 30% international collaboration publication metric. The highest eight countries share of international collaborative linkages were with the USA (12), followed by the U.K. (5), Germany and Norway (3 each), Greece, Italy, Nepal, South Korea (2 each). Table 6 & Figure 6 shows the list of the top eight countries with internationally collaborated papers on Earthquake engineering with India from 2010 to 2016.

Table 6  
International Collaboration

Country	Publications
United States	12
United Kingdom	5
Germany	3
Norway	3
Greece	2
Italy	2
Nepal	2
South Korea	2

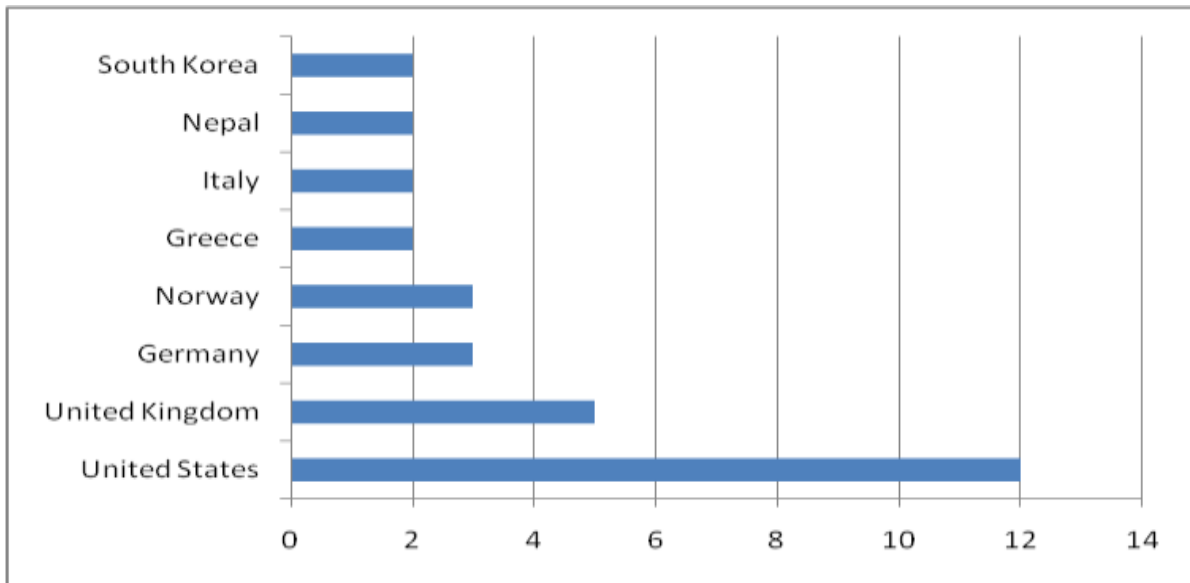


Figure 6: International Collaboration

### 5.7 Top Institutions Involved in Studies on Earthquake Engineering in India

The top ten most-productive organizations involved in Earthquake engineering studies in India published 5 or more papers each and contributed 99 publications output in Earthquake engineering studies from 2010 to 2016. These institutions include Indian Institute of Technology, Bombay (16 pubs.) Indian Institute of Technology, Kanpur (14); Indian Institute of Science (13); Vellore Institute of Technology and Indian Institute of Technology Roorkee (12 pubs. each); Indian Institute of Technology Gandhinagar (10); Indian Institute of Technology Delhi (7); Indian Institute of Technology, Kharagpur, Structural Engineering Research Centre India, Bhabha Atomic Research Centre (5 pubs. each). Table 7 & diagram 7 shows the profiles of the top twenty organizations along with their research output.

Table 7  
Top Institutions

Institutions	Publications
Indian Institute of Technology, Bombay	16
Indian Institute of Technology, Kanpur	14
Indian Institute of Science	13
Vellore Institute of Technology	12
Indian Institute of Technology Roorkee	12
Indian Institute of Technology Gandhinagar	10
Indian Institute of Technology Delhi	7
Indian Institute of Technology, Kharagpur	5
Structural Engineering Research Centre India	5
Bhabha Atomic Research Centre	5

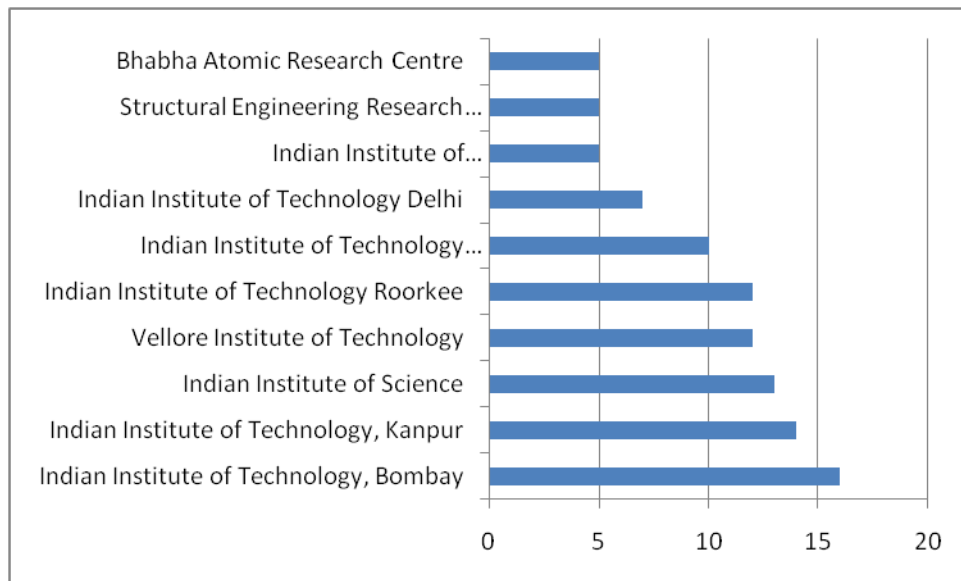


Figure 7: Top Institutions

### 5.8 Top Authors in Earthquake Engineering Studies in India

The top seven most-productive researchers in Earthquake engineering studies published 5 or more papers each and together contributed a 34 % (52 publications) share in the cumulative research output of India in Earthquake engineering from 2010 to 2016. The profile of the top seven authors along with their research output, are shown in Table 8 & Figure 8.

The seven authors are Choudhury, D. (11); Jain, S.K. and Samui, P. (9 each); Kumar, J. (7); Rai, D.C. (6); Reddy, G.R. and Singh, Y. (5 each).

Table 8  
Broad Subject Distribution

Author	Publications
Choudhury, D.	11
Jain, S.K.	9
Samui, P.	9
Kumar, J.	7
Rai, D.C.	6
Reddy, G.R.	5
Singh, Y.	5

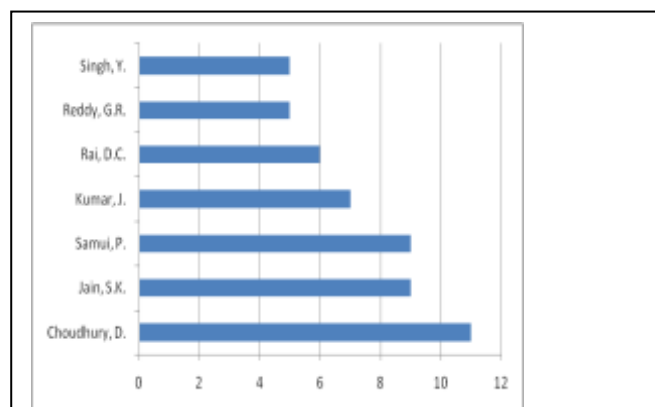


Figure 8: Broad Subject Distribution



## 6. Discussion and Conclusion

The purpose of this study was to conduct a bibliometric analysis of Earthquake engineering research in India in order to understand the growth of literature in the discipline, the pattern of publications of research. For this purpose, 151 papers published in India during 2010–2016 were analyzed.

Analysis indicates that research in the area is gaining momentum and that India may play a key role in Earthquake engineering study in the future. It was found that most of the papers were published in the form of articles in Journals. This indicates that researchers in India in the discipline like to publish their articles in periodicals. This may be because periodicals allow a platform for the exchange of ideas. However, it was found that the highest numbers of articles on Earthquake engineering were published in International Journal of Earth Sciences and Engineering making it a preferred journal title as a publication outlet among researchers. As a large number of authors indicate the interdisciplinary nature of research in the area, it can be deduced that research in Earthquake engineering in India is interdisciplinary in nature. A total of 46 publications (34%) were international collaborative papers. This shows that research in Earthquake engineering in India involves more international collaboration. Among the ICP, the highest collaborator is the USA, which indicates the sharing of knowledge and expertise in the discipline between the two countries. Among the top twenty institutions, IIT, Bombay emerged as the number one institution on the basis of research productivity, followed by IIT, Kanpur, Indian Institute of Science, Vellore Institute of Technology, IIT, Roorkey, IIT, Gandhi Nagar, IIT, Delhi, IIT, Kharagpur, Structural Engineering Research Centre, India, Bhaba Atomic Research Centre. The top seven most-productive authors contributed a 34 % (52 publications) share in the cumulative research output of India in Earthquake engineering. It is concluded that there is good potential that the profiles of the Indian institutions and authors will become more influential as they gain citations in time.

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