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Research publication trends in structural engineering based on *Journal of Structural Engineering*

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Provides a historical perspective on structural engineering research as reflected in the *Journal of Structural Engineering* (JoSE). Reports the result of a twelve year (1993 – 2005) analysis of the journal from 1993 through 2005. The JoSE is intended to be of interest to researchers, professionals and students in all civil / mechanical engineering disciplines.

Introduction

Information is the result or product of processing data that it leads to knowledge. This knowledge in turn leads to development. Such a development brings in further information which adds to the earlier knowledge, which helps further development. This is the knowledge development cycle which plays a vital role in the growth and sustenance of any library and information science (LIS) environment.

One of the areas of knowledge generation involving the LIS professionals is the study of publication trends of research papers published in general[1]. A number of studies have been carried out on information use patterns in various disciplines of science based on citation analysis[2-4]. Bibliometric studies on collaborative research trends and its explorations have been done by various authors[5-7]. Over the years, scientometrics and bibliometrics techniques have become tools to evaluate the productivity of research institutes, individual researchers, as well as to map growth of the research field. Kademani and Vijayakumar[8] have given a bird's eye view of the bibliometric and scientometric techniques used to study various quantitative and qualitative aspects of scientific endeavours. Kannappanavar et al have studied the authorship trend and collaborative research in chemistry in India during 1999-2000 and reported the trend towards multi-authorship papers[9].

Journal of Structural Engineering (JoSE, ISSN 0970-0137)[10] is a bimonthly journal being brought out by Structural Engineering Research Centre (SERC) Chennai, India, to disseminate results of R&D investigations being carried out in various academic and research institutions in India and abroad in the field of civil / mechanical engineering discipline. The first issue of every volume is dedicated to a special topic/theme of current R&D interest. The primary components of the journal are technical papers, technical reports, news & notes, book reviews / receipts and special issues. The JoSE is intended to be of interest to researchers, professionals and students in all civil/mechanical engineering disciplines. *Journal of Structural Engineering* is a well known journal among professionals with 350 subscribers in India and 30 subscribers from abroad. It is being catalogued by Library of Congress.

Objectives of the study

In this analysis, the research publication trends in structural engineering as reflected through the *Journal*

Table 1— Technical content of the JoSE

Volume no.	Year	Technical papers	Technical notes	Book reviews & Book receipts
20	1993-1994	19	3	8
21	1994-1995	24	5	12
22	1995-1996	19	8	9
23	1996-1997	21	9	21
24	1997-1998	18	15	8
25	1998-1999	22	15	12
26	1999-2000	24	15	9
27	2000-2001	23	16	13
28	2001-2002	18	11	12
29	2002-2003	21	16	4
30	2003-2004	23	19	3
31	2004-2005	28	17	2
	Total	260	149	113
	Average	21.67%	12.42%	9.42%

of Structural Engineering are studied. The study has been undertaken with the following objectives:

1. To study the main areas and topics that were the focus of the published papers during twelve years of the journal;
2. To compile main contributing organizations / institutions at the national and international level;
3. To analyse the information about the authors and their collaborations with inter and intra institutions at national and international level; and
4. To determine the technical topics covered in the journal.

Methodology

The required statistical data have been collected from JoSE for 12 year period from 1993 – 2005 to gain a better understanding of the nature and dynamics of the civil and structural engineering research community and the research areas. The parameters analysed include, contents pages of the issues, titles of special issues with editors details, number of authors appearances, authors affiliation such as type of organization, country of origin, collaborations with inter and intra institutions at national and international level and subjects of R&D thrust areas. In some cases, the twelve years analysis is broken into three periods to better analyze trends over time. Period 1 is a 4 year period from 1993 through 1996, Period 2 is from 1996 through 2001, and Period 3 from 2001 through 2005. The collected data has been tabulated and charts prepared to analyse them.

Results and discussions

Technical papers

JoSE provides a publication platform for papers of interest to a broad area of civil engineering and related disciplines. The number of papers published in the journal over the twelve year period totaled 260 and averaged 21.67 per year or 5.42 per issue. The distribution of papers is shown in Table 1. In its first four years of study, the average was 20.75 papers per year or 6.9 papers per issue. In the last four years, the average is 22.5 or nearly 7.5 papers per issue.

Technical notes

Technical notes constitute original, practical information, potential results of research or presented results or innovative techniques to accomplish design objectives. Table 1 shows that the JoSE publishes on an average 12.42 technical notes per year. The publication of the

Table 2 — Special issues

Year	Vol. & Issue	Title of special issue	Editors	No. of Tech. papers	No. of Tech. Notes
1993-1994	20& 1	Damage Assessment, repair and Rehabilitation of Structures	R.Narayanan and S.Gopalkrishnan	6	0
1994-1995	21& 1	Nonlinear Analysis of Structures	R.Narayanan and S.Gopalkrishnan	7	1
1995-1996	22& 1	Analysis, Design and Construction of Structures to Mitigate Damages due to Natural Disasters	R.Narayanan, S.Gopalkrishnan and N.Jayaram	6	2
1996-1997	23& 1	Recent Developments in Application of Computers to Structural Analysis, Design and Construction	R.Narayanan, S.Gopalkrishnan and N.Jayaram	5	3
1997-1998	24& 1	Recent Developments in Construction Materials and their Applications	R.Narayanan, S.Gopalkrishnan and N.Jayaram	5	3
1998-1999	25& 1	Reliability Based Design of Structures	R.Narayanan, S.Gopalkrishnan and N.Jayaram	8	2
1999-2000	26& 1	Recent Developments in Fatigue and Fracture Mechanics –based Analysis, and Design of Structures	R.Narayanan, S.Gopalkrishnan and N.Jayaram	8	2
2000-2001	27& 1	Recent Developments in Use of Steel for Construction of Buildings, Bridges and other Structures	R.Narayanan and S.Gopalkrishnan	6	3
2001-2002	28& 1	Recent Developments in High Performance Construction Materials and their Applications	R.Narayanan and S.Gopalkrishnan	5	3
2002-2003	29& 1	Advances in Engineering of Structures in Mitigate Damage due to Earthquakes	S.Gopalkrishnan and K.Balaji rao	8	1
2003-2004	30& 1	Analysis, Design and Construction of Special Structures	S.Gopalkrishnan and K.Balaji rao	8	4
2004-2005	31& 1	Advances in Health Monitoring / Assessment of Structures including Heritage and Monumental structures	S.Gopalkrishnan and K.Balaji rao	10	0

Table 3 – Number of authors and percentage of appearances

No. of authors	Technical Papers			Technical Notes		
(A)	Number (B)	(A) x(B)	Percentage	Number (C)	(A) x(C)	Percentage
Period 1 (1993-1996)						
1	7	7	8.43	9	9	36.00
2	49	98	59.04	12	24	48.00
3	14	42	16.87	3	9	12.00
4	10	40	12.05	1	4	4.00
5	3	15	3.61	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
Total	83	202	100 %	25	46	100 %
Period 2 (1996-2001)						
1	14	14	16.09	23	23	37.70
2	49	98	56.32	28	56	45.90
3	16	48	18.39	9	27	14.76
4	7	28	8.05	1	4	1.64
5	0	0	0	0	0	0
6	1	6	1.15	0	0	0
7	0	0	0	0	0	0
Total	87	194	100 %	61	110	100 %
Period 3 (2001-2005)						
1	17	17	18.89	31	31	49.21
2	38	76	42.22	21	42	33.34
3	25	75	27.78	8	24	12.69
4	5	20	5.56	3	12	4.76
5	3	15	3.33	0	0	0
6	1	6	1.11	0	0	0
7	1	7	1.11	0	0	0
Total	90	216	100 %	63	109	100 %
Total (12 years)	260	612	100 %	149	265	100 %

technical notes is almost equivalent to the technical papers i.e ~ 36.43 % of total of papers and notes.

The number of notes published in the journal over the twelve year period totaled 149 and averaged 12.42 per year or 3.1 per issue. The technical notes distribution is shown in Table 1. In its first four years of study, the average was 6.25 per year or 1.56 per issue. In the recent 4 years, the average was 15.75 or nearly 5.25 per issue. Thus, there is a considerable growth with a steady source of material available to publish in the journal.

Special issues

Special issues of the journal are brought out to present a collection of papers that focus on a single topic or theme. Table 2 identifies the special issues published in the JoSE for the period of study. There have been a total of twelve special issues for the period of study. The special issues have focused on topics that are of significant interest to civil and structural engineers.

The number of technical papers published in the twelve special issues totaled 82 and averaged 6.83 per special

Table 4 — Contributions from major academic institutions

Sl. No.	Institutions papers &	No. of papers & tech. notes appearance	Adjusted number of papers & tech. notes	No. of Technical papers	Adjusted Number of Papers	No. of Tech. Notes appearance	Adjusted Number of Tech. notes
1	Indian Institute of Technology, Kanpur	37	35.33	10	8.33	27	27
2	Indian Institute of Technology, Madras	27	19.67	20	16.34	5	3.3
3	Indian Institute of Science, Bangalore	22	17.33	22	17.33	0	0
4	National Institute of Technology, Calicut	22	20	10	8	12	12
5	Banaras Hindu University, Varanasi	20	20	17	17	3	3
6	Indian Institute of Technology, New Delhi	17	10.33	14	9.33	3	1.5
7	Jordan University of Science & Technology, Jordan	13	10.5	12	9.5	1	1
8	S.G.S. Institute of Technology & Science, Indore	12	9	4	3.5	8	5.5
9	Nanjing Institute of Technology, China	10	9.5	1	1	9	8.5
10	Southeast University, China	6	2.83	2	0.83	4	2
11	Hong Kong Polytechnic, Hongkong	6	4.5	4	3	2	1.5
12	PSG College of Technology, Coimbatore	6	5.33	5	4.33	1	1
13	National Institute of Technology, Rourkela	6	6	5	5	1	1
14	Indian Institute of Technology, Kharagpur	6	5.66	5	4.66	1	1
15	University of Arizona, USA	5	3.5	4	3	1	0.5
16	Aligarh Muslim University, Aligarh	5	3.25	2	1.25	3	2
17	Anna University, Chennai	5	2.58	2	0.58	3	2
18	SSVPS College of Engg., Dhule, India	5	3	1	1	4	2
19	Andhra University, Vizag	5	4	4	3	1	1
20	University of Roorkee, Roorkee	5	3.33	4	3	1	0.33
21	Technische Universitat Muchen, Germnay	4	2.88	4	2.88	0	0
22	Indian Institute of Technology, Mumbai	4	2.88	4	2.88	0	0
23	JNTU College of Engg. Ananthapur	4	1.33	4	1.33	0	0
24	Visvesvaraya REC, Nagpur	4	2	2	1	2	1
25	Institute of Construction and Architecture of Slovak Academy of Science, Slovakia	3	3	2	2	1	1
26	University of South Central China, China	3	2.5	1	0.5	2	2
27	Malnad College of Engg.,Hassan	3	1.66	3	1.66	0	0
28	Purdue University, USA	3	1.5	3	1.5	0	0
29	Motilal Nehru Regional Engg. College, Allahabad	3	3	2	2	1	1
30	Manipal Institute of Technology, Manipal	3	3	2	2	1	1 33
31	Annamalai University	3	0.99	3	0.99	0	0

Table 5 — Contributions from government and industry

Sl. No.	Government and Industry	No. of papers & tech. notes	Adjusted Number of Papers & Tech. Notes	No. of Technical papers	Adjusted number of papers	No. of Tech. notes	Adjusted Number of Tech. notes
1	SERC, Chennai	57	50.65	43	38.77	14	11.88
2	PVT. – Structural Engg./Consultant	17	13	8	6.5	9	6.5
3	VSSC, Trivandrum	8	8	3	3	5	5
4	Kothari Associates (P) Ltd., New Delhi	6	5.5	0	0	6	5.5
5	BARC, Mumbai	5	3.93	4	2.93	1	1
6	CBRI, Roorkee	4	3.33	3	2.33	1	1
7	SERC, Ghaziabad	3	1.33	1	0.5	2	0.88
8	Technical Research Centre of Finland Building Technology & Wood Technology, Finland	2	2	2	2	0	0
9	Common wealth Associates, Inc. USA	2	1.5	1	0.5	1	1
10	Fugro (Hong Kong) Ltd., Hong Kong	2	1.25	2	1.25	0	0
11	R&D Esst. (Engrs.)., Pune	2	2	2	2	0	0
12	Larsen & Tubro Ltd., Chennai	2	1.25	2	1.25	0	0
13	Engineers India Limited	2	0.66	2	0.66	0	0

issue. Likewise, the number of technical notes published in the twelve special issues totaled 24 and averaged 2 per special issue.

Contributors

A total of 877 different authors contributed to the journal during the twelve year period of study that included 260 authors for technical papers and 149 authors for technical notes. There are several repeat authors amongst the above. Table 3 shows the breakdown of the 877 authors by the multiplicity of authorship and by the number of times they were listed as an author regardless of number of co-authors, for both technical papers and technical notes.

Table 3 also shows that the number of appearances of authors has been steadily maintained as far as technical papers are concerned. As regards to technical notes, it is seen that in the period 1, 25 authors contributed, but in the subsequent two periods it has steadily increased. It is also seen that more than 65 % of technical papers are authored by one or two authors, whereas in the case of technical notes more than 80 % of notes are authored by one or two authors throughout the period of study.

Institutional contribution

An overwhelming majority of the authors were affiliated with institutions of higher education. Table 4 lists the academic institutions whose faculty contributed the most number of papers to the JoSE. For each institution, the adjusted number of papers is computed using the equation: $\Sigma^{n}_{i=1} 1 / M$, where n=number of papers published by an institution and M=number of contributing institution for the i^{th} paper[11]. For example, if two authors contributed from two different institutions, then each one would receive 1/2 point for that paper. If three authors contributed to a paper, two from one institution and one from another, then the first one would receive 2/3 point whereas the second one would receive 1/3 point. Table 4 lists only those institutions that have contributed thrice, or more

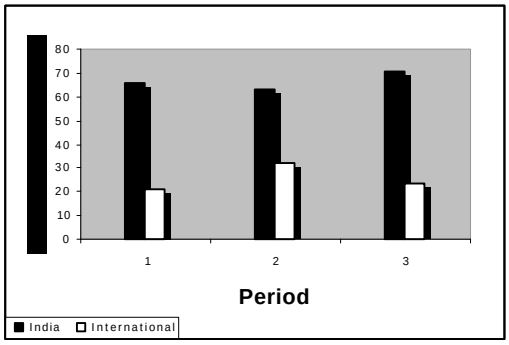

Fig.1 — Contributions from national and international authors - Technical Papers

number of times. Likewise, Table 5 lists governments and industries that have contributed twice or more number of times.

Internationalization

Both JoSE and its publication committee have expanded efforts aimed at greater internationalization. This section addresses this subject with respect to the JoSE's authors.

Researchers from 24 countries contributed to the journal between 1993 and 2005 for technical papers and technical notes. Table 6 identifies these countries and shows the number of appearances and adjusted number of paper (at least once) for each country.

Table 6 shows the change for each country level of contribution from period 1 to 2 and period 2 to 3. For each country, the adjusted number of papers is computed using the equation $\Sigma^{n}_{i=1} 1 / M$, where n=number of papers published by authors from that country and M=number of contributing countries for the i^{th} paper. For example, if two authors contributed from two different countries, then each one would receive 1/2 point for that paper. If three authors contributed to a paper, two from one country and one from another, then the first one would receive 2/3 point whereas the second one would receive 1/3 point. Table 6 gives the details of contributing authors of papers (by period).

Figure 1 shows the graphical data on international authors over the total period with respect to technical papers. Although only an average of 21.69% of the papers from Period 1 were written by international authors, this number increased to 28.74% during the Period 2. Period 3 shows a slight decrease to 22.22%. Overall, there have been approximately, 76% from India and 24% from international organizations. The JoSE has more or less maintained its attractiveness to foreign authors. Likewise Table 7 shows the country of origin and contributing authors for technical notes (total period under study). Figure 2 shows the graphical data that indicates that the

Table 6 — Country of origin of contributing authors for papers

Country	Number of appearances	Adjusted number of papers
Period 1 (1993-1996)		
India	66	64.84
Jordan	7	6
United States	4	1.83
United Kingdom	2	2
Hong Kong	2	1.5
Germany	2	2
Australia	2	1.5
Italy	1	1
Croatia	1	1
Greece	1	1
Egypt	1	1
Period 2 (1996-2001)		
India	63	62.5
Jordan	4	3
United States	5	3.5
United Kingdom	2	1.66
China	2	2
Hong Kong	2	1.33
Slovakia	1	1
Germany	4	3.5
Czech	1	1
Italy	1	1
Oman	1	0.5
Egypt	1	0.5
Canada	2	1.5
France	1	0.5
Finland	2	2
Sri Lanka	1	0.5
Algeria	1	0.5
Syria	1	1
Period 3 (2001-2005)		
India	71	70.5
Jordan	2	2
United States	12	11
United Kingdom	1	0.5
China	3	3
Hong Kong	1	1
Slovakia	1	1
Germany	2	1.5
Japan	1	0.5

contribution for technical notes is approximately 75% from India and 25% from international organizations.

Table 8 shows the contributing authors for technical papers and notes from India and foreign countries over the twelve year period (1993-2005) with the number of authors appearances, adjusted number of papers (as like in the earlier cases) and the percentage of the appearances. It is found that 76.09% of technical papers are from Indian authors, but 23.91% of contributing papers are from the foreign authors. In a similar way, it is found that 75.17% are from Indian authors and 24.83% are from foreign authors in the case of technical notes. As a whole, it was found that JoSE's contributions are around 75% from Indian authors and 25% from the foreign authors for both technical papers and notes.

Technical topics

To determine the subject areas addressed by the journal, each published paper was classified based on the broad area or topic in which it makes its main civil engineering contribution. Table 9 shows the topics with most appearances for each of the three periods and the total period under study.

A review of the compiled data for all the three periods reveals that concrete composites and materials and reinforced concrete structure is the major topic in all the three periods. However, its predominance had a significant decrease in number published over time though it remains the first position for all the periods. Similarly computer aided analysis and design of structures has decreased over time from Period 1 to 3. Other topics like fatigue and fracture, shock and vibration and experimental mechanics, construction engineering and pre-stressed concrete, structural dynamics,

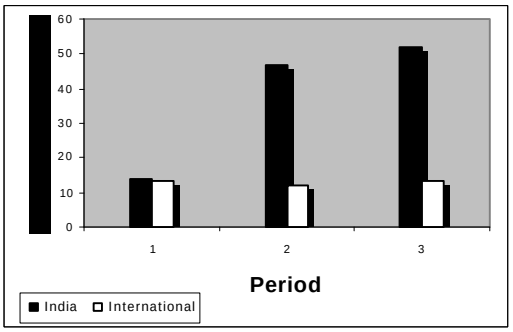

Fig. 2 — Contributions from national and international authors - Technical Notes

Table 7 — Country of origin of contributing authors - Technical notes

Country	Number of appearances	Adjusted number of papers
Period 1 (1993-1997)		
India	14	13.5
United Kingdom	4	3.5
United States	2	1.33
Hong Kong	2	1.5
Jordan	1	1
China	1	1
Russia	1	1
Oman	1	0.5
Turkey	1	1
Period 2 (1998-2001)		
India	47	47
China	7	7
Hong Kong	2	2
Jordan	1	1
Slovakia	1	1
Canada	1	1
Period 3 (2002-2005)		
India	52	51.33
United States	6	5.66
China	6	5.5

Table 8 — Contributing authors for technical papers and notes from India and foreign countries (Total period under study)

Country	Technical papers			Technical notes		
	No. of authors appearance	Adjusted no. of papers	% of appearance	No. of authors appearance	Adjusted no. of notes	% of appearance
India	200	197.84	76.09	113	112	75.17
Foreign	78	62.16	23.91	38	37	24.83
Total	278	260	100%	151	149	100%

Table 9 — Journal content by topic* (Period-wise)

Sl. No.	Topic	Number of papers
Period 1 (1993-1996)		
1	Concrete Composites & Materials and Reinforced Concrete Structure	30
2	Computer Aided Analysis and Design of Structures	18
3	Structural Dynamics, Earthquake engineering and Wind Engineering	17
4	Fatigue & Fracture, Shock & Vibration and Experimental Mechanics,	12
5	Construction Engineering and Pre-stressed concrete	11
6	Steel Structures and other Skeletal Structures	9
Period 2 (1996-2001)		
1	Concrete Composites & Materials and Reinforced Concrete Structure	28
2	Fatigue & Fracture, Shock & Vibration and Experimental Mechanics,	17
3	Structural Dynamics, Earthquake engineering and Wind Engineering	15
4	Computer Aided Analysis and Design of Structures	13
5	Construction Engineering and Pre-stressed concrete	9
6	Steel Structures and other Skeletal Structures	5
Period 1 (2001-2005)		
1	Concrete Composites & Materials and Reinforced Concrete Structure	20
2	Structural Dynamics, Earthquake engineering and Wind Engineering	20
3	Fatigue & Fracture, Shock & Vibration and Experimental Mechanics,	13
4	Construction Engineering and Pre-stressed concrete	10
5	Steel Structures and other Skeletal Structures	9
6	Computer Aided Analysis and Design of Structures	4

**The classification of subject areas is in tune with the R&D thrust areas being pursued at SERC, India*

earthquake engineering and wind engineering and steel structures and other skeletal structures almost occupied the same level of appearance throughout the period of study. In the recent period, a remarkably increasing number of papers appeared for topics related to structural dynamics, earthquake engineering and wind engineering, probably indicating that many of the authors have shown interest in the field of natural disasters like earthquake, cyclone and other calamities.

Research topics related to computer aided analysis and design of structures show the civil engineers' involvement in the usage of computer and information technology, modeling and simulation etc in the field of civil and structural engineering. Though there is considerable reduction in number of papers in this topic, computer programs, and various algorithms were applied by the researchers for their research work in their respective fields like nonlinear analysis, theoretical analysis, finite element modeling, simulation, damage assessment, and numerical analysis and dynamics analysis.

Conclusion

This paper analyzed the main areas and topics published during twelve year period of JoSE. This study found that in the case of technical notes there is a considerable growth and a steady source of material available to publish in the journal. From the results of this paper, it can be concluded that in the field of civil/structural engineering, the collaborations are limited and much of the articles are written by one or two authors in both the cases of Technical

papers and notes. Contributions to JoSE are more from Indian authors while the number of papers from foreign authors is on the rise. It is further concluded that the field of research, covering concrete composites & materials and reinforced concrete structures, has produced greater output in the form of research papers, indicating enhanced interest of researchers and authors in civil/structural engineering.

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