# Citation Rates of Award-Winning ASCE Papers

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**Abstract:** Citation data is increasingly being used to assess quality and importance. By this criterion, a paper that is not cited is automatically assumed to lack both quality and significance. This paper examines the validity of this hypothesis by reviewing citation rates of award-winning ASCE papers over a 25-year period from 1978–2002. In the study, citation data for seven civil engineering subdisciplines were obtained from the Science Citation Index developed by the Thomson Institute for Scientific Information (ISI). The analysis showed that nearly 25% of the award-winning papers were never cited with over 30% cited just once. Citations were higher in subdisciplines that are science based and lower in those that are more applied or specialist. These findings indicate that although citations provide a quantitative measure of use, they are imperfect indicators of quality and significance. **DOI: 10.1061/(ASCE)EI.1943-5541.0000092.** 

**CE Database subject headings:** ASCE; Awards; ASCE publications.

**Author keywords:** ASCE; Citation; ISI; Uncitedness; Award.



## Introduction

The Science Citation Index (SCI) developed in the 1960s by the Philadelphia-based Institute for Scientific Information (ISI) was the first database linking scholarly articles and references. ISI currently indexes articles from over 9,300 of the most influential journals in basic sciences, technology, social sciences, arts, and humanities. Its online version, the "Web of Science," facilitates easy access.

The availability of the ISI database made it possible for librarians to conduct analyses to identify resources most used by researchers. This information enabled them to make rational choices on managing collections and optimizing space by moving older material into compact storage thereby freeing up shelf space (Musser and Conkling 1996). With the increasing demand for objectivity in identifying quality and productivity of researchers, the role of citation analysis underwent radical change. Citations are now used to create lists of the most highly cited authors in 22 disciplines (available in ISI's HighlyCited.com) and world-wide university rankings are on the basis of total citations received by universities. Cumulative citation rates of all the papers published in a journal over a period of time are used to develop "impact factors" to rank journal quality. Journals have higher impact factors if they contain a higher number of cited papers. It should be no surprise that policymakers, funding bodies, and tenure promotion committees increasingly rely on citation data in decision making because they are perceived to provide a more objective and unbiased measure of scholarly performance, e.g., Nisonger (2004); Castellano and Radicchi (2009).

Information on citation analysis in engineering is, however, relatively scarce. Hamilton (1990) mentions that only 42% of articles published between 1969 and 1981 in hard sciences (that included medicine and engineering) had received more than one citation, that is, 58% were uncited. A year later, Hamilton (1991) reported on citations for engineering articles published in 1984 over a 5-year period. This showed that 72% of all engineering papers were uncited. Among disciplines, civil engineering at 78% had the highest uncitedness rate followed by mechanical and aerospace (76.8%), electrical (66.2%), chemical (65.8%), and biomedical (59.1%). These uncitedeness percentages were much higher than those, for example, in atomic physics (9.2%), inorganic and nuclear chemistry (17%), and molecular biology (19.4%).

Pendlebury (1991) commenting on Hamilton's 1991 data noted that although the figures quoted were correct, uncitedness percentages were higher since they included "marginalia" (editorials, obituaries, letters, etc.) that should be excluded. This was reiterated by Garfield (1998) who pointed out that uncitedness was "almost nonexistent" 5 years after publication in the 200 journals with the highest impact. However, marginalia (other than editorials) are not the norm in civil engineering journals and therefore Hamilton's data is still valid for comparison.

More recently, Trifunac (2006) reviewed data for 51 academics in earthquake engineering to estimate their relative standing among highly cited engineers. He concluded that there were no earthquake engineers in this elite list because there were too few researchers in the field. Though this finding is not surprising, it is nonetheless an important one. A corollary of this observation is that the absolute number of citations for "ordinary" papers in disciplines with large numbers of researchers, e.g., nanotechnology, will far exceed those for "landmark" papers in earthquake engineering because the pool of active researchers is so much smaller.

Since citations indicate use by other researchers, it may be concluded that they provide an impartial basis for assessing the quality and importance of an article. Under this hypothesis, the best papers are the ones with the highest number of citations and vice versa. This paper presents results of a citation analysis conducted to evaluate the validity of this hypothesis. In the study, citation rates of papers were examined whose quality, relevance, and significance, on the basis of rigorous peer review, is unquestioned. These were

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papers that had been handpicked by ASCE for its most prestigious awards. Citation rates of these award-winning papers in seven civil engineering subdisciplines were determined and reviewed. Data for the study spans a 25-year period from 1978–2002. The citation information used was obtained from ISI's SCI.

## Overview

Among engineering societies, ASCE, founded in 1852, is the oldest in the nation. As Musser and Conkling (1996) observed, "society-based publications … are widely recognized as being highly prestigious and form the core of the engineering literature." Since 1874, ASCE has selected papers adjudged to be the best and most influential from those published the preceding year. Initially, ASCE published a limited number of journals and therefore the number of awards was commensurately smaller. With the emergence of new subdisciplines within civil engineering, the number of journals published by ASCE has increased steadily over the years, as has the number of awards.

As of 2009, ASCE published 32 journals of which 16 were indexed in ISI's database. A summary of these journals together with their respective impact factor is given in Table 1. The highest impact factor is for the Journal of Water Resources Planning and Management (1.275) and the lowest is for the Journal of Bridge Engineering (0.438).

The journals indexed by ISI are only those they deem to be the most influential. Thus, citations provided by ISI exclude those journals that are not indexed by it including the other 16 ASCE journals (making up 32) not listed in Table 1. Therefore, the total number of citations obtained using the ISI database underestimates the true number. This shortcoming has been noted by others, e.g., Nisonger (2004). However, since previous studies, e.g., Hamilton (1991) utilized the same database, its use provides a valid basis for comparison.

**Table 1.** List of ASCE Journals Indexed by ISI (2009)

| Discipline | Impact factors |
|---|---|
| Journal of Aerospace Engineering | 0.907 |
| Journal of Bridge Engineering | 0.438 |
| Journal of Construction Engineering and Management | 0.564 |
| Journal of Composites for Construction | 0.798 |
| Journal of Computing Civil Engineering | 1.114 |
| Journal of Environmental Engineering | 1.085 |
| Journal of Geotechnical and Geoenvironmental Engineering | 0.849 |
| Journal of Hydraulics Engineering | 1.272 |
| Journal of Irrigation and Drainage Engineering | 0.822 |
| Journal of Materials in Civil Engineering | 0.526 |
| Journal of Performance of Constructed Facilities | 0.5 |
| Journal of Water Resources Planning and Management | 1.275 |
| Journal of Waterway Port Coastal and Ocean Engineering | 0.789 |
| Journal of Structural Engineering | 0.789 |
| Journal of Surveying Engineering | 0.569 |
| Journal of Transportation Engineering | 0.665 |

## Awards Used in Analysis

Since the intent of the study is to determine the correlation between citation rates and quality, the oldest and most prestigious awards covering multiple subdisciplines were selected for analysis. Though it can be argued that such a choice is inherently flawed because award-winning papers are selected by a committee, nonetheless, they are perceived by most civil engineers and the public at large to be the best in any given year. They will be expected to be highly cited; their citation rate provides a benchmark against which other papers can be compared.

The awards used in the study are summarized in Table 2. No awards were made on three occasions. The list includes the Norman Medal and the J. James R. Croes Medal awarded to papers ranked the best and second best, respectively, among all ASCE publications. Although structures has the largest share of these awards, construction, engineering mechanics, environmental, geotechnical and geoenvironmental, and transportation have all been recipients (Table 3).

The more recent awards reflect emergence of subdisciplines such as geotechnical (Thomas A. Middlebrooks Award) and prestressed concrete (T. Y. Lin Award). The latter is given to the best paper in prestressed concrete from three society journals, namely ASCE, the American Concrete Institute (ACI), and Precast/Prestressed Concrete Institute (PCI).

## Approach

The names of authors of award-winning papers are published in ASCE's official register. Since only names of authors were available, searches were conducted to identify the title and publication details of each award-winning paper. In several instances, abstracts confirmed that the paper identified had indeed been a recipient of

**Table 2.** ASCE Awards Analyzed

| Award | First awarded | Discipline | Comments |
|---|---|---|---|
| Norman Medal | 1874 | All | Recognizes paper making a definitive contribution to engineering science; not awarded in 1981. |
| Rowland Prize | 1883 | Construction | Awarded for valuable contributions to construction management and construction engineering; not awarded in 1998 or 2000. |
| J.James R. Croes Medal | 1913 | All | Runners-up to Norman Medal. |
| Rudolph Hering Medal | 1927 | Environmental Water Resources | Original paper dealing with water works, sewerage works, drainage, refuse collection and disposal, or any branch of environmental engineering. |
| Thomas A. Middlebrooks Award | 1956 | Geotech | Awarded to paper worthy of special commendation for its merit as a contribution to geotechnical engineering. |
| T. Y. Lin Award | 1969 | Prestressed Concrete | Awarded to the most "meaningful" paper in prestressed concrete published in ACI Structural Journal, Prestressed Concrete Journal, and ASCE. |



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**Table 3.** Subdisciplines Awarded the Norman Medal and the J. James R. Croes Medal

| Journal title (ASCE) | Norman Medal | J. James R. Croes Medal |
|---|---|---|
| Journal of Bridge Engineering | 0 | 1 |
| Journal of Construction Engineering and Management | 1 | 0 |
| Journal of Engineering Mechanics | 2 | 2 |
| Journal of Environmental Engineering | 1 | 4 |
| Journal of Geotechnical Engineering | 7 | 6 |
| Journal of Geotechnical and Geoenvironmental Engineering | 0 | 2 |
| Journal of Structural Engineering | 11 | 7 |
| Journal of Transportation Engineering | 2 | 2 |

the award. In other instances, resumes of individual researchers available on the web were used for verification purposes.

Citations for each of the award-winning articles were manually retrieved from ISI's "Web of Science" using publication details. Eight of the papers were in publications not indexed by ISI (Table 4) and therefore their citations are excluded.

## Results

For the 25-year period 1978–2002, 25 papers were expected for each award but the actual numbers were lower ranging from 20–25. This was because no awards were given on three occasions (see Table 2) because eight of the award-winning publications were not indexed by ISI (Table 4) and therefore no comparable citation data were available.

Table 5 provides data on the net number of papers for each award (excludes those not indexed by ISI), the cumulative total number of citations for each award, and the total number of uncited papers. From this data, the percentage of uncited papers and the average number of citations (ratio of total citations to net number of papers) were calculated. The uncited percent varied from 8.3% for the Rudolph Hering Prize to a maximum of 40% for the Rowland Prize. Thirty-four of the 139 papers constituting 24.5% of the total were uncited.

**Table 4.** List of Awards in Publications not Indexed by ISI

| Award | Publication | Number |
|---|---|---|
| Rowland Prize | Construction engineering and management[a] | 2 |
| | conference proceedings | 1 |
| Rudolph Hering Medal | Environmental engineering[a] | 1 |
| J. James R. Croes Medal | Geotechnical and geoenvironmental engineering[a] | 1 |
| Thomas A. Middlebrooks Award | Geotechnical engineering conference proceedings | 2<br>1 |
| Total | | 8 |

[a]Particular paper not found in database though journal is indexed by ISI.

The average number of citations varied from 4.8 (construction) to 34.0 for the Norman Medal, adjudged to be the best paper published by ASCE . The citations for the paper deemed to be the second best (J. James R. Croes) at 14 was smaller than the average number of citations for all the papers at 18.3.

The disparity between the average citation per paper (18.3) and the percentage of uncited papers (24.5%) indicates that the distribution of citations is highly skewed with only a few papers being highly cited. This is shown in Table 6 that provides a detailed breakdown of the citation for eight different ranges. Selected ranges are also plotted in a pie chart in Fig. 1.

Table 6 shows that a significant proportion of the papers are cited one or fewer times ranging from 16.6% (environmental/water resources) to 55% (construction). The corresponding values are 20.9% for the Norman Medal (best paper) but 41.3% for the J. James R. Croes Medal (second best paper). Papers cited more than 50 times averaged 9.4% overall and range from 0% (for construction and prestressed concrete) to 25% for the Rudolph Hering Medal. The corresponding percentages for the Norman Medal and the J. James R. Croes Medal are 12.5% each.

Since the citation analysis was carried out in 2009, the cumulative citations correspond to between 8 and 32 years following publication (award-winning papers were published a year earlier, i.e., publication date varied from 1977–2001). This time interval is significantly greater than the 5-year period used previously by Hamilton (1991). The longer time frame means that the total number of citations obtained in this study is higher as indicated by Musser and Conkling (1996). They state that, for engineering overall, it takes 8 years for citation levels to reach 50%, 16 years to reach 75%, and 25 years to reach 90%.

The trend in citations over time is shown in Table 7. This table gives a breakdown of the citation data at 5-year intervals. The total citations for all the papers awarded for 1998–2002 is 817 (after 10 years) is larger compared to 535 for recipients from 1993–1997 (after 15 years), and 429 for 1988–1992 (after 20 years).

The Rudolph Hering Medal had the highest number of citations for the periods 1978–1982 and 1993–1997. The J. James R. Croes Medal had the highest number for the period 1983–1987 with the Thomas A. Middlebrook Award receiving the highest number of citations from 1988–1992. The Norman Medal had the highest citations for the most recent period from 1998–2002. These changes reflect shifts in the direction of research in civil engineering. Table 7 also shows that since 1993 there has been a reduction

**Table 5.** Citation Analysis Summary (1978–2002)

| Awards | Number of awards | Not in ISI | Net papers | Uncited papers | Percentage uncited | Total citations | Average citation |
|---|---|---|---|---|---|---|---|
| J. James R. Croes Medal | 25 | 1 | 24 | 8 | 33 | 335 | 14.0 |
| Thomas A. Middlebrooks Award | 25 | 3 | 22 | 3 | 13.6 | 374 | 17 |
| Norman Medal | 24 | 0 | 24 | 4 | 16.7 | 815 | 34.0 |
| Rudolph Hering Medal | 25 | 1 | 24 | 2 | 8.3 | 731 | 30.5 |
| Rowland Prize | 23 | 3 | 20 | 8 | 40 | 95 | 4.8 |
| T. Y. Lin Award | 25 | 0 | 25 | 9 | 36 | 188 | 7.5 |
| Total | 147 | 8 | 139 | 34 | 24.5 | 2,538 | 18.3 |



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**Table 6.** Citation Analysis of Award-Winning Papers

| Awards | Disciplines | Details | Uncited | Cited once | Cited up to 2 times | Cited 1–5 times | Cited 6–15 times | Cited 6–25 times | Cited 26–49 times | Cited more than 50 times |
|---|---|---|---|---|---|---|---|---|---|---|
| J. James R. Croes Medal | All | Total | 8 | 2 | 10 | 4 | 4 | 3 | 2 | 3 |
| | | Percent | 33 | 8.3 | 41.7 | 17.0 | 17.0 | 12.5 | 8.3 | 12.5 |
| Thomas A. Middlebrooks Award | Geotech | Total | 3 | 3 | 7 | 7 | 3 | 1 | 7 | 1 |
| | | Percent | 13.6 | 13.6 | 31.8 | 31.8 | 13.6 | 4.5 | 31.8 | 4.5 |
| Norman Medal | All | Total | 4 | 1 | 7 | 6 | 7 | 1 | 3 | 3 |
| | | Percent | 16.7 | 4.2 | 29.2 | 25 | 29.2 | 4.2 | 12.5 | 12.5 |
| Rudolph Hering Medal | Environment | Total | 2 | 2 | 4 | 2 | 6 | 1 | 7 | 6 |
| | | Percent | 8.3 | 8.3 | 16.7 | 8.3 | 25.0 | 4.2 | 29.2 | 25.0 |
| Rowland Prize | Construction | Total | 8 | 3 | 11 | 6 | 4 | 2 | 0 | 0 |
| | | Percent | 40.0 | 15.0 | 55.0 | 30.0 | 20.0 | 10.0 | 0.0 | 0.0 |
| T. Y. Lin Award | Structural | Total | 9 | 0 | 12 | 8 | 4 | 1 | 2 | 0 |
| | | Percent | 36.0 | 0.0 | 50.0 | 33.3 | 16.7 | 4.2 | 8.3 | 0.0 |
| Total | | Papers | 34 | 11 | 51 | 33 | 28 | 9 | 21 | 13 |
| | | Percent | 24.5 | 7.9 | 36.7 | 23.7 | 20.2 | 6.5 | 15.2 | 9.4 |

in the number of uncited papers. This could be because of easier electronic access to papers.

## Discussion

Conventional wisdom equates low-citation rates to poor quality. To test its validity, this study examined citation rates for articles selected for ASCE's most prestigious awards (Table 2) over the period 1978–2002. The results showed that although the average citation rate for the 139 papers examined was 18.3, nearly 1 in 4 were uncited (Table 6). Moreover, 7.9% of the papers were cited only once so that the percentage cited one or fewer times was over 30%. The uncitedness ratios obtained from this study are much lower than the 78% reported by Hamilton (1991) though it was for a 5-year window compared to 20 years in this study. Nonetheless, given the pedigree of the papers examined, the nearly 25% uncitedness ratio is exceptionally high. This finding indicates that citations are an unreliable measure of quality and significance.

### *Norman Medal*

This award is given to the paper that is considered to be the best among all ASCE publications. Yet over 40% of the award-winning papers were cited five or fewer times with 16.7% being uncited (Table 6). This could be because the awards are heavily weighted toward structures (46%) and geotech (29%) (see Table 3). The impact factors for these disciplines are 0.789 and 0.849, respectively, in Table 1. At the other extreme, 12.5% are cited more than 50 times.

### *J. James R. Croes Medal*

This paper is rated the second best among all ASCE publications. The citation rates are significantly poorer compared to the Normal Medal. For example, 50% of the papers were cited five or fewer times with 33% uncited. Like the Norman Medal, it is heavily weighted toward structures and geotech papers that have lower impact factors as mentioned previously.

### *Rowland Prize*

This award rated the lowest citations in all categories with 40% of the publications being uncited (Table 6). This is because of the applied nature of the topic, and is consistent with data reported by Hamilton (1991) that 84.2% of publications in construction and building technology were uncited.

### *Rudolph Hering Medal*

The citations in the environmental area are among the highest in all categories. Only 8.3% were uncited—this is better than the percentages reported for the basic sciences by Hamilton (1991). At the upper end, 25% of the papers were cited 50 or more times. Another 29.2% were cited between 26 and 49 times.

### *Thomas A. Middlebrook Award*

Citation rates for this award were better than average—13.6% were uncited but over 35% were cited more than 26 times with 4.5% more than 50 times.

### *T. Y. Lin Award*

The citation rates for this award were very low and comparable to those for the construction award. Uncited percentages were 36% and there were no citations of more than 50. Prestressed concrete is a relatively new but specialized discipline that is not as broad-based as geotechnical or environmental engineering.

### *Why Citations Are Low*

Citations are greatly influenced by the numbers of researchers in the field (Seglen 1992) and also by referencing norms of the discipline. Table 8 compares information for various engineering disciplines indexed by ISI. Table 8 shows that the average number of references in civil engineering journals (12.4) is the second lowest. The impact factor for the 91 civil engineering journals indexed by ISI is only 0.71. Both indicators show that compared to other disciplines, civil engineering authors tend to make fewer references to journal articles. This is because many of the important findings are quickly incorporated into codes of practice or textbooks that are subsequently referenced rather than the original research (Musser and Conkling 1996).

### *Why Papers Are Uncited*

Citations provide a count on the number of researchers utilizing the findings of a study. Given that researchers utilize secondary references such as textbooks, and codes of practice, software manuals



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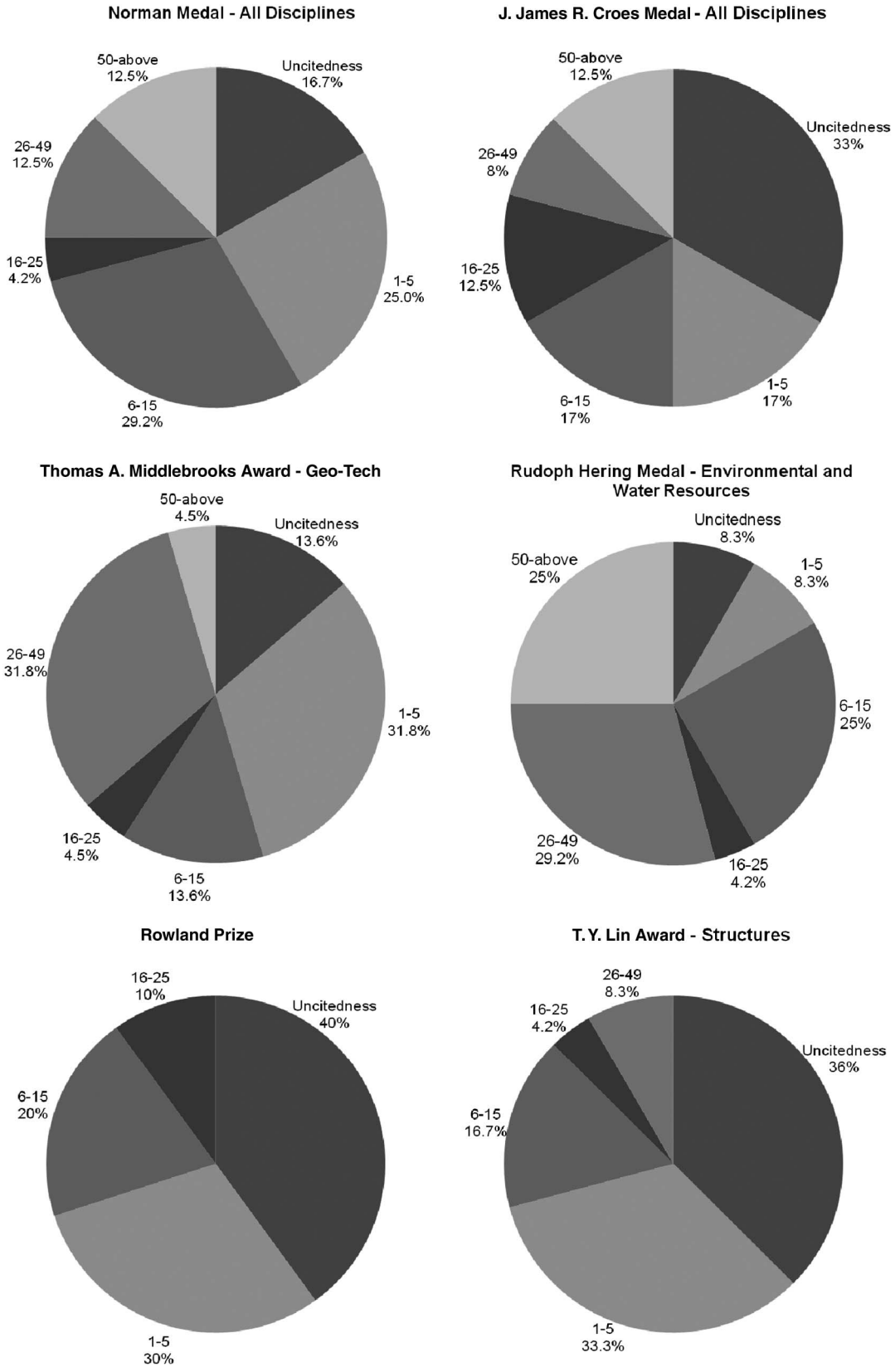


**Fig. 1.** Citation distribution for ASCE awards (1978–2002)

citations to original sources are fewer. In some instances, research studies were conducted to solve a specific problem whose finding is then immediately incorporated in codes or design manuals. As a result, significant contributions can remain uncited.

Seglen (1992) has argued that because of the skewness of citation distributions, from statistical considerations alone a large fraction of the published work in any field will remain uncited or cited very few times. However, uncitedness does not necessarily imply

**Table 7.** 5-Year Citation Analysis of Award-Winning Papers

| | | 1978–1982 (30 years)[a] | | 1983–1987 (25 years) | | 1988–1992 (20 years) | | 1993–1997 (15 years) | | 1998–2002 (10 years) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Award | Disciplines | Number of citations | Uncited (%) | Number of citations | Uncited (%) | Number of citations | Uncited (%) | Number of citations | Uncited (%) | Number of citations | Uncited (%) |
| J. James R. Croes Medal | All | 17 | 20 | 142 | 20 | 83 | 40 | 47 | 40 | 46 | 40 |
| Thomas A. Middlebrook Award | Geotech | 33 | 20 | 92 | 20 | 127 | 0 | 69 | 20 | 53 | 0 |
| Norman Medal | All | 80 | 40 | 62 | 40 | 50 | 0 | 64 | 0 | 559 | 0 |
| Rudolph Hering Medal | Environment | 183 | 20 | 87 | 0 | 85 | 20 | 228 | 0 | 148 | 0 |
| Rowland Prize | Construction | 4 | 80 | 9 | 60 | 34 | 20 | 47 | 0 | 1 | 0 |
| T. Y. Lin Award | Structural | 38 | 40 | 10 | 40 | 50 | 20 | 80 | 20 | 10 | 60 |
| Total | | 355 | | 402 | | 429 | | 535 | | 817 | |

[a]Time in print; papers were published a year before the award.

**Table 8.** Citations and Impact Factors for Engineering Disciplines in ISI

| Engineering discipline | Number of journals | Number of articles | Total citations | Median impact factor | Aggregate cited half-life | Average references |
|---|---|---|---|---|---|---|
| Aerospace | 25 | 2,408 | 30,411 | 0.467 | 10 | 12.6 |
| Biomedical | 51 | 6,726 | 1,68,743 | 1.71 | 5.8 | 25.1 |
| Chemical | 116 | 18,626 | 3,27,868 | 0.855 | 6.9 | 17.6 |
| Civil | 91 | 8,673 | 107955 | 0.71 | 7.4 | 12.4 |
| Electrical and electronic | 229 | 34,367 | 7,05,078 | 1.055 | 7 | 20.5 |
| Environmental | 38 | 7,063 | 1,64,473 | 1.131 | 6.3 | 23.3 |
| Industrial | 33 | 3,705 | 59,679 | 1.112 | 7.5 | 16.1 |
| Mechanical | 105 | 10,507 | 1,68,636 | 1.078 | 7.7 | 16.0 |
| Petroleum | 24 | 1,324 | 12,331 | 0.359 | 10 | 9.3 |

that the paper is not read and not used. Practitioners routinely keep up with developments as part of professional registration requirements and make use of new findings in their work. Their reference to such research in technical reports for clients or in design calculations cannot be determined as they are not part of the ISI index.

## Conclusions

This paper presents results from a limited study that examined citation rates for high-quality papers that were selected for the most prestigious ASCE awards in seven subdisciplines. In the study, papers selected for awards extend over the period 1978–2002 and total citations were those that were in existence in 2009. Since papers selected for awards were published at least a year earlier, this means that the minimum citation time was 8 years and the maximum, was 32 years. This is considerably higher than previous data that was for only 5 years.

On the basis of the information presented in the paper, the following conclusions may be drawn:

1. Nearly 25% of the papers selected for ASCE's most prestigious awards over the past 25 years were uncited. Over 30% were cited just once. The vast majority (75%) are cited 25 times or fewer.
2. Citation rates are strongly influenced by the subdiscipline. The more applied (construction) and more specialist (prestressed concrete) the subdiscipline, the fewer the number of citations. Currently, citations are highest for environmental engineering (Table 5). Nearly 55% of the Rudolph Hering Medal winning papers were cited more than 26 times compared to the average 18.3 times for all the award-winning papers.
3. Average citations for the paper ranked the best by ASCE (Norman Medal) was the highest (34.0) but the second best paper (J. James R. Croes Medal) with 14.0 was the third lowest; that is below the average for all the award-winning papers.

If over 30% of papers adjudged by ASCE to be among its best are cited just once, citations alone cannot be a reliable measure of quality or significance. Thus, it is unwise to place too much reliance on citation data in judging quality especially in applied or specialty areas in which the pool of researchers may be small.

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