Analysis of Dispute Review Boards Application in U.S. Construction Projects from 1975 to 2007

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Abstract: Since their first successful implementation in 1975, dispute review boards (DRBs) gained popularity as a standing neutral alternative dispute resolution (ADR) technique, and were implemented on a number of high profile construction projects in the United States and worldwide. The purpose of this study is to present a review, trend analysis, and classification of U.S. construction projects that had DRBs for the period of 1975–2007. Thus, a total of 1,042 U.S. construction projects that had DRB as part of their contract provisions are extracted from the Dispute Review Board Foundation database and are analyzed. The results of this study are presented in two major sections. In the first section, results of trend analysis are reported as growth in number of projects with DRB since 1975, as well as the distribution of these projects in terms of construction type (i.e., building, highway, and tunnel), and construction volume category. On the other hand, the second section includes the results of the analysis undertaken to study the mechanics of DRB application in construction projects. In this context, the effectiveness of DRB as a preventive measure against the escalation of conflicts to disputes is first studied. For those projects that had disputes heard by a DRB panel, the data was further analyzed to determine the effectiveness of the DRB as an ADR technique that can help in the resolution of a dispute at the project level without further escalation to arbitration or litigation. The results of the study indicate that DRBs have been successfully implemented in all three construction sectors in the United States. The effectiveness of DRB as a prevention technique was observed on approximately 50% of the 810 projects where no disputes were ever heard through a DRB panel formal hearing. For the remaining 50% of the projects, the effectiveness of DRB as an ADR technique was found to exceed 90% when comparing the number of disputes that were settled due to DRB recommendation to those that were actually heard during a DRB hearing session. Finally, the paper concludes with a set of questions and hypotheses that may be undertaken to explain the recorded observations, and set the way for future research efforts in this area.

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Motivation of This Study

Dispute review boards (DRBs) have been extensively used in construction projects across the United States since 1975 as an alternative dispute resolution (ADR) technique. The main concept of a DRB is to engage three neutral experts during the construction phase of the project [Dispute Review Board Foundation (DRBF) 2007b]. These three experts become familiar with the progress of construction on site and are ready to lend a neutral third party recommendation in case a conflict escalates to a dispute between the construction parties. A number of studies (Harmon 2003a,b; Thompson et al. 2000; Vorster 1993) have been reported that document the history, characteristics, and effectiveness of DRBs as a dispute resolution technique for construction projects.

The purpose of this paper is to complement the available literature by presenting the results of an analysis undertaken to determine trends in the application of DRB across different types of U.S. construction projects between the fiscal years of 1975–2007 (a 32-year period). The data used for this study covers up to 1,042 U.S. construction projects extracted from the Dispute Review Board Foundation database (DRBF 2007a). The main criteria in selecting these projects for the study include: (1) the projects are known to have DRB implemented on them during their construction; (2) construction start date for these projects is between 1975 and 2001 inclusive; and (3) construction of those projects is 100% completed by the end of 2007.

Thus, the objectives of the study are to classify DRB applications in different kinds of construction projects; namely, building (B), highway (H), and tunnel (T) construction; to compare the rates of adoption; and to measure the effectiveness of the DRB process as a dispute prevention and ADR technique. This latter objective involves classifying the selected projects into those that had no disputes referred to DRB and those that had disputes requiring a DRB hearing session for final resolution.

This paper is divided into four main sections. The first section provides background information about the inception of DRB and the history of their application. In the second section, the data used to conduct the study is described followed by a complete analysis of this data in the third section of the paper. Finally, the

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fourth section provides a detailed discussion of the results, and proposes some explanations of the observed trends, and presents a set of questions for further research and investigation.

Background

A DRB is an ADR adopted on a number of domestic and international projects (Peña Mora et al. 2003; Harmon 2003a; Thompson et al. 2000; Vorster 1993; Construction Industry Institute (CII) Dispute Prevention and Resolution Research Team 1995) to provide the construction parties with neutral expert advice and incentive to try to resolve conflicts as they arise, and mitigate their escalation into disputes. Over the last three decades, DRBs have been successfully implemented on major construction projects in the United States. The largest single contract construction project is the T-Rex Transportation Expansion Project in Denver, which was built between 2001 and 2006 to a total construction value (CV) of $1.67 billion.

A number of national organizations, such as the American Arbitration Association (AAA), provide for DRBs in their standard forms of contract documents as a precursor to arbitration or litigation (Freshfields Bruckhaus Deringer 2006). The provisions are typically stipulated in the bid documents and include DRB Guide Specifications and Three Party Agreement (Poage et al. 2007; Brennan 2006). In choosing the three-member DRB panel, both the owner and the contractor need to be completely satisfied with the members' experience and technical qualifications in relation to the construction process, as well as impartiality, complete objectivity, neutrality, and freedom from bias and conflicts of interest (DRBF 2006). Consequently, both contracting parties have the freedom to reject any nominee they deem as unqualified to serve as a board member (DRBF 2006, 2007b). The neutrality of the DRB members allows them to stand at equal distance from all project participants especially when dealing with a dispute related to construction project matters (Peña Mora et al. 2003; Cheung et al. 2002; Fenn et al. 1998).

In addition, the contractual arrangement at the time the DRB was established will determine whether the DRB recommendations are nonbinding or binding as well as the enforcing jurisdiction (DRBF 2007b; Freshfields Bruckhaus Deringer 2006). For example, the DRB recommendations are binding to the parties awaiting a decision by court or other arbitral committee on the issue if the DRB is established under the standard form of contracts from the International Federation of Consulting Engineers or the World Bank (World Bank 2007; Freshfields Bruckhaus Deringer 2006). However, other forms of contractual arrangements give the parties complete freedom on whether to accept or reject a given DRB recommendation. In case one or both parties reject the recommendations, then they can either go back to direct negotiation or refer the issue to other forms of ADR techniques such as arbitration or go all the way to litigation for final settlement. Most projects with DRBs undertaken in the United States fall under the latter category, where the DRB recommendations are nonbinding in giving the parties the freedom to further pursue other arbitral or litigious venues to settle their disputes if an agreement is not achieved at the DRB level (DRBF 2006; Vorster 1993).

Other structural variations to the three-member DRB are given in DRBF (2006). These include: single-member DRB, interlocking board member (when several contracts of the project are awarded to different contractors, then one of the DRB members can serve on several contracts), five-member DRB, consolidated DRB (when one contractor has several contracts with the same owner, then it is typical to use a single consolidated DRB), standing DRB (when the owner has several large contracts in the same geographic region, then a single DRB can be used where the contractor association plays an important role in selecting the contractors' representative in the board), regional DRB (a modification of the standing DRB adopted by the Florida DOT where all projects with no specific DRB have access to one regional DRB) (DRBF 2006). Finally, the costs associated with the DRB panel are typically shared by both the owner and the contractor (Peña Mora et al. 2003; Vorster 1993).

According to the DRBF (2006), the professional fees of each board member range between $1,000 and $2,000 per day for regular site visits and hearing sessions. These members are also paid on an hourly fee to review and prepare documents. The costs associated with a given dispute hearing will vary depending on the type of the dispute and the time it takes to review the parties' prehearing submittals, the hearing itself, as well as the post hearing deliberations and preparation of the written recommendations. In general, the costs of a DRB will "vary depending on how often the Board is asked to resolve disputes" but in general does not exceed 0.25% of the total project value for project with complex disputes (DRBF 2006). Other general forms of contract like the World Bank also provide for a DRB members' retainer fee to be paid on a monthly basis to ensure the availability of the board members on a 28 day notice for all site visits and hearings, as well as remain up to date with all developments on the project (World Bank 2007). In addition to the direct costs of the DRB, both the owner and contractor will incur indirect costs of having their employees prepare for and participate in DRB progress meetings as well as dispute hearings (DRBF 2007b, 2006).

Project Identification and Selection

The data for this study is obtained from the DRBF database which includes information on a total of 1,373 construction projects with DRBs undertaken in the United States as of December 30, 2007 (DRBF 2007a). The construction start date for these projects ranges between the fiscal years of 1975 and 2007, and accordingly, the reported CVs for each of the projects in the database are based on the start of construction year current dollars. Prior to performing the analysis described in the next section, all these CV were adjusted to 2007 dollar amounts using the construction cost index yearly averages published by the Engineering News Record (Grogan 2007). These 2007 adjusted CVs will be referred to as ACV07 throughout the paper. In addition, projects in the database are distributed over three main construction type categories, namely: B—building construction including all public building types such as offices, schools, prisons, and subway station facilities, H—highway and heavy construction not included under B and T categories, and T—tunnel and underground structures excluding pipelines (DRBF 2008a).

While the database includes a "fairly complete and accurate" compilation of all the projects in the United States with construction starting prior to 2001, complete and reliable data for projects undertaken post 2001 period are not available due to lack of reporting to the DRBF (DRBF 2008b). Therefore, only projects with the following characteristics were considered for analysis (Fig. 1):

1. Construction start date on or prior to 2001: these projects represent 824 or 60% of the 1,373 projects listed in the database with a total ACV07 of $54.67 billion; and

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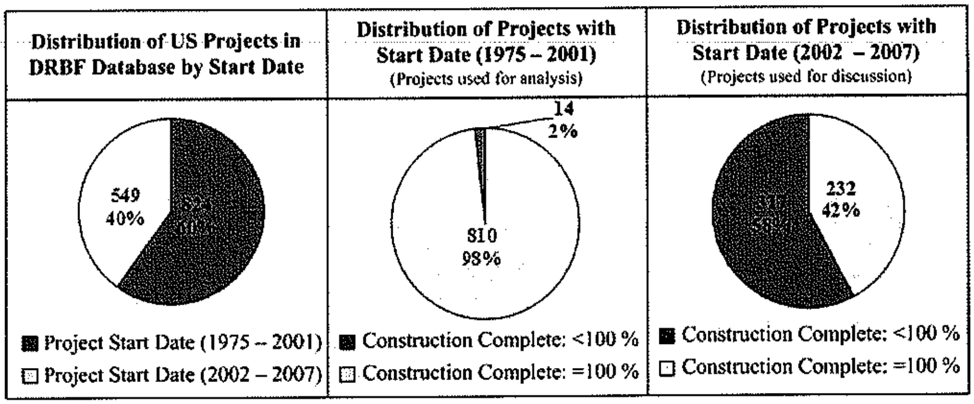

Fig. 1. Projects distribution by fiscal year and percent complete

2. Construction is 100% completed as of December 30, 2007: these projects represent 810 projects or 98% of the 824 projects in Category (1) above or 58% of the total number of projects in the DRBF database. The total ACV07 of these projects is $49.17 billion.

The analysis of the remaining 549 projects in the DRBF database with construction start date after 2002 indicated that only 232 projects (i.e., 42%) have their construction 100% complete by December 2007. These 232 projects have a total 2007 ACV07 equal to $5.62 billion and will be used in the last section of the paper to discuss future trends taking into consideration the implications of the results of analyzing the 810 projects with DRB between 1975 and 2001.

These 810 projects are distributed over a total of 31 states within the United States. Table 1 analyzes the 810 projects from 1975 to 2001 by state, total number of projects per type (i.e., B, H, and T) and the accumulated total ACV07 value per type in each state. California has the highest number of projects (287) with a total ACV07 of $15.35 billion. If distribution by project type is considered, then Washington has the highest total ACV07 ($2.45 billion) distributed over 40 B-type projects. Also, California has the highest total ACV07 ($10.43 billion distributed over 233 projects) for H-type projects, while Massachusetts has the highest total ACV07 ($3.55 billion distributed over 13 projects) for T-type projects. Fig. 2 shows the share in percent of the total ACV07 for each of the top three states in each project type category.

Trends in DRB Application in U.S. Construction Projects

This section reports the results of the trend analysis undertaken to determine the growth/decline DRB application since 1975 and up to 2001.

Growth in Number of Projects with DRB in Contract Provisions

The data was first analyzed to determine the growth in the number of projects having DRBs as part of their contract provisions in the United States between the fiscal years of 1975 and 2001. In performing this analysis, it was assumed that the DRB was adopted in the projects from start to finish of construction. This assumption was made to avoid considering the DRB implementation in the project just either at the start or finish year of construction. For example, assume 10 projects with varying construction durations have their construction start dates in 1995 and only one project with construction start date in 1996. If DRB implementation is considered only to be at construction start date, then a peak in DRB will be observed in 1995 and almost no implementation in 1996 even though most of the 1995 projects were still undergoing construction in 1996. Thus, the above assumption allows the DRB application in the project to be prorated over the project construction duration with one DRB panel per project per construction year. In this case, each project in construction during any given year adds an additional project to the total number of projects per year using DRB. For a project construction starting in 1990 and completed in a 4-year period, one project is added to each of the years 1990–1993 to represent that this project had a DRB panel during those years. In addition, the 2007 ACV07 for each of the 810 projects was divided over the respective project durations to determine the average construction volume per DRB panel per year. The results from this analysis are reported in Fig. 3 which shows the number of projects with DRB panels per year, the total ACV07 of these projects, and the average ACV07 per DRB panel per year. In general, the number of projects having DRB has steadily increased from one project having a total ACV07 equal to $77 million in 1975 to a maximum of 291 projects having a total ACV07 equal to $5.58 billion in 2001.

With reference to Fig. 2, the analysis performed to determine the total prorated and ACV07 for the five states that had the highest CV in all three project type categories (i.e., California, Florida, Massachusetts, and Washington), it was found that the total contribution of the four states is 70% per year of the overall total prorated and ACV07 shown in Chart (b) of Fig. 3.

Finally, the average ACV07 per DRB panel per year indicates that this number decreased from $77 million during the fiscal years of 1975–1978 where only one project (i.e., Eisenhower-Johnson Memorial Tunnel) had DRB panel implemented during construction to an average of $26 million per year for over the last 10 fiscal years (i.e., 1991–2001). This indicates that even though the total ACV07 increased, the number of projects with DRB increased at a more rapid rate, resulting in this decrease in the average ACV07 per DRB panel per year. The average ACV07 per DRB panel per year over the last 10 fiscal years when considering only the five states that had the highest ACV07 in Fig. 2 was found to be $29 million per year, only $3 million higher than the overall average value. This indicates that growth in DRB applications in the United States is largely due to construction

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Table 1. Distribution of the 810 Projects by State

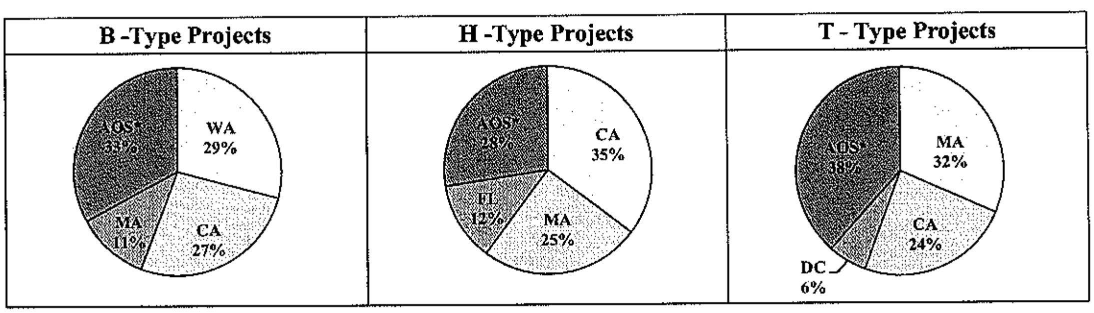
State	Number of projects				Construction value ($ million)			
	B	H	T	Total	B	H	T	Total
Alaska—AK	1	—	2	3	$36	—	$215	$251
Arizona—AZ	3	—	1	4	$136	—	$38	$173
California—CA	22	233	32	287	$2,235	$10,433	$2,683	$15,351
Colorado—CO	1	4	8	13	$16	$249	$665	$930
Delaware—DE	—	1	—	1	—	$108	—	$108
District of Columbia	—	1	8	9		$17	$678	$695
Florida—FL	19	152	—	171	$234	$3,614	—	$3,847
Georgia—GA	4	—	1	5	$262	—	$137	$399
Hawaii—HI	2	8	7	17	$236	$701	$442	$1,379
Idaho—ID	—	4	—	4	—	$81	—	$81
Maine—ME	—	5	—	5	—	$175	—	$175
Maryland—M.D.	2	5	2	9	$88	$319	$135	$543
Massachusetts—MA	8	30	13	51	$955	$7,399	$3,548	$11,901
Michigan—MI	—	—	6	6	—	—	$163	$163
Minnesota—MN	—	—	1	1	—	—	$134	$134
Mississippi—MS	1	—	—	1	$432	—	—	$432
Missouri—MO	—	—	1	1	—	—	$34	$34
Montana—MT	—	—	1	1	—	—	$3	$3
Nevada—NV	15	9	3	27	$596	$135	$128	$859
New Mexico—NM	—	1	—	1	—	$277	—	$277
New York—NY	1	2	2	5	$181	$133	$56	$370
Ohio—OH	3	1	4	8	$90	$253	$103	$446
Oregon—OR	1	8	5	14	$23	$139	$326	$488
Pennsylvania—PA	—	—	2	2	—	—	$114	$114
Puerto Rico—PR	—	—	1	1	—	—	$324	$324
Tennessee—TN	—	1	2	3	—	$21	$117	$138
Texas—TX	3	19	8	30	$431	$912	$571	$1,914
Utah—UT	—	2	1	3	—	$1,751	$66	$1,817
Virginia—VA	—	1	—	1	—	$126	—	$126
Washington—WA	40	72	12	124	$2,449	$2,708	$517	$5,674
Wisconsin—WI	—	—	2	2	—	—	$20	$20

projects undertaken in these five states. These results will be further assessed in the subsequent section where the data will be analyzed to study the trends in each of the three types of construction (i.e., B, H, and T) independently.

Distribution of Projects in Terms of Construction Type

The data analysis indicates that DRBs have been implemented on B-, H-, and T-type projects in varying amounts since the inception of DRB in 1975 and up until 2001. This implementation is depicted in Fig. 4, which shows the number of projects with DRB panels per year, the total ACV07 of these projects, as well as the average ACV07 per DRB panel per year for the three construction type categories, respectively.

Although DRBs have been initially implemented on a tunnel project and endorsed by the tunnel mining industry, it is clear from Fig. 4 that DRBs gained more recognition and popularity on



*AOS – All other states

Fig. 2. Percent distribution of projects by 2007 ACV07 category

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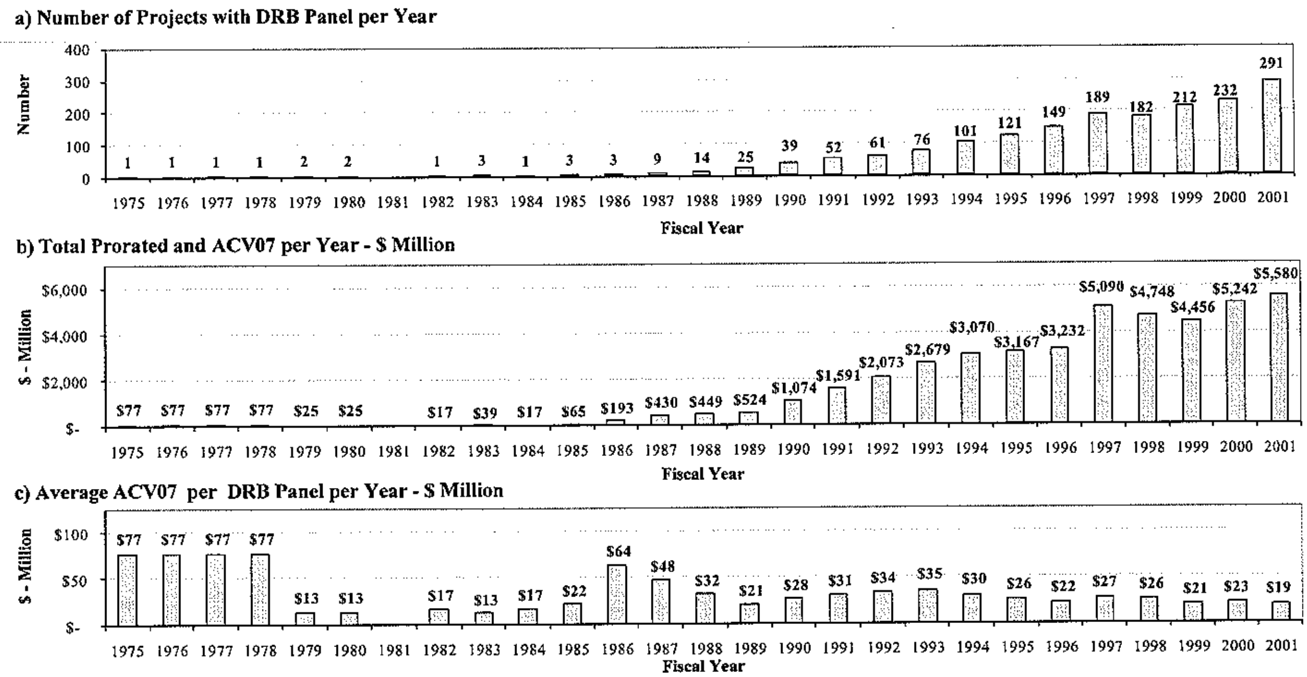
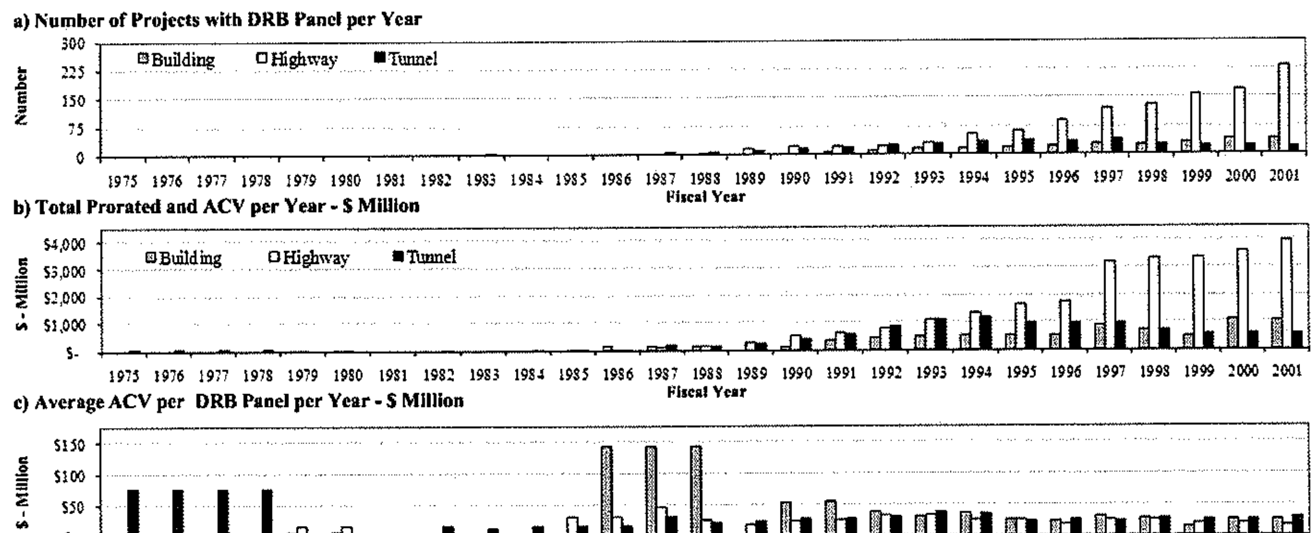


Fig. 3. Number and ACV07 of projects with DRB panel

H-type projects. The number of H-type projects with DRB panel per year as well as the total prorated and ACV07 increased over the years and reached a peak of 231 projects having a total ACV07 equal to $3.95 billion in 2001. On the other hand, the increase in DRB application in B- and T-type projects remained more modest where the number of projects with DRB panel per year was below 50 at all times while the total prorated and ACV07 was below $1.0 billion for B-type projects and $1.2 billion for T-type projects at all times.

In addition, the average ACV07 per DRB panel per year for B-type projects was highest between the fiscal years of 1986–1988 at $0.14 billion, then dropped to an average of $29 million for the last 10 years from 1992 to 2001. For H-type projects, this value remained below $50 million at all times with an average of $25 million per DRB panel per year for the last 10 years. Finally, the value for T-type projects dropped from a high of $77 million during the first four years of DRB implementation (i.e., 1975–1978) and reached an average of $29 million for the last 10 years.



Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
B	$-	$-	$-	$-	$8	$8	$-	$-	$-	$-	$-	$144	$144	$144	$-	$54	$55	$40	$33	$37	$27	$25	$32	$28	$15	$27	$26
H	$-	$-	$-	$-	$17	$17	$-	$-	$-	$-	$33	$33	$47	$26	$19	$25	$25	$33	$34	$26	$27	$19	$27	$25	$21	$21	$17
T	$77	$77	$77	$77	$-	$-	$-	$17	$13	$17	$16	$16	$32	$22	$24	$28	$28	$32	$38	$35	$25	$27	$25	$28	$27	$26	$30

Fig. 4. Number and ACV07 of projects with DRB panel for B-, H-, and T-type construction projects

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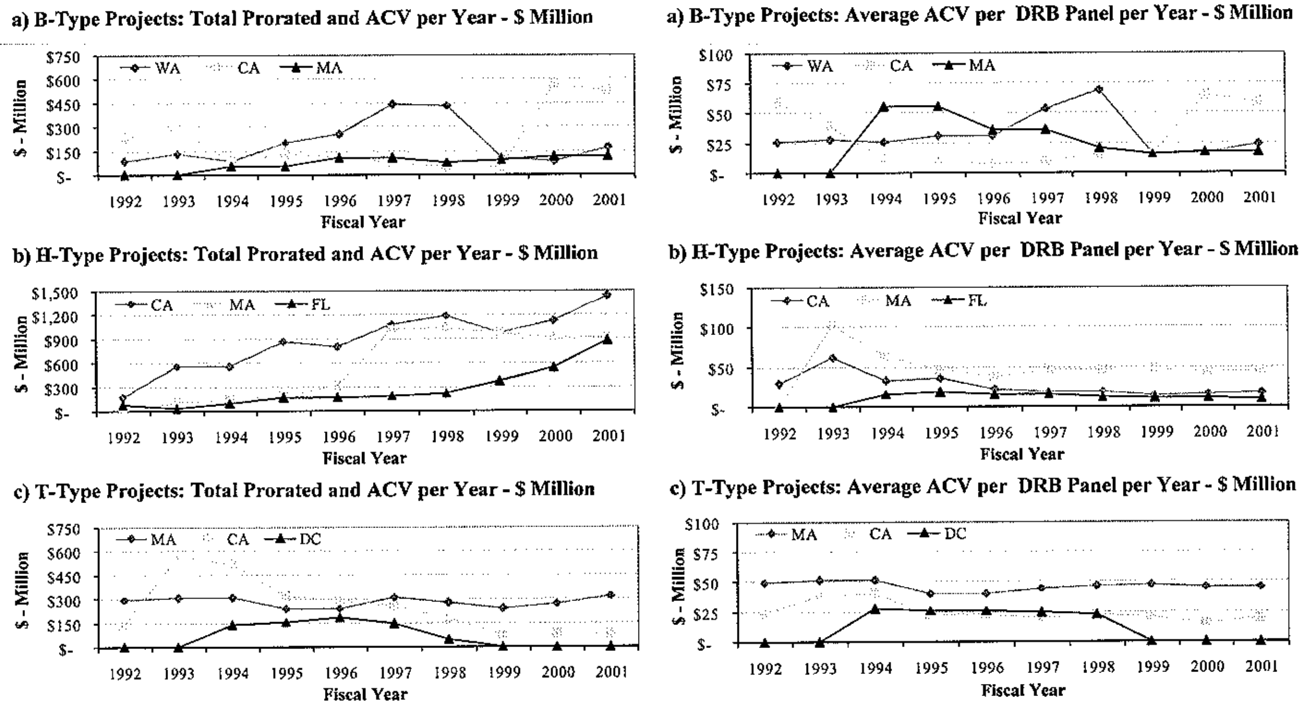

Fig. 5. Total prorated and ACV07 of projects with DRB for top three states in B-, H-, and T-type construction projects

Thus, even though the total prorated ACV07 per year for H-type projects increased significantly over time compared to B- and T-type projects, the average ACV07 per DRB panel per year remained comparatively lower, indicating the increase in number of projects with DRB panel per year occurred at a faster rate than the increase in the total ACV07 per year.

By comparing these results to those obtained in the previous section, it is clear that H-type projects have the highest influence on the general trend of DRB application in U.S. construction projects. One argument that might explain the increase in the number of H-type projects having DRB panel per year as compared to the two other project types is that DRBs were endorsed by a number of DOTs across the United States like the California DOT (CALTRANS) (California DOT 2003) and the Florida DOT (FDOT) (DRBF 2007b).

In addition, B-type projects are generally privately financed as opposed to H-type projects that are typically undertaken by state or federal entities that are responsible to ensure the projects are completed within a specified budget and schedule with the minimum number of disputes as possible. This is not to discount the risk of disputes associated with privately financed projects; however, these projects tend to be smaller in scale, with the owner, architect/engineer working closely together to ensure successful completion of the project. On the other hand, fewer T-type projects are typically undertaken relative to other types of construction due to their inherent complexity. Finally, the results indicate that for all three project types, the average ACV07 per DRB panel per year did not change significantly over the last 10 years even though the total ACV07 has increased over time since 1975.

Based on these results, further analysis was conducted to determine the trend in DRB application in the three states that had the highest total ACV07 for each construction type (refer to Fig. 2). The data indicates that DRB was adopted on construction projects in these five states (i.e., Washington, California, Massachusetts, Florida, and District of Columbia) after the fiscal year of 1992. Thus, Fig. 5 shows the results for the total and prorated ACV07 as well as the average ACV07 per DRB panel per year over the three project types and three top states therein. No general trend in DRB implementation can be detected for B and T-type projects in the top three states in each category. However, for H-type projects, the number of projects with DRB increased over time for the three states at varying amounts. On the other hand, the average ACV07 per DRB panel per year varied randomly over time for B-type projects in the top three states in that category. For H-type projects, this value was lower in California when compared to Massachusetts, although California has the highest total ACV07 across all states. For T-type projects, this value remained constant at approximately $50 million and $25 million for Massachusetts and California, respectively, but increased for zero to a constant $25 million between 1994 and 1998 for the District of Columbia.

Distribution of Construction Projects in Terms of Construction Volume

The data was then analyzed to determine the distribution of the projects in terms of ACV07 and type (i.e., B, H, or T). Hence, the projects were divided into three ACV07 categories, namely: small scale projects that are less than or equal to $0.1 billion, medium scale projects between $0.1 and $0.5 billion, and large scale projects that are greater than $0.5 billion and up to $1.75 billion. The upper limit was chosen based on ACV07 for the I-15 reconstruction project in Salt Lake City. The construction on this project started in and was completed in 2001 to a $1.7 billion ACV07 or $1.3 billion actual total construction cost. For the lower limit, the data indicates that the project with ACV07 as low as $0.79 million had DRB on them with projects mainly distributed in the $10 to $50 million range, as shown in Fig. 6.

Based on the above, Fig. 7 shown the total number of projects

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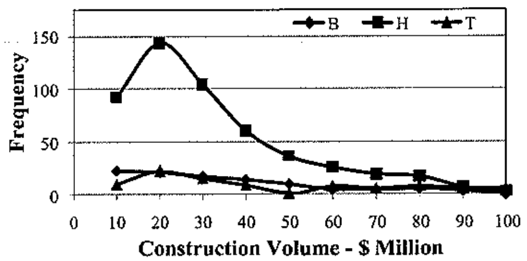

Fig. 6. Distribution of projects in the <$0.1 billion ACV07

and ACV07 for the three ACV07 categories and project types, respectively. For B-type projects, the number of projects decreased from 103 in the first ACV07 category (i.e., <$0.1 billion) to 19 projects in the $0.1–$0.5 billion ACV07 category, and 2 projects in the $0.5–$1.75 billion ACV07 category. This decrease in number can be attributed to the fact that in general B-type projects are mostly privately funded, which limits the availability of resources to construct large scale projects with a few exceptions such as the two large scale projects falling in the $0.5–$1.75 billion ACV07 that include the Mariner's Baseball Stadium in Seattle at $0.53 billion ACV07. On the other hand, the total ACV07 of B-type projects with DRB in them is approximately equally distributed at $3 and $4 billion in the <$0.1 and $0.1–$0.5 billion ACV07 categories.

Although the number of H-type projects is highest among the three construction types for all ACV07 categories, this number also decreased from 512 projects for the <$0.1 billion ACV07 category to 44 and 6 projects in the $0.1–$0.5 and $0.5–$1.75 billion ACV07 categories, respectively. Again, the most feasible explanation to this phenomenon is that projects with higher ACV07 tend to be fewer across the United States. The total ACV07 for H-type projects is also higher than that for B- and T-type projects which is an anticipated outcome based on the results obtained in the previous section. This total ACV07 is $14.4, $9.4, and $5.778 billion for each of the three ACV07 categories, respectively. It is worth noting here that the last ACV07 category (i.e., $0.5–$1.75 billion) includes several high profile H-type projects such as the I-15 reconstruction in Salt Lake City (CV=$1.3 billion in 1997, ACV07=$1.69 billion) and San Joaquin Hills Corridor Toll Road in Orange County, Calif. (CV =$0.7 billion in 1993, ACV07=$1.0 billion).

Finally, the results for T-type projects are very comparable to those of B-type projects in terms of lower number of projects in

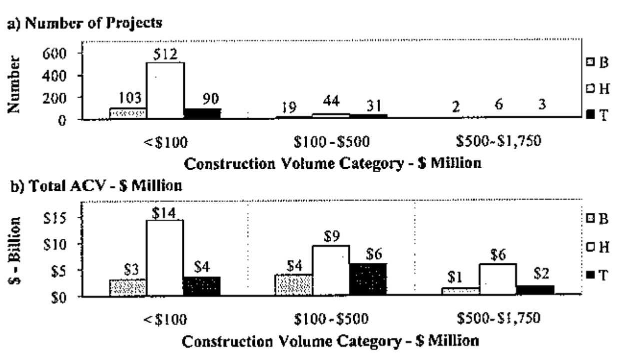

Fig. 7. Number of projects with DRB and total ACV07 ($ billion) for three construction types versus construction volume category

each ACV07 category at 90, 31, and 3 project, respectively. However, the total ACV07 value increases from $3.6 billion in the first category to $6 billion in the second category before it drops down to $1.5 billion in the last category.

The above results have two significant indications. First, as determined in the previous section, DRB has been more extensively used in H-type projects compared to B and T-type projects due to the its endorsement by a large number of public project owners across the United States; namely, DOTs and other federal/state organizations. The second significant indication is that DRB panels have been mostly implemented in projects with ACV07s not exceeding $0.1 billion. Thus, the results indicate that DRBs can be used on lower cost projects without significantly affecting the project budget while, at the same time, allowing project participants to reap significant improvement in the project environment, leading to a reduction in the actual number of disputes. This issue is investigated in more details in the next two sections.

Effectiveness of a DRB as a Prevention and ADR Technique

In this section, the data was further analyzed to assess the effectiveness of DRB as a preventive and as an ADR technique. This effectiveness is measured with reference to Fig. 8, which shows that the prevention/ADR process begins when a conflict arises during the construction phase of the project. If the parties agree to solve the conflict within the contract provisions, then the conflict is resolved without any further escalation. The effectiveness of the DRB process at this level can be measured in retrospect by looking at the number of conflicts that actually escalated to a dispute that required a DRB hearing. Thus, the lower the number of conflicts that escalate to a dispute, the higher the probability is that adopting a DRB encouraged project participants to resolve their issues at this initial phase among themselves. On the other hand, DRB hearing sessions are undertaken whenever all interparty negotiations have been exhausted without successful resolution of the dispute (DRBF 2006). Again, the events leading to the hearing session and those associated with a particular hearing session are shown in Fig. 8 as the second phase of the conflict/dispute resolution process. Thus, the end result of a DRB hearing session is a recommendation rendered by the DRB members and communicated to the disputing parties in writing. It is assumed that the higher the rate of settlement of any given dispute based on a DRB recommendation, the more effective the DRB is as an ADR technique because it assisted the parties in resolving their dispute without the need of further escalation to the third phase of resolution (i.e., arbitration or litigation).

To assess the effectiveness of the DRB as a prevention and ADR technique, the data from the 810 construction projects are analyzed for the following: (1) determine the number of disputes per project referred to DRB during the construction phase and (2) the effectiveness of DRB hearings in resolving these disputes and preventing their escalation to binding dispute resolution methods like arbitration and litigation.

Prevention Effectiveness of DRB Process

The anticipated prevention role of the DRB process is studied in this section by determining the actual number of disputes heard by DRB panels on each of the 810 projects considered in this study. Fig. 9 shows the total number of disputes heard by DRB for all three construction project types across the nine ACV07

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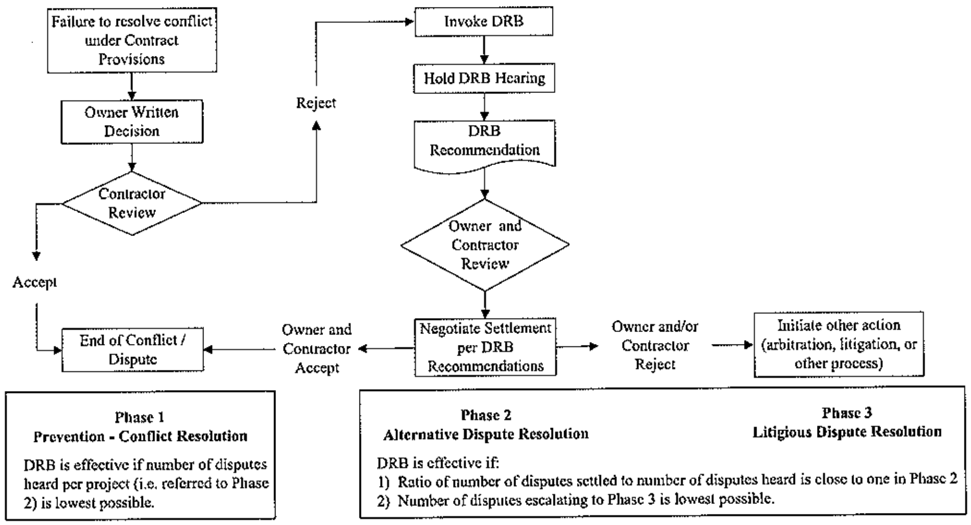

Fig. 8. Conflict/dispute resolution process [modified from DRBF (2006, 2007b)]

categories defined in the previous section between 1975 and 2001. In this respect, disputes heard refer to those disputes that required a DRB hearing session and the issuance of a DRB recommendation for final settlement, and do not include any conflicts that were resolved without the need for a DRB panel meeting. Thus, the lower the number of disputes heard by a DRB panel on any given project, the higher the probability is that these disputes were resolved through negotiation at the first phase of resolution. It can be seen that the first ACV07 category has the highest total number of disputes heard by DRBs (i.e., 70% of the total 1,314 disputes heard by DRB panels between 1975 and 2001) compared to the other ACV07 categories. This result is expected given that 87% of the 810 projects considered for this study have their ACV07 less than $0.1 billion.

In order to be able to compare the level of disputes over each of the three ACV07 categories, all the numbers shown in Fig. 9 were normalized by determining the number of disputes heard per project for all projects in each project type and ACV07 category. The minimum and maximum number of disputes heard per projects; as well as the corresponding average were determined for each of the three project types and ACV07 categories and discussed here below.

Minimum Number of Disputes Heard per Project

The minimum number of disputes per project is zero for 410 or 51% of the 810 projects considered. In addition, the mode of the number of disputes heard for all projects of the same type and within the same ACV07 category was determined to be zero. It can be inferred from both of these results that the DRB application in most of 810 projects considered in the analysis was a catalyst in mitigating the escalation of any conflict to a dispute that required a DRB hearing for final settlement.

Maximum Number of Disputes Heard per Project

Fig. 10 gives the maximum number of disputes heard per project for those projects that had disputes heard by the DRB panel. The maximum number reported is for a single project within each project type and ACV07 category. As seen in Fig. 10, the maximum number of disputes heard per project was the lowest for all three construction project types in the $0.5–$1.75 billion ACV07 category. In particular, this number is zero for the two B-type projects in this category, and 3 for both the six H-type and three T-type projects in this category. For projects having a lower ACV07 budget, the maximum number of disputes heard per project varied between 13 and 36. As in the case of the $0.5–$1.75 billion ACV07 category, B-type projects have the lowest maximum number of disputes heard per project at 13 and 19 in the <$0.1 billion and $0.1–$0.5 billion ACV07 category, respectfully. For H-type projects, there was not much difference between the maximum numbers of disputes per project for the first two ACV07 categories, indicating that this number is on the average 32 for H-type projects with ACV07 budget that is <$0.5 billion. However, this number increases from 13 for T-type projects in the <$0.1 billion ACV07 category to 36 for similar types of projects in the $0.1–$0.5 billion ACV07 category.

Two main observations can be inferred from these results. First, in general, B-type projects have lower maximum number of disputes per project compared to the two other project types. This

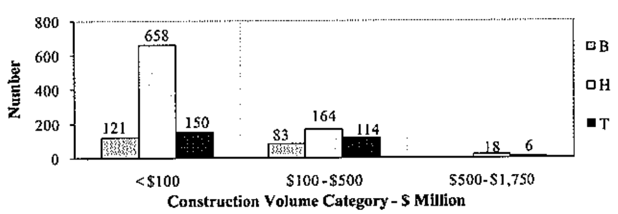

Fig. 9. Total number of disputes heard versus construction volume category

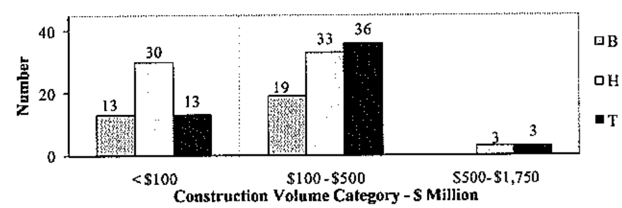

Fig. 10. Maximum number of disputes heard per project versus construction volume category

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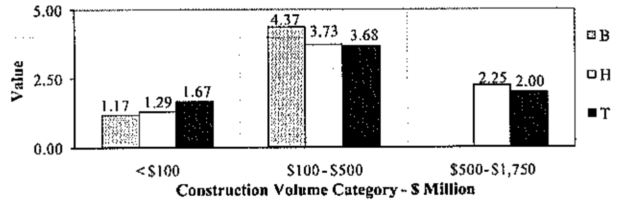

Fig. 11. Average number of disputes heard per project versus construction volume category

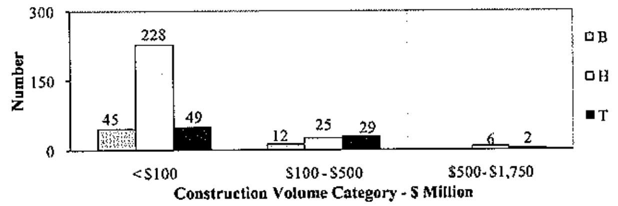

Fig. 12. Number of projects with disputes heard by DRB panel

is probably because of the lower uncertainty associated with differing site conditions in B-type projects when compared to H- and T-type projects where differing site conditions are the main contributors to construction contract change orders and claims. Second, larger construction projects having DRB panels implemented in them during construction have lower maximum number of disputes heard compared to project in lower ACV07 categories. This might be attributed to the fact that large scale construction projects utilize DRB as part of a more formalized process that might also include partnering and other forms of dispute prevention methods. In these projects the commitment for expeditious dispute resolution might be higher, and the parties are typically trained in the dispute resolution process at project inception. Thus, the parties are well prepared and have the incentive to resolve their conflicts as early as possible and preferable through negotiation to ensure that the project construction process is not interrupted at any level.

Average Number of Disputes Heard per Project

The average number of disputes heard per project is also determined for each project type and ACV07 category, as shown in Fig. 11. Contrary to the results for the maximum number of disputes heard per project, the average number of disputes heard per project is lowest for all project types in the <$0.1 billion ACV07 category. For this category, the average number of disputes heard per project ranges from 1.17 to 1.67 with a weighted average relative to the number of projects equal to 1.32. This low average number of disputes heard per project for this ACV07 category supports the arguments in the previous section regarding the benefits of applying DRBs in projects having ACV07 <$0.1 billion. When a DRB is implemented on these projects, the number of disputes actually requiring DRB hearing sessions is very low, indicating that fewer DRB hearing sessions will be required. Thus, DRBs are economical dispute prevention and ADR techniques to implement on projects with <$0.1 billion ACV07 because the number of DRB hearing sessions required on these projects are low, resulting in fewer expenses associated with inviting the DRB member to the construction the site for DRB meetings. On the other hand, the highest average number of disputes heard per project is the highest for all project types in the $0.1–$0.5 billion ACV07 category. In this category, the average number of disputes heard per project is highest for B-type projects at 4.37 and lowest for T-type projects at 3.68 resulting in a weighted average number of disputes heard per project equal to 3.85. It is interesting to note that projects in this ACV07 category have the highest average number of disputes heard per project in addition to the highest maximum number of disputes heard per project for all three project types. These results indicate that projects in this category experience the most inefficiency in terms of DRB implementation in construction projects resulting in more disputes requiring DRB hearing sessions for determination of merit. Finally, for projects with ACV07 in the $0.5–$1.75 billion category, B-type projects had zero average number of disputes heard per project as anticipated based on the results in the previous section. H- and T-type projects have an average number of disputes heard per project equal to 2.25 and 2.00, respectively. As argued in the last section, projects in this ACV07 category might have a more structured dispute resolution approach that supports and complements the DRB application in these projects, resulting in highly effective prevention and dispute resolution combinations.

Effectiveness of DRB Hearings—ADR Perspective

In this section, an examination of the DRB hearing process is undertaken by looking at the status of disputes that were actually heard by a DRB panel during the project construction phase. The results of this analysis will highlight the effectiveness of DRB as an ADR technique by measuring its ability to render recommendations that assist in settling claims without further escalation to the third phase of resolution (refer to Fig. 8). In this context, a DRB hearing is assumed to be effective in resolving a dispute if the project participants agreed to a final settlement of the dispute based on the DRB panel recommendation. Thus, the DRB effectiveness ratio for each of the projects in the 810 data set that had disputes heard by DRB is determined by Eq. (1) below

$$\text{DRB effectiveness ratio} = \frac{\text{Number of disputes settled per project}}{\text{Number of disputes heard per project}} \quad (1)$$

For the results of this analysis to be more representative of the DRB hearing effectiveness, all projects that had zero number of disputes heard per project were excluded from the study. Fig. 12 shows the number of projects in each of the three project types and ACV07 categories that had disputes heard by a DRB panel. These projects add up to 396 or 49% of the 810 selected projects. Using Eq. (1), the DRB Effectiveness Ratio was determined for each of the 396 subset projects and reported in Table 2.

As can be seen from Table 2, the effectiveness ratio for B-type projects is 1.00 for all ACV07 categories. For H-type projects, the effectiveness ratio decreases from 0.99 in the <$0.1 billion ACV07 category to 0.91 in the $0.5–$1.75 ACV07 category. On

Table 2. DRB Effectiveness Ratio versus ACV07 Category and Project Type

	DRB effectiveness ratio		
ACV07 category ($ million)	B	H	T
<$100	1.00	0.99	0.93
$100–$500	1.00	0.96	0.94
$500–$1,750	—	0.91	1.00

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the other hand, this effectiveness ratio increases from 0.93 for projects in the <$0.1 billion ACV07 category to 1.00 for projects in the $0.5–$1.75 ACV07 category. These results indicate that even in the case when a conflict escalates to a dispute that needs to be heard by a DRB panel for final resolution, the probability of having this disputed settled with no further deliberations exceeds 90%. This result again emphasizes the important role a DRB plays in dispute resolution during the construction phase of the project. In particular, a DRB acts as buffer which absorbs all unresolved disputes from negotiation and prevents their escalation to a higher, more protracted level of resolutions like arbitration and litigation.

Discussion and Recommendations for Future Research

The previous section has provided a history of DRB implementation in U.S. construction projects between 1975 and 2001 based on information obtained from the DRBF database. In this section, four important results from the previous analysis are highlighted, followed by hypotheses that may help to explain these results. These hypotheses are developed based on the observed results and additional extrapolations performed on the limited data available for construction projects with construction start date after 2002 and up to 2007 (refer to Fig. 1). Because of the incompleteness of this data, extrapolations to determine the average ACV07 per DRB per year were only feasible as this value provides a normalized way to account for DRB implementation during those years without having to determine the number of projects with DRB panel per year or the total prorated and ACV07 per year. Finally, recommendations for future research to validate or refute these hypotheses are provided.

Number of Construction Projects with DRB Panel per Year

Observation

The number of projects with DRB panel per year has increased since its inception and reached a maximum of 291 projects in 2001 with a total prorated and ACV07 equal to $5.6 billion. However, the average ACV07 per DRB panel per year was highest during the first four years of DRB implementation at $77 million and decreased to $26 million in the subsequent years. The available data for 2002–2007 indicate that average ACV07 per DRB per year continued to drop and was $2 million in 2006.

When distributed over the project types considered in the study, the results indicate that the number and total prorated ACV07 of H-type projects with DRB panels per year has steadily increased over the 1975–2001 period to a maximum of 231 projects and $3.6 billion total prorated ACV07 in 2001 (i.e., 80% of the total number of projects with DRB for that year, and 70% of the total prorated and ACV07 for that year). On the other hand, adoption of DRBs in B- and T-type projects has been relatively modest with a maximum of 41 B-type projects with DRB panel in 2000 and 2001, and 40 T-type projects with DRB panel in 1997. The total prorated ACV07 for both of these types of projects is also lower than that for H-type projects and does not exceed $1.25 billion per year. The average of the average ACV07 per DRB per year over the study period was $50, $26, and $34 million per DRB per year for B-, H-, and T-type projects, respectively. Further analysis of the data available for the fiscal years of 2002–2007 indicated that the average value of the average ACV07 per DRB panel per year dropped to $20 and $11 million per DRB panel per year for B- and H-type project, and increased to $39 million per DRB panel per year for T-type projects.

Hypothesis

The increase in number of projects with DRB panel per year over the period from 1975 to 2001 can be attributed to the fact that DRB was accepted by construction industry participants across the United States as an effective dispute resolution technique. As mentioned above, this is more so for H-type projects than for building and tunnel projects. Again, this finding highlights the fact that DRBs are more adopted by state and public agencies like DOTs who have a structured approach toward dispute resolution in their contract documents. For example, in their "Construction Manual," the CALTRANS specifies that DRBs can be either optional or mandatory depending on the project size and duration. This manual refers to Section 5 of the Special Provisions of the Contract for specifications of DRB establishment and operation (California DOT 2003). This is also verified by the data which shows that out of the 810 projects completed on or prior to 2001, 213 projects or 26.3% belong to CALTRANS. On the other hand, the results for the average ACV07 per DRB per year remained relatively constant after 1990 for the three project types even though the total and prorated ACV07 increased per year. This is mainly due to the fact that the number of projects with DRB panel per year increased at a much rapid rate than the total and prorated ACV07.

Recommendations for Future Research

To study the phenomenon that DRBs are more adopted in H-type projects and more so by DOTs in the United States, seeking answers to the following questions warrant further research:

- Are DOTs using DRBs in their projects because they tried other dispute resolution techniques and found DRBs to be more effective in terms of reducing disputes, and preventing their escalation to arbitration or litigation?;
- Do DOTs implement DRBs because this dispute resolution method is more economical from their perspective or because their employees are more experienced with the technique, or both?;
- Is the lack of reporting in the past five years to the DRBF a result of affirmative answers to the above questions? In other words, DOTs may have reduced their reporting of any new projects with DRBs because this approach to dispute resolution has become so common a practice and part of their project tradition is that they do not feel they are still adopting a state-of-the-art technique to dispute resolution in their projects; and
- Conduct a comprehensive study to determine if B- and T-type project owners are not specifying DRBs in their projects. If not, then is that because they prefer other forms of dispute resolution, lack of adequate experience in the process, or prefer to use other methods that might be more economical?

Distribution of Construction Projects in Terms of CV

Observation

The analysis to determine the number and total prorated ACV07 per year indicated two main observations:

1. The number of projects with DRB having an ACV07 less than $0.1 billion across all project types is 705 or 87% of the

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810 projects undertaken with DRBs in the United States between 1975 and 2001, while projects with ACV07 between $0.1 and $0.5 billion constitute 12% with the remaining 1% for projects with ACV07 in excess of $0.5 billion; and
2. Consistent with the results from the previous section, H-type project have the highest number of projects and total ACV07 among all three ACV07 categories.

Hypothesis

The finding that most construction projects with DRBs are below $0.1 billion in total value can be attributed to the fact that DRB might be an economical ADR technique to be used in this category of projects where budget constraints might be the driving factor behind choosing any dispute resolution method. Thus, in most of the cases where DRBs are used in these projects, the perceived benefits of reduced conflicts escalating to disputes as well as early resolution of disputes if they occur far exceed the costs associated with establishing and conducting DRB in the project. In addition, construction projects with ACV07 in excess of $1.0 billion are generally less in number, and the ones reported in the DRBF database may represent most of the projects undertaken in the United States at this scale. Thus, it is difficult to generalize that DRBs are not used on this type of large scale construction projects. Finally, the second observation was explained earlier by the fact that B-type projects are usually undertaken by private entities with the owner, architect/engineer working closely together to ensure successful completion of the project. On the other hand, fewer T-type projects are typically undertaken relative to other types of construction due to their inherent complexity.

Recommendations for Future Research

To study the phenomenon that DRBs are mostly used in construction projects with a total ACV07 below $0.1 billion due to budgetary constraints, it needs to be investigated by studying other projects (not included in DRBF database) of the same scale that had other ADR techniques implemented (e.g., mediation). Such a study will provide project participants with information comparing the benefits of each ADR with the associated cost. In addition, research regarding B-type projects and particularly those that are privately financed will determine if these projects had other types of ADR techniques typically implemented in them. If this is the case, then an analysis can be conducted to determine why private owners prefer other types of ADR in their projects.

DRB as a Prevention Tool—Number of Disputes Heard per Project

Observation

The number of disputes heard by the DRB panel per project was determined to infer the effectiveness of DRB as a prevention technique against the escalation of conflicts to disputes that require DRB hearing sessions for final resolution. The following two main observations are recorded:

1. The minimum number of disputes heard per project was zero for 51% of the projects in each project type and ACV07 category. This is also verified by the mode of the number of disputes heard per project which was also zero for each group of projects considered;
2. The maximum number of disputes heard per project was highest for projects in the <$0.1 billion and $0.1–$0.5 billion categories. This number was very low (i.e., less than 3) for project in the $0.5–$1.75 ACV07 category; and
3. The average number of disputes per project for all three project types exhibits a bell-shaped behavior with projects in the $0.1–$0.5 ACV07 categories having the highest average number of disputes heard per project.

Further analysis of the limited data available for 2002–2007 indicated the minimum number of disputes remained zero for 189 (or 81% of the 232 projects). The mode was again zero for all construction types and ACV07 categories. The average number of disputes heard was well below one for the three construction types indicating relatively high prevention effectiveness for the 232 projects undertaken during 2002 and up to 2007.

Hypothesis

The high maximum number of disputes heard per project and average number of disputes heard per project for all project types in the $0.1–$0.5 billion ACV07 can be attributed to an increase in the complexity of the construction projects as they become larger in scale. However, this explanation is contradicted by the results for projects having an ACV07 in the $0.5–$1.75 billion range. One interpretation for this observation is that project participants worked closely together and with the DRB members to ensure the minimum number of disputes in their project. It might also be the case that these projects have undergone more design and constructability studies to ensure that all projects' details are executable and avoid surprises during construction. Finally, these large-scale construction projects might have a more structured approach to dispute prevention which starts with partnering. Such an approach complements and enhances the prevention effectiveness of the DRB during construction.

Recommendations for Future Research

One important aspect of this study was to assess whether the DRB process is effective as a prevention technique. This effectiveness was deduced based on the low number of disputes heard per projects which indicated that probably most conflicts were resolved prior to escalation to a DRB hearing. However, other project conditions might have played an important role in reducing the number of conflicts escalating to a dispute, especially in construction projects having an ACV07 in excess of $0.5 billion. Thus, the role of the DRB in this aspect needs to be assessed relative to these other project conditions if they exist. One proposed way to more accurately measure this effectiveness is to investigate comparable projects having similar contract documents with only one of the projects having a DRB established from the beginning of construction. In addition, the characteristics of the projects in the different ACV07 categories need to be studied and compared to determine which factors mostly affect the expected average number of disputes heard per project. In this case, the characteristics of high value construction projects that make them less susceptible to disputes, if they exist, can be highlighted.

DRB Effectiveness Ratio

Observation

The DRB effectiveness ratio was determined for 396 projects that had disputes heard by a DRB panel. This ratio had an average of 1.00, 0.97, and 0.96 across all ACV07 categories for B-, H-, and T-type projects, respectively. Thus, the effectiveness of DRB as

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an ADR technique that facilitates the dispute resolution between the parties and prevents further escalation to arbitration and litigation is almost 100%.

The above high effectiveness ratio results are complemented by further analysis of the 232 projects completed between 2002 and 2007. For these projects, the average DRB effectiveness ratio was 0.86 for 33 B-type projects, 0.95 for 190 H-type projects, and 1.00 for 9 T-type projects.

Hypothesis

The high average DRB effectiveness ratio in excess of 0.96 is an indication that DRBs indeed provide project participants with a neutral venue during the DRB hearings to discuss their disputes and reach an agreeable settlement based on the DRB recommendations. On the other hand, the relatively lower DRB effectiveness ratio for T-type projects can be attributed to the fact that tunnel projects are characterized by more uncertainty surrounding the existing ground conditions as well as the complexity of the construction methods used. These two characteristics render T-type projects more susceptible to complicated disputes that might lead to arbitration or litigation when parties disagree or reject the DRB recommendations.

Recommendations for Future Research

This study indicated that, in general, DRB hearings are effective in resolving disputes referred to them by the project participants by comparing the number of disputes heard to those settled for a given construction project. This was also verified by a large data set of projects that had ACV07 less than $0.1 billion. Future research should focus on studying this process in more detail for large scale construction projects if they exist. In addition, methods to improve this process across different types of projects, in particular, H- and T-type projects, need to be investigated to achieve higher DRB effectiveness ratios for all projects in these categories. This can be done by studying projects where the DRB recommendation was rejected by both parties and the dispute had to be referred to arbitration/litigation to determine the reasons for this phenomenon. In addition, an important aspect of DRB panel that might have a strong correlation with the DRB effectiveness ratio is the level of experience of the DRB panel members with the construction process. This aspect needs to be further studied to determine this relationship if it exists.

Finally, other future research efforts can focus on:

1. Studying DRB effectiveness by comparing projects with different contractual types (i.e., design-bid-build, design-build, and build-operate-transfer) as well as different owner types (i.e., private and public); and
2. In this study, the DRB effectiveness as a prevention and ADR technique were investigated. Another important aspect of DRB effectiveness from the owner's perspective is whether it is going to help the project participants to settle the claims and disputes at lower amounts that what was originally asked for. This is particularly important for project owners looking at dispute resolution as a method to also reduce additional costs incurred during the project construction. This study can be undertaken by looking at claims and disputes data that were referred to DRB panels and determine the final amounts of settlement compared to the original or initial value of these claims.

Conclusions

This paper reports on the results of the analyzed 1,042 construction projects with DRBs in the United States. The results indicate that the use of DRBs as a prevention and ADR technique has risen over the past three decades, in particular, in H-type construction projects. In addition, the results indicate that B- and T-type project participants have been implementing DRBs as part of their dispute mitigation and resolution methodology but to a lesser extent when compared to H-type projects. In addition, the effectiveness of DRB in mitigating and resolving disputes was also evaluated through the use of two variables; namely, number/average disputes heard per project and DRB effectiveness ratio. The average disputes heard per project was generally low for the three ACV07 categories considered in the study. On the other hand, the DRB effectiveness ratio indicated that the settlement of disputes heard in DRB hearing session exceeded 90% on the average for all three ACV07 categories and project types.

The last section of the paper summarized the findings and provided some hypotheses to explain the results. This section also includes recommendation for future research which will help to either prove or disprove the hypotheses and explain the results obtained.

Finally, this paper studied historical trends of DRB applications in U.S. construction projects. However the DRBF database includes examples of large international construction projects that were successfully completed with DRBs implemented during their construction phase. Among these projects are the Channel Tunnel project between the United Kingdom and France ($15.7 billion), the Chek Lap Kok Airport in Hong Kong Airport ($10 billion), Ertan Hydropower project in China ($2 billion), Xiaolangdi Multipurpose Dam in China ($0.94 billion), and Oresund Fixed Link Bridge in Denmark ($0.82 billion). However, the database includes only 81 projects distributed over 20 countries like India, Canada, United Kingdom, Denmark, New Zealand, Australia, and Hong Kong. In this respect, more data are required to be able to assess the applicability and effectiveness of DRBs in international projects. Therefore, application of DRBs in international construction projects need to be studied to determine similarities and dissimilarities with the application in U.S. construction projects, and to study the mode of application and effectiveness.

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