ISSUES FOR REGULATORY ENFORCEMENT AND COMPLIANCE WITH BUILDING CODES: AMERICAN PERSPECTIVES

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SUMMARY

Shortfalls in compliance with building codes have been identified as a serious problem that contributes to high losses in earthquakes. The United States is not immune to this problem as evidenced by studies of the Northridge earthquake in California and Hurricane Andrew in Florida. This paper presents findings from a national study of code enforcement in the United States involving the collection and analysis of data from a national sample of 819 local governments. Enforcement shortfalls are identified, but they can be overcome if the federal government and states invest adequate resources to increase the attention local governments give to the enforcement of the earthquake-related provisions of building codes. Also, local governments must invest adequate resources in the code enforcement function and make the right choices about enforcement philosophy and effort.

INTRODUCTION

For building codes to result in a built environment that is resilient to earthquakes codes must contain appropriate standards, and the standards must be complied with in the design and construction of buildings. The United States has a long history of codes that address natural hazards and a strong reputation for good building practices. Nevertheless, recent disasters suggest that code standards are not complied with in a significant percentage of new construction. Following Hurricane Andrew in 1992, the insurance industry attributed fully a quarter of insured losses to construction that did not meet code standards (Insurance Institute for Property Loss Reduction 1995). Following the Northridge earthquake in 1994, the California Seismic Safety Commission (1995) concluded that there would have been far less damage had building codes been rigorously enforced. The Commission's conclusion is reinforced by the findings of Burby, French and Nelson (1998), who found a strong empirical correlation between weak local government code enforcement and the number of buildings damaged in particular localities affected by the Northridge earthquake. Clearly, one key to reducing losses in future earthquakes is better enforcement of the earthquake-related provisions of building codes.

This paper has two purposes. One is to urge the earthquake engineering community to pay more attention to the enforcement of building codes. The need for this appeal is suggested by the fact that the terms building code and enforcement cannot be found in the key word indexes provided for this conference. The second is to suggest concrete steps that can be taken to help ensure that building regulations will be followed by those who design and construct buildings. These suggestions are based on analyses of data from a national sample state and local governments in the United States.

ABOUT THE DATA AND ANALYSES

In 1995 we gathered data from each of the state governments with comprehensive state building regulations (33 states) and from a national sample of 819 local governments. The sample frame for the study of local

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governments is based on a prior national survey conducted by the National Conference of States on Building Codes and Standards (1992) that addressed state and local capacity to enforce the seismic safety provisions of building codes. In order to provide a profile that is representative of the distribution of local governments in the United States, we weighted the sample data in our analyses to reflect each state's proportion of the total number of local governments in the United States.

The data from state and local governments provide an indication of the degree of compliance being obtained through local enforcement of building regulations and the degree of priority local enforcement officials attach to the earthquake-related provisions of building codes. The data were analysed using multivariate statistical techniques to isolate (1) factors associated with the degree of compliance with code provisions by building contractors and (2) factors associated with the level of priority given to the enforcement of earthquake-related code provisions by code enforcement agencies. Based on the multiple regression analyses, "effects analyses" were performed to see to what degree compliance would likely improve, if a hypothetical enforcement agency took steps to change its staffing, level of effort, and use of facilitative enforcement tools from the level of the lowest quartile of agencies in the sample to the level of the highest quartile, keeping constant all of the other factors that affect compliance (see Burby, May and Paterson 1998 and Burby and May 1999 for additional information on this procedure). These analyses provide a basis for suggesting key steps governments can take to improve the enforcement of the seismic-related provisions of building codes.

THE ISSUES: NONCOMPLIANCE AND LOW PRIORITY OF EARTHQUAKE PROVISIONS

Violations of building standards revealed by the Northridge earthquake and Hurricane Andrew were not unique to the local governments affected by those disasters. Our survey results indicate that non-compliance with building regulations is an issue of national scope and significance. When asked to rate the degree of compliance obtained through their enforcement efforts, 25 percent of the local building code enforcement agencies we queried reported compliance levels at 6 or lower on a 10-point scale (as in a classroom, we graded performance at this level as a "D" or an "F"). The enforcement agency at the median rated compliance at 8 (the mean is 7.9), which rates a grade of C These results provide credible national evidence that attaining compliance with code standards in new construction and remodelling is problematic for a number of local governments.

This situation is likely to be more serious for compliance with the earthquake-related provisions of building codes. When asked to rate (on a scale of 1, low, to 5, high) the priority they attached to various provisions of the building code they enforced, two-thirds of the building code enforcement agencies report that they give high priority (score of 5) to the structural provisions of the building code. In contrast, only 17 percent give high priority to the earthquake-related provisions of the code In fact, on average the priority assigned earthquake-related provisions (score of 2.6) is below the mid-point of the scale.

The low priority that code enforcement agencies place on earthquake-related provisions is due, in part, to the fact that earthquake hazards are very unevenly distributed across the United States Where seismic hazard is high a higher proportion (57 percent versus 17 percent for the sample as a whole) of enforcement agencies report giving high priority to the earthquake-related provisions of codes. These include a majority of the jurisdictions in the sample from Alaska, California, Nevada, Utah, and Washington State. The greater issue is the intermediate earthquake-hazard jurisdictions where earthquakes can cause substantial damage. These include local governments in the New England states, South Carolina, states affected by the New Madrid fault zone, and parts of the West. In these "intermediate-hazard" states, just 22 percent of the local building code enforcement agencies report that earthquake-related provisions receive a high priority in their enforcement efforts. In contrast, 57 percent of these agencies rate earthquake provisions as a mid-level or low priority (3 or less on the 5-point scale). Where seismic risk is low, almost 90 percent of enforcement agencies afford enforcement of earthquake-related building code provisions a mid-level to low priority.

Although compliance with code standards is low in many jurisdictions and the priority local governments give to the earthquake-related provisions of codes can be low as well, there was sufficient variation in compliance and priority among the sample of local governments to identify factors that predict to low compliance and low priority. We turn next to analyses that isolated these key variables, which, in turn, provide clues about what governments can do to improve the rate of compliance.

IMPROVING COMPLIANCE WITH BUILDING CODES

Improving the degree of compliance with building codes requires that local government enforcement agencies build commitment to comply with code standards voluntarily by the private sector, develop the capacity to detect

violations and enforce compliance when it cannot be obtained voluntarily, and become committed themselves to vigorously enforcing the earthquake-related provisions of codes. Each of these requirements for improved compliance requires attention to a different set of factors.

Fostering Voluntary Compliance

There is general agreement that enforcement agencies must have adequate staff and technical capacity and make an adequate effort to enforce, if willingness by the private sector to comply voluntarily with building code requirements is to be fostered. However, there are two competing schools of thought (we call these "enforcement philosophies") regarding other factors that contribute to voluntary compliance with regulations (see Burby, May and Paterson 1998). One philosophy emphasises the systematic application of deterrence, while the second philosophy emphasises flexibility and facilitation. From the deterrent perspective, voluntary compliance can best be obtained by frequent inspection of construction activity, uniform and strict application of code and permit requirements, and the use of severe sanctions (such as stop work orders and fines) to deter violations. The general idea is that by making the costs of non-compliance much greater than any rewards obtained from violating the law regulations will by followed without the need for intervention by enforcement agencies. From the facilitative perspective, voluntary compliance can best be obtained if good working relationships with designers and contractors are developed by using general, flexible guidelines in assessing compliance (focusing on the attainment of enforcement goals rather than the strict letter of the law), using incentives such as relaxed inspection schedules and leniency when violations are detected in order to reward those who make an honest effort to comply, and using technical assistance to improve the capacity of regulated groups and individuals to comply. The general idea here is that by lowering the costs of compliance (i.e., facilitating compliance) and by rewarding good behaviour while reserving punishment for recalcitrant "bad apples" who consistently violate code requirements, a regulatory climate will be created that fosters voluntary compliance (for additional information on these enforcement tools to foster voluntary compliance, see Balch 1980 and Scholz 1994).

The results of empirical tests of the effects of enforcement capacity, effort, and philosophy on contractor commitment to comply voluntarily with building code requirements, while controlling for situational factors, are summarised in Table 1. The columns list the variables included in the regression model (column 1), the standardised regression coefficients that show the effects of a one-standard-unit change in a given factor upon contractor commitment to comply, also expressed in standard units (column 2), and, for the policy factors examined, the percentage increase in commitment that can be expected if a jurisdiction moves from the value of the lower quartile of that factor to the value of the upper quartile (column 3).

This analysis affirms that improvements in voluntary compliance can be attained by increasing the capacity and level of effort of enforcement agencies and by using a facilitative philosophy. In terms of policy effects, more proactive agency leadership would have the greatest impact, followed by improvements in legal support and then the use of a facilitative enforcement philosophy. Enhancing these three factors has the potential to noticeably raise the commitment of contractors to comply with building code requirements. If all three were simultaneously strengthened from the level of the community at the lowest quartile to the level of the community at the highest quartile, the commitment of contractors to comply voluntarily would be expected to increase by 22 percent.

Fostering Enforced Compliance

In addition to persuading designers and contractors to comply with building regulations voluntarily, enforcement agencies must have adequate capacity and then use that capacity by making a stronger effort to compel compliance by detecting violations and then demanding that they be corrected. Capacity to enforce includes staffing (plan checkers, building inspectors, support personnel), technical expertise, and legal support. Previous research has found that each of these is often missing in local government enforcement agencies. (e.g., see International Conference of Building Officials 1980; Nilson and Olson 1981; Southern Building Code Congress International 1992). Effort includes agency leadership and the vigour with which agencies undertake enforcement tasks, such as surveillance to detect building without a permit, plan checking, field inspections, technical assistance, prosecution of violators, and public relations.

Table 1. Factors Affecting the Commitment of Contractors to Comply Voluntarily with Building Codes

Explanatory Factors	*Standardised OLS Coefficient*	*Effect of Change in Policy Factor*
Policy: Staff capacity		
Staffing	.01	0
Technical expertise	-.02	0
Legal support	.13***	8%
Policy: Effort to enforce		
Proactive leadership	.15***	9%
Enforcement task effort	-.01	0
Policy: Enforcement philosophy		
Systematic	-.02	0
Facilitative	.13***	5%
Situational factors		
Contractor incompetence	-.15***	---
Interest group support	.12***	---
Absence of corruption	.08*	---
Population in 1990	-.09*	---
Population growth, 1980-1989	.06*	---
Weak economy	-.07*	---
Adjusted R2	.12	---
Significance	.000	---
Number of cities and counties	819	---

Notes: *p < .05, **p < .01, ***p < .001, one-tailed test. Scales used to measure commitment to comply voluntarily and the various factors affecting commitment are available from the authors. Standardised coefficients are from OLS regression. Effects represent change in a policy variable from 25th to 75th percentile of all cases while all other factors are kept at the level of the average community in the sample for that factor.

The results of empirical tests of the effects of enforcement capacity, effort, and philosophy on the effectiveness of agencies in enforcing compliance with code standards, while controlling for contractor commitment to comply and various other situational factors, are summarised in Table 2. The table reports the standardised regression coefficients that show the effects of a one-standard-unit change in a given factor upon the attainment of compliance (expressed in standard units) and the percentage increase in compliance that can be expected if a jurisdiction moves from the value of the lower quartile of that factor to the value of the upper quartile (i.e., from the 25th percentile to the 75th percentile).

Enforcement capacity, effort, and philosophy each has an effect on the ability of agencies to enforce compliance, either directly, or indirectly through their impacts on contractors' willingness to comply voluntarily. If enforcement agencies increased each of these aspects of enforcement from the level of the lowest quartile of all jurisdictions to the level of the highest quartile, their overall effectiveness in obtaining compliance with code standards would be expected to increase on average by 36 percent. Almost half of this effect would come from enhancing staff capacity. Other notable effects come from the effort agencies devote to enforcement and technical expertise. Legal support, agency leadership, and enforcement philosophy have less impact, since their effects are indirect and occur by fostering voluntary compliance among contractors.

Enhancing Agency Commitment to Enforce Earthquake-Related Provisions of Building Codes

To better understand how to enhance the attention local code enforcement agencies give to the earthquake-related provisions of building codes we focus this part of our analysis on data from a subset of our national sample—258 local governments in 11 western states, where earthquake risks are highest and state agencies in several states have made a concerted effort to foster attention to seismic safety in the built environment (see May and Feeley 1999). The object of the analysis is to determine whether these state efforts have had a discernible effect on the priority local governments give to the enforcement of earthquake-related code provisions and thus might serve as models that other states could emulate.

Table 2. Factors Affecting Effectiveness of Enforcement in Attaining Compliance with Building Codes

Explanatory Factors	*Standardised OLS Coefficient*	*Effect of Change in Policy Factor*
Policy: Staff capacity		
Staffing	.29***	17%
Technical expertise	.14***	5%
Legal support	-.04	2%
Policy: Effort to enforce		
Proactive leadership	.04	2%
Enforcement task effort	.19***	9%
Policy: Enforcement philosophy		
Systematic	---	--
Facilitative	---	5%(through effect on commitment)
Situational factors		
Contractor commitment	.24***	---
Contractor incompetence	-.02	---
Interest group support	-.04	---
Absence of corruption	-.01	---
Population in 1990	.10**	---
Population growth, 1980-1989	-.05*	---
Weak economy	-.07**	---
Adjusted R2	.29	---
Significance	.000	---
Number of cities and counties	819	---

Notes: *p < .05, **p < .01, ***p < .001, one-tailed test. Scales used to measure compliance with code standards and the various factors affecting compliance are available from the authors. Standardised coefficients are from OLS regression. Effects represent change in a policy variable from 25th to 75th percentile of all cases while all other factors are kept at the level of the average community in the sample for that factor.

May and Feeley (1999) classified the eleven western states into three categories, based on the extent to which state governments have addressed earthquake hazards. Only one state—California—was classified as playing an "aggressive" role in earthquake hazard mitigation. It stands head and shoulders above other states in its attention to earthquake hazards, in large part because it has experienced a series of serious earthquakes throughout this century with catastrophic losses. California State government first addressed earthquake hazards after serious damages were experienced in the Long Beach earthquake in 1933. Through the Field Act it required more attention to earthquake hazards in the construction of schools. Following the San Fernando earthquake in 1971, the state required local governments to develop seismic safety elements of required comprehensive plans. The state also placed limits on development that could occur in identified fault zones and required real estate agents to disclose the presence of fault zones to potential homebuyers. The seismic safety provisions of building codes have been strengthened significantly over time, and local governments are required to enforce those elements of the code. In addition, California requires local governments to identify unreinforced masonry structures that are particularly vulnerable to damage in earthquakes and to take other steps to increase the resilience of the built environment to earthquake hazards (see Burby and May et al. 1997).

Five states—Alaska, Oregon, Nevada, Utah, and Washington—were classified by May and Feeley as playing an "attentive" state government role in dealing with earthquake hazards. These states have strong state building codes, which require local enforcement of seismic provisions, and have taken other steps to promote seismic safety, such as creation of state seismic safety commissions. The remaining five states—Arizona, Idaho, Montana, New Mexico, and Wyoming—were classified as playing "minimalist" roles in relation to earthquake hazards. These states have adopted seismic provisions in state building codes, but they do not necessarily require local enforcement of those provisions. In addition, they have not created seismic safety commissions or taken other steps, beyond routine emergency management functions, to foster resilience to earthquake hazards.

The percentage of local building code enforcement agencies that give high priority to the earthquake-related provisions of building codes varies significantly among these three groups of states, but the degree of seismic risk does as well. In the "aggressive" state of California, 83 percent of the sample of 75 local building code enforcement agencies queried there give earthquake-related provisions high priority. The percentage of agencies

giving high priority to earthquake-related provisions dropped to 50 percent among the 123 local governments surveyed in the "attentive" states, and to just 29 percent among the 60 local governments surveyed in the "minimalist" states. These differences suggest that state programs may be having an effect, but the potential mean peak ground acceleration (at a 10 percent chance of exceedence over 50 years) also varied in a similar way among the three groups of states, with values of 47.37 for local governments in California, 21.84 among the localities in the "attentive" states, and 10.32 among local governments in the "minimalist" states. The regression model reported in Table 3 sorts this out. We regressed dummy variables representing the state earthquake hazard programs, seismic risk, and other factors against the priority given to enforcement of earthquake-related code provisions reported by local enforcement agencies. The results shown in Table 3 indicate that the strength of state earthquake hazard mitigation efforts make a difference when the degree of seismic hazard and other factors are controlled statistically. The coefficients for the "aggressive" and "attentive" state programs are positive and relatively strong (although the coefficient for California is not statistically significant at the .05 level of confidence). The weaker influence of California's program reflects the greater diversity of local building departments in this very large state in comparison with the smaller states that make up the "attentive" group and also the fact that the building code function is spread across a number of state agencies in California, which may dilute program effects on local priorities (see May and Birkland 1994).

The strongest effect on priority among local governments in these western states, however, comes from the degree of seismic hazard, which indicates that in addition to taking their signals from state regulatory requirements, local building code officials also respond to the actual extent of earthquake risk. The other factors we examined as possible predictors of the priority officials give to earthquake hazards had little effect. The fact that local political factors have little effect on priority reflects the low salience of earthquake hazards in most local jurisdictions (except in the aftermath of a serious earthquake). The lack of an effective political constituency for earthquake hazard mitigation helps explain the uneven effect of state programs, since local officials who give little attention to state directives likely experience few local political repercussions from their actions.

CONCLUSIONS

There is ample reason for concern about compliance with the earthquake-related provisions of building codes and the enforcement systems in place to bring about compliance. Recent disasters in the United States brought to light evidence of more than incidental violations of building code standards, which have contributed significantly to the toll of property damages. In this paper, we have shown that shortfalls in compliance with building code standards are national in scope in the United States. They can be attributed to a variety of factors, including inadequate staffing of local enforcement agencies, inadequate technical expertise, inadequate legal support, inadequate leadership and effort in undertaking enforcement functions, and failure to work in a facilitative way with building designers and the construction industry. In addition, many local governments do not place a high priority on enforcement of the earthquake-related provisions of building codes. Thus, deficiencies in building code enforcement present a significant barrier to effective management of earthquake hazards.

Remedying these deficiencies requires attention to strengthening the code enforcement function in general in local governments and raising the level of attention agencies give to the earthquake-related provisions of building codes. Our analyses point to ways both goals can be accomplished, although they also suggest that there are no quick fixes. Effective enforcement is a function of multiple, interrelated agency activities and capabilities. These have to be carefully managed, if agencies are to succeed in the dual mission of preventing and correcting violations. Our findings suggest that effective enforcement is most likely to occur in an agency employing a facilitative enforcement philosophy with an adequate number of technically competent staff, strong proactive leadership, adequate legal support, and a consistently strong effort to check building plans, inspect construction activities at building sites, and provide technical assistance to designers and contractors.

Agency attention to earthquake-related provisions of building codes can be counted on when earthquake risks are extremely high. The bad news is that when risks are lower, but still significant (particularly for older unreinforced masonry construction), enforcement agencies tend to afford them little priority. The good news, however, is that proactive state programs and initiatives from the private sector can have a marked effect on agency priorities, above and beyond the effects of the degree of earthquake hazard itself. Proactive state efforts can include requiring local enforcement of state building regulations, provision of technical assistance to local enforcement personnel, requirements for certification of local code enforcement personnel to ensure that they understand the earthquake-related provisions of building codes, and programs to increase public awareness of earthquake risks and the importance of building codes and code enforcement as a way of managing these risks. Appointment of a state seismic safety commission is an important way of ensuring that earthquake hazards

Table 3. Factors Affecting the Priority Enforcement Agencies Give to Earthquake-Related Provisions

Explanatory Factors	*Standardised OLS Coefficient*
Policy: State Earthquake-Hazard Regulatory Program	
Aggressive state program (a)	.14
Attentive state program (b)	.14***
Situational factors	
Problem characteristics	
Seismic hazard (c)	.31**
Experienced earthquake disaster since 1980	.09
Political considerations	
Political demand for stronger code enforcement	.04
Political demand for weaker code enforcement	-.05
Economic considerations	
Population in 1990	.07
Population growth, 1980-1989	-.03
Median value of housing, 1990	-.01
Adjusted R2	.22
Significance	.001
Number of cities and counties	218

Notes:

*p < .05 **p < .01 ***p < .001

(a) Whether or not a jurisdiction is located in the state of California.

(b) Whether or not a jurisdiction is located in the states of Alaska, Nevada, Oregon, Utah, or Washington.

(c) Peak ground acceleration (PGA) at 10 percent chance of exceedence over 50 years. Higher values indicate increased seismic hazards.

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receive continuing attention in state policy making. Notable private-sector initiatives include the formation by the insurance industry of the Institute for Business and Home Safety (IBHS) to foster building practices that give adequate attention to natural hazards and the insurance industry's local code enforcement agency grading system, administered by the Insurance Services Organisation (ISO), which offers insurance rate reductions as an inducement to strengthen the code enforcement function in local government.

Traditionally, building codes and their enforcement has been a state-government function. Nevertheless, there are a number of ways the federal government can bring about greater emphasis on enforcement of the earthquake-related provisions of building codes. First, as it did with energy conservation, it can create strong financial incentives for the states to adopt and local governments to enforce building regulations with seismic provisions. Second, it can put in place grant-in-aid programs to improve state-government capacity to oversee these functions. Third, it can expand existing technical assistance to state and local code enforcement personnel (e.g., see Olshansky 1998).

In sum, compliance shortfalls and weak code enforcement are serious barriers to effective management of earthquake risks in the United States. But, the actions needed to reduce these barriers are clear-cut. In this paper, we have demonstrated that no single action, by itself, will bring about better enforcement results. But, we have shown that, by taking a number of steps to enhance the capacity of building code enforcement agencies and their commitment to enforce the earthquake-related provisions of building codes, significant progress can be made.

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