

Natural Hazard Research

RESTORATION AND RECOVERY
FOLLOWING THE COALINGA EARTHQUAKE
OF MAY, 1983

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SUMMARY

On May 2, 1983, Coalinga, California was struck by an R6.7 earthquake that caused considerable damage to property throughout the town. The event provided an opportunity to examine not only the patterns of damage, but the restoration and reconstruction processes as well.

In Coalinga, unreinforced masonry buildings, built before the adoption of current building codes, suffered considerably more damage than any other structures. Recovery following the quake was rapid. The repair of damaged utilities came a few hours to two weeks after the disaster. An analysis of building permits shows that most repair and demolition began in the three months immediately following the disaster and that permits for the construction of new residences peaked five months later, in October. However, business recovery, particularly in the downtown area, has been slow. An analysis of recovery financing shows that federal, state, and local agencies, as well as private institutions, were all involved. The presence of a local development agency funded by the Economic Development Administration was particularly helpful, whereas the efforts of the Small Business Administration seemed significantly less helpful than those of other agencies.

Coalinga effected few policy changes as a result of the earthquake. However, Coalinga's experience strongly suggests that one critical mitigation measure other communities should adopt is the razing or reinforcement of hazardous structures. That measure was not adopted by Coalinga, since all such structures were destroyed by the earthquake.

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PREFACE

This paper is one in a series on research in progress in the field of human adjustments to natural hazards. It is intended that these papers be used as working documents by those directly involved in hazard research, as well as inform a larger circle of interested persons. The series was started with funds from the National Science Foundation to the University of Colorado and Clark University, but it is now on a self-supporting basis. Authorship of the papers is not necessarily confined to those working at these institutions.

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TABLE OF CONTENTS

| | |
|-----------------------------------------------|------|
| List of Figures | .vii |
| Introduction | 1 |
| The Earthquake and Its Aftermath | 2 |
| Restoration of Services | |
| The Rate of Recovery | |
| Financing Recovery | |
| Conclusions and Policy Implications | 20 |
| References | .22 |

LIST OF FIGURES

Figure

| | | |
|---|-----------------------------------------------------------|-----|
| 1 | Extent of Damage to Residences | .3 |
| 2 | Damage Map--May 2, 1983 | 4 |
| 3 | Total Number of Building Permits Issued, 1983 | 7 |
| 4 | Number of Addition/Alteration Permits (Repairs) | 9 |
| 5 | Demolition Permits | 10 |
| 6 | Residential Permits | .11 |
| 7 | Mobile Home Permits | .11 |
| 8 | State of Repairs--January, 1984 | .14 |
| 9 | Map of Rebuilding and Repair--January, 1984 | .16 |

INTRODUCTION

The purpose of this quick response research project was to investigate short-term restoration and reconstruction following a damaging earthquake. The eight months' period following the May 2nd, 1983 earthquake in Coalinga, California provided an excellent opportunity to examine that process in one particular community.

Coalinga, California is a small town of about 7,000, located in Fresno County, on the western edge of the San Joaquin Valley. The economy of the community is dependent on nearby oil fields, originally developed in the 1920's, and, to a lesser extent, on surrounding agriculture. The earthquake, which struck at 4:42 p.m. on May 2, 1983, registered 6.7 on the Richter scale and was centered less than 10 miles from Coalinga. According to Governor George Deukmejian's letter to President Reagan, the earthquake caused an estimated \$31 million in damages (Deukmejian, 1983). About 90% of the older brick buildings of the downtown shopping area were destroyed by the earthquake. Many older residences of wood frame construction were thrown off their foundations, but buildings constructed under more recent codes showed little or no damage. Several dozen aftershocks of magnitude R4.0 and greater were experienced during the recovery period.

Following Haas, Kates and Bowden (1977), the recovery period subsequent to this natural disaster has been broken into four parts: emergency, restoration, short-term reconstruction and long-term reconstruction. This investigation primarily focuses on the middle two stages of this process: restoration and short-term reconstruction. Particular attention has been paid to the patterns of damage caused by the earthquake, the rate and pattern of construction activity during the remainder of 1983, the financing of this reconstruction activity, and

any adjustments in land use regulations or building code standards instituted to mitigate the earthquake hazard in Coalinga. Hopefully, this work will point out lessons that may be useful to local governments and other policy-making agencies that play a significant role in the recovery process.

THE EARTHQUAKE AND ITS AFTERMATH

The earthquake of May 2, 1983 literally shattered the community of Coalinga. Ground motion was the major cause of damage and was particularly strong, since the epicenter of the earthquake was located only about five miles from Coalinga. Many old structures could not withstand this motion. Ninety-five percent of the central business district and about 45-50% of the city's total retail space was destroyed (Lichterman and Eisner, 1983).

Throughout the city, the R6.7 earthquake turned structures into rubble and dust in a matter of seconds. The physical effects of the earthquake included major damage to the following portions of structures: parapet walls, exterior walls, roof systems that were poorly designed, brick chimneys and walls, veneered walls not properly secured, overhanging signs, poorly connected roofs over sidewalks, and display windows (Lichterman and Eisner, 1983).

Many older homes simply "walked off" their foundations due to the severe ground motion. However, secondary hazards commonly associated with earthquakes and usually considered in land use planning, such as the mass wasting of slopes and liquefaction, did not occur. Ground rupture was limited to minor cracks near the epicenter five miles away and did not occur within the city (Topping, 1983).

According to the official damage estimates, there was \$31,076,000 in damages to Coalinga. The private sector suffered \$25,129,000 worth

of damage, while the public sector sustained a \$5,947,000 loss (Deukmejian, 1983).

Most of the damage was sustained by older buildings constructed before adoption of current building codes. Unreinforced brick and masonry, as well as old wood frame homes with insufficient foundations, were virtually destroyed (Topping, 1983). As previously discussed, the central business district was almost completely destroyed. The masonry structures there were built before the current regulations for mitigating the effects of an earthquake were instituted. The effectiveness of current building codes and their enforcement is reflected in the little damage suffered by critical facilities (California Seismic Safety Commission, 1983). The fire station, hospital, and community college remained intact and served as nodes for immediate disaster response activity.

Figure 1 displays the mix of earthquake damage to dwelling units. Fully 68% of the residential units suffered some damage, while 35% were either totally destroyed or made uninhabitable due to the earthquake. A total of 141 businesses were destroyed, and another 73 incurred major damage (Deukmejian, 1983).

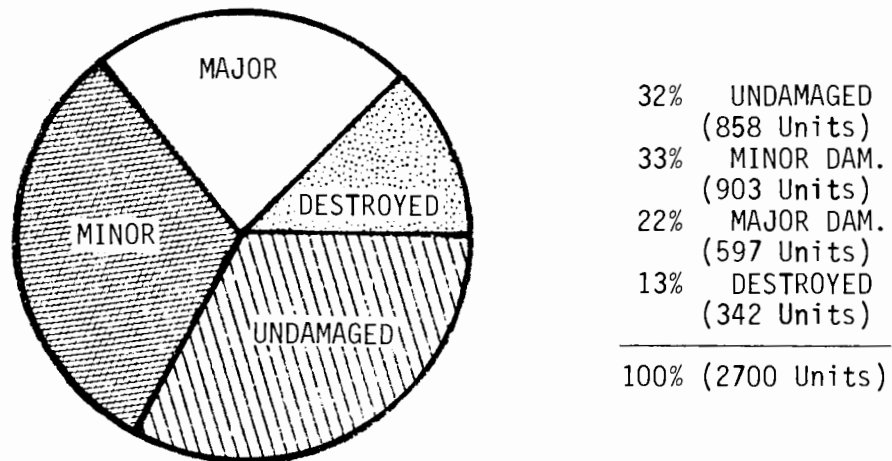


FIGURE 1
EXTENT OF DAMAGE TO RESIDENCES

Figure 2 shows the general pattern of damage after the earthquake. Major damage tended to be concentrated in the older parts of town, with only minor damage in the newer, outlying areas.

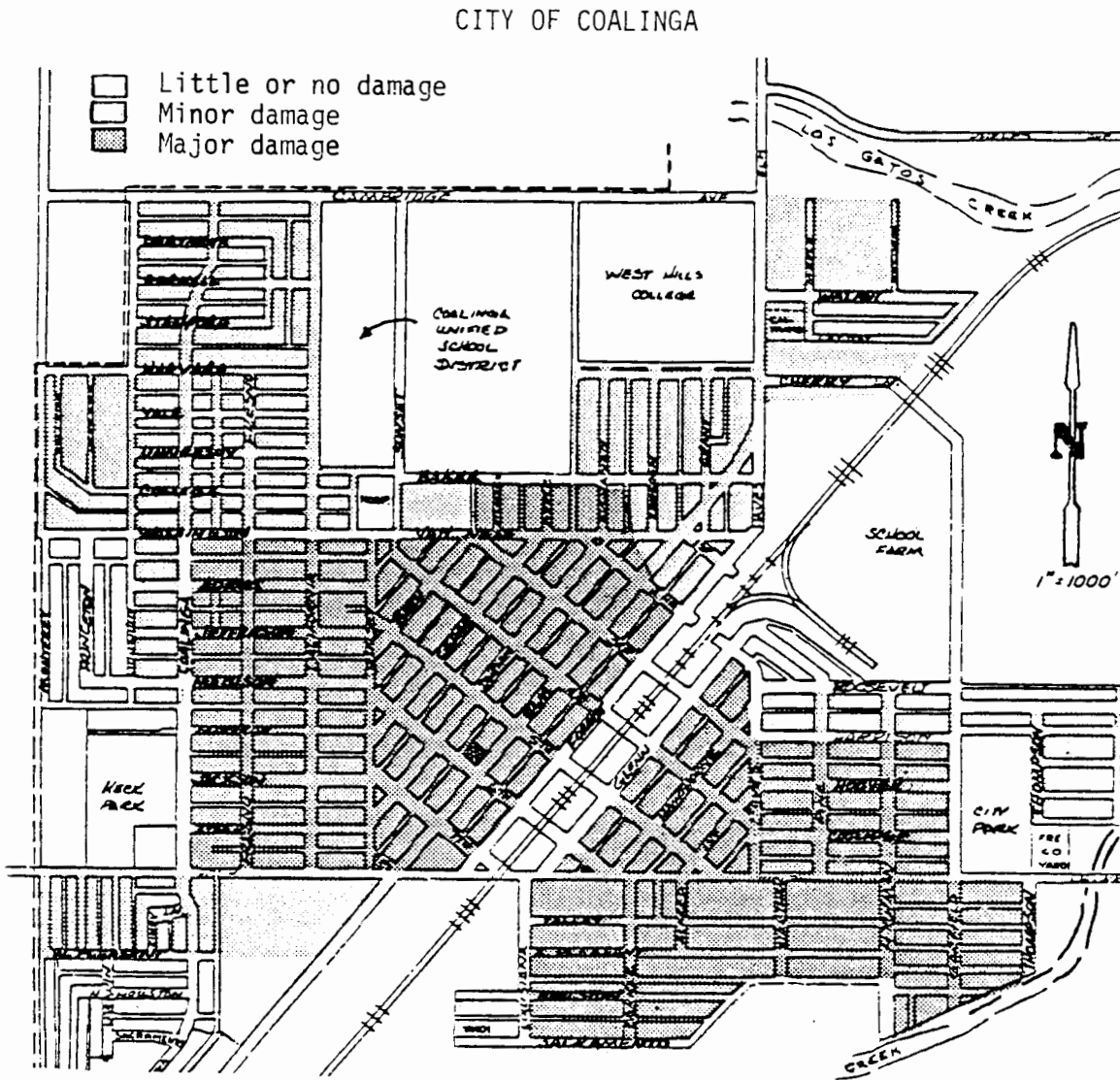


FIGURE 2
DAMAGE MAP--MAY 2, 1983
(California Division of Mines and Geology, 1983)

The age and type of structure greatly influenced the amount of damage sustained. Buildings constructed in the last twenty years were minimally damaged, if at all (Topping, 1983). The primary damage was to unreinforced commercial brick structures and to older wood frame homes with inadequate foundations. The damaged commercial establishments were constructed in the early 1900's during the oil boom in the area. The older wood frame homes which suffered foundation damage were also built in this time period. Many, however, were initially built near the oil fields to provide housing for workers and were transported to Coalinga in the late 1920's (Lichterman and Eisner, 1983). Most of these structures were not adequately attached to their concrete foundations. Newer wood frame structures which were securely bolted to their foundations suffered only minor damage, primarily to interior furnishings, brick veneers, and chimneys.

Restoration of Services

Initially public services to the residents of Coalinga were seriously disrupted by the earthquake. For fear of possible fires, all gas lines were shut down. Generally, water was either not available or not potable. One water main was broken, causing water to flow down the main street of downtown. Questions as to whether sewer lines might have been broken, allowing effluent to enter the water system, caused officials to shut off water supplies. While electricity and telephone lines were initially cut off, both were restored within 24 hours after the earthquake. During this 24-hour period, essential communication was provided by mobile radios. Within two weeks, crews had repaired damage to the water system and service was restored (California Seismic Safety Commission, 1983).

The clearance of dangerous structures was begun within 48 hours. Priority for demolition was given to those structures under imminent danger of collapse and included most buildings in the central business district. Merchants were only allowed entry to their businesses in order to retrieve records and money. They therefore not only lost considerable inventory but also had difficulty assessing those losses because of their inability to examine damaged merchandise.

Clearance of dangerous structures in residential areas did not occur until later, and some structures were simply abandoned rather than demolished. However, certain structures, such as a severely damaged adobe church, were marked off limits because of the possibility of further collapse due to aftershocks (Topping, 1983).

Numerous emergency response organizations such as the National Guard, the Red Cross, and the Federal Emergency Management Agency (FEMA) provided emergency food and shelter. Law enforcement agencies from the state and county provided security against looters, while CalTrans (the California State Transportation Department) operated heavy equipment to clear the rubble. Some 200 trailers and mobile homes were supplied by FEMA to provide temporary housing. These arrived by the end of the first week, and were placed either in areas previously designated in the city's general plan for mobile home parks or in the area south of the central business district. They were provided with water, but did not have sewer or gas.

The Rate of Recovery

Following the restoration of basic services, the focus of recovery changed. Efforts were directed toward returning the city's economy and social activities to pre-disaster levels. Areas not immediately

threatening public health and safety (residential property, parking lots, for instance) were cleared, and construction of replacement buildings began. Superficial damage to nonstructural items such as chimneys or awnings was removed.

The rate of reconstruction at this stage can be estimated by the number of building permits issued by the Coalinga Public Works Department. Figure 3 shows the number of building permits of all types issued during 1983. Note that each month after the earthquake (including May) shows considerably more permits than the months preceding the earthquake.

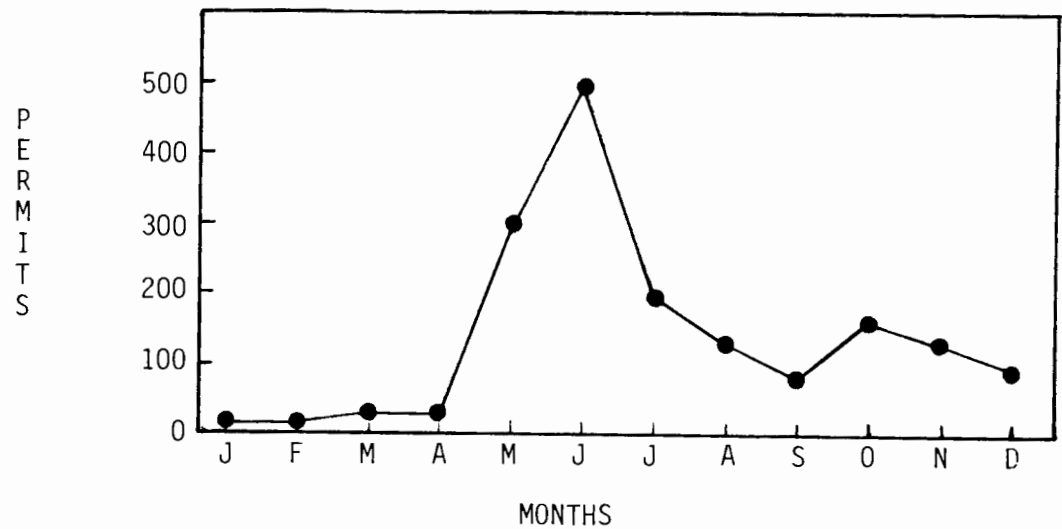


FIGURE 3
TOTAL NUMBER OF BUILDING PERMITS ISSUED, 1983

The graph of total permits shows a peak in June, four to eight weeks after the quake, when 499 permits were issued. This suggests a relatively rapid progression from restoration to reconstruction, because the granting of a permit requires several preconditions: the return of evacuated residents, the assessment of damages and repairs, the processing of the permit request. According to the data, these steps occurred within the first few weeks after the quake. Thus, despite the loss of the central business district, it appears that the social and political fabric of the area was not destroyed.

The ability of Coalinga to move quickly into the recovery stages was due in large part to the many resources provided for the area by local, regional, state, and federal agencies and institutions. Coordination of the public and private aid flowing into the area was assumed by the State Office of Emergency Services (OES), which also prepares programs and drills directed at emergency earthquake response. One such drill was being planned for the Fresno County area at the time of the earthquake, and preparations for it may have provided additional "readiness" for the actual earthquake.

Like the number of total permits, additions and alterations permits required for repair (Figure 4) jumped in May and peaked in June. More than 520 permits of this type were issued during the 12 weeks following the earthquake. Since this type of permit would be necessary for the repair of seriously damaged structures, this number would appear to represent nearly all the residences in the major damage category. No doubt some of these homes were or will be demolished rather than repaired, and some permits must have gone to the 73 businesses that sustained damage. Yet it is safe to say that many of the seriously damaged

structures had been assessed and their owners granted permits within three months of the earthquake. Still, repair activity remained strong throughout the eight months following the May 2nd earthquake.

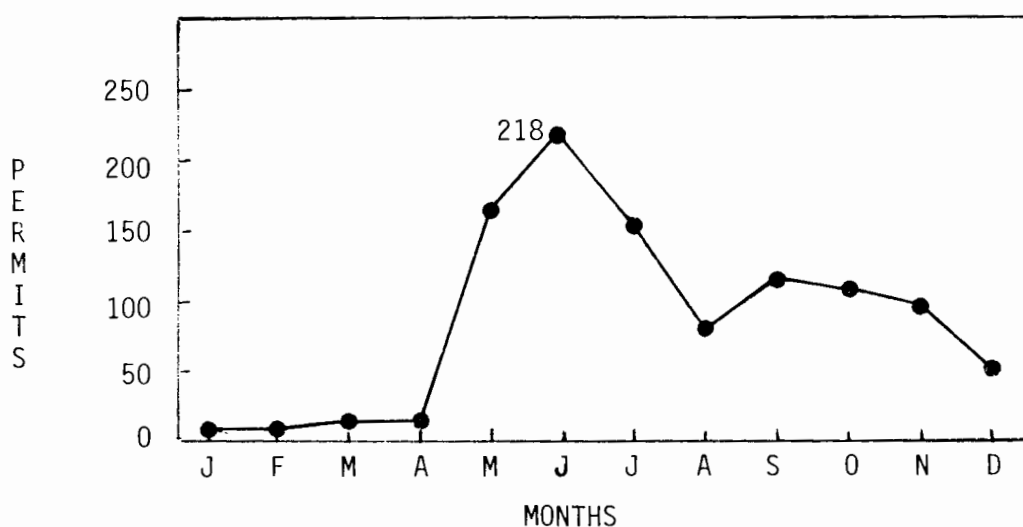


FIGURE 4
NUMBER OF ADDITION/ALTERATION PERMITS (REPAIRS)

Demolition permits (Figure 5) were necessary for those buildings slated for removal and possible replacement. More than 280 such permits had been issued by the end of September, and the peak of 102 in June follows the trend for addition/alteration permits. Within eight weeks, more than half of all demolition permits (180) had been issued. A second peak in September suggests a delay in the issuing of some permits, possibly because some property owners were absent for several weeks after the quake or were unable to secure immediate financing for demolition and reconstruction (e.g., federal/state disaster relief, insurance settlements, bank financing).

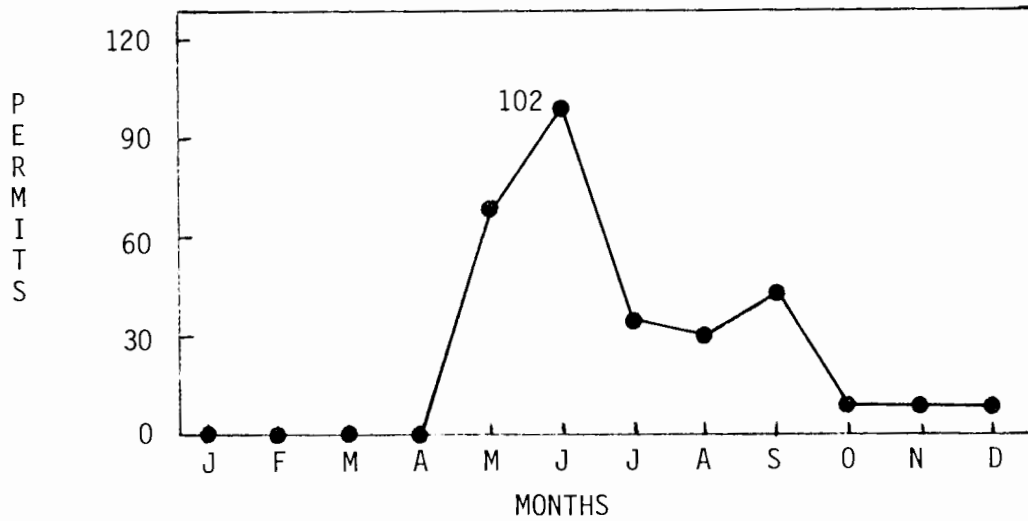


FIGURE 5
DEMOLITION PERMITS

Of all the permit types, residential permits (Figure 6) showed the greatest delayed response. Although early response was evident--over 50 permits were issued in May and June--the largest monthly total (37) was issued in October, 22 to 26 weeks following the quake. The reasons for this three- to four-month lag may again be late returning evacuees or financing delays. Additionally, erecting a new house requires more planning and resources than demolition or alterations. Several weeks may be spent securing an architect, contractor, and lender. Indeed, many residences had not been rebuilt at the time of this study, and it appeared that some rebuilding might not begin until a year or more after the disaster. Homeowners who finally decide not to return will probably sell their cleared lot rather than rebuild.

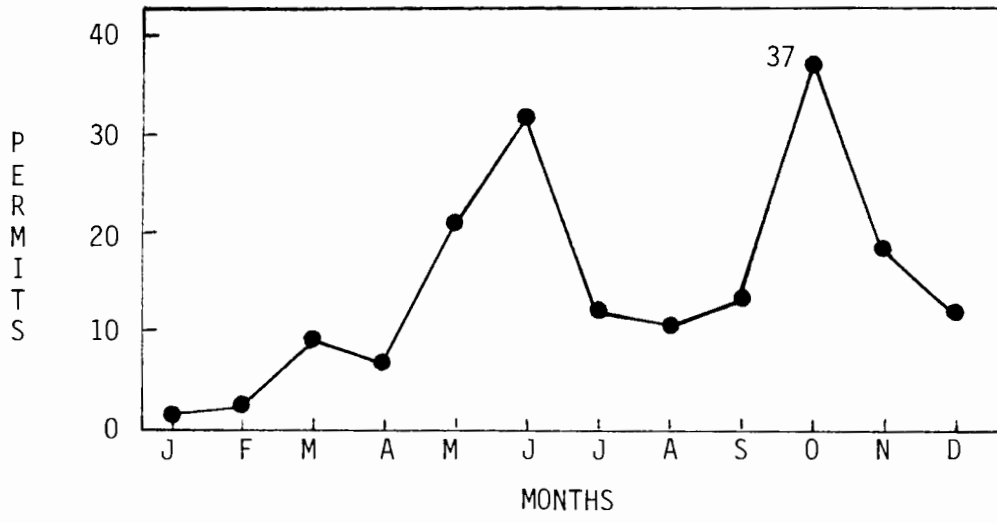


FIGURE 6
RESIDENTIAL PERMITS

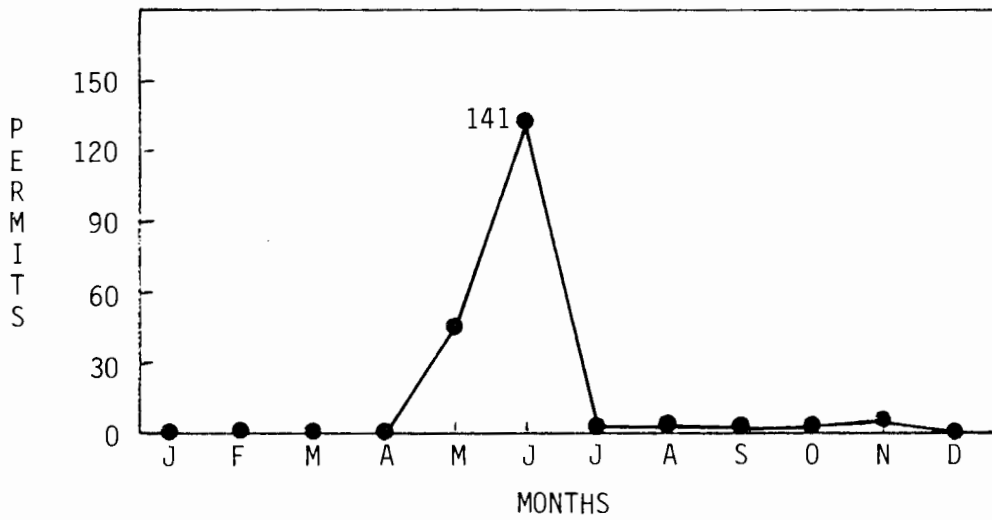


FIGURE 7
MOBILE HOME PERMITS

Mobile home permits (Figure 7) were issued more quickly than any other type of permit. Mobile homes are used regularly by FEMA and others as temporary shelter during the restoration stage of a disaster. The absence of any mobile home permit activity before the earthquake or after June suggests that mobile homes were specifically used as relief housing, and that issuance of these permits was a short-term phenomenon.

In an emergency such as an earthquake, rapid response to shelter needs is critical. Therefore, the placement of mobile homes might have to precede the issuance of permits in order to satisfy such a need. The data for mobile home permits suggests that this may have occurred in Coalinga, since the bulk of permits were issued in June, four to eight weeks after the quake.

The occurrence of an earthquake seemed to have little effect on non-residential permits. However, like the permits for new residences, these require substantial planning and preparation prior to request and approval. Only 34 permits were issued in the 30 weeks after the earthquake. This could only represent less than half the businesses destroyed, and reflects the fact that the downtown retail area had seen no significant rebuilding as of January, 1984. The ability of Coalinga to rebuild its commercial area is not adequately reflected in the time frame of this study, however, and non-residential permits bear further watching as one indicator of the rate at which the local economy is recovering from this disaster.

As local merchants assessed the impact of the earthquake on their businesses, many found their goods and services in demand sooner than they were prepared to supply them. Hardware stores, lumber and building

suppliers and other recovery-related businesses had customers for clean-up and repair goods starting the day after the earthquake. Though this business activity will last only as long as the recovery stage, it will help offset some of the losses brought on by damage to other types of retail stores. Goods and service which are considered luxuries (jewelry, special fashions) or which were marginally profitable before the earthquake may not be able to recover as quickly, if at all. Retail sales for 1983 were quite strong, even with the destruction of downtown (Semple, 1983). However, the strength of Coalinga's retail sector in future years, when disposable income is diverted to repay reconstruction loans, is an open question. Further investigation of the damage to specific economic sectors will help in developing a picture of the likely future of business activity in the community.

In addition to the time series analysis of building permit records, a field survey was conducted on January 20, 1984 to inventory the location and progress of repair construction. This inventory provides a "snapshot" of the rebuilding process almost nine months after the earthquake. In this limited field survey it was not always possible to tell if a particular structure had been damaged or not. This probably resulted in some undercounting, particularly of structures with only minor damage.

Figure 8 shows that of those lots where significant earthquake damage was apparent, the largest number (over one third) had repairs completed, and the next largest number (about one fourth) showed signs of active repair construction. There was also a significant number of lots (about 15%) where new construction had taken place, presumably after demolition of a damaged structure. These three categories account

for roughly three quarters of the parcels surveyed. Thus, after only eight months, a majority of the damaged structures had been or soon would be completely restored.

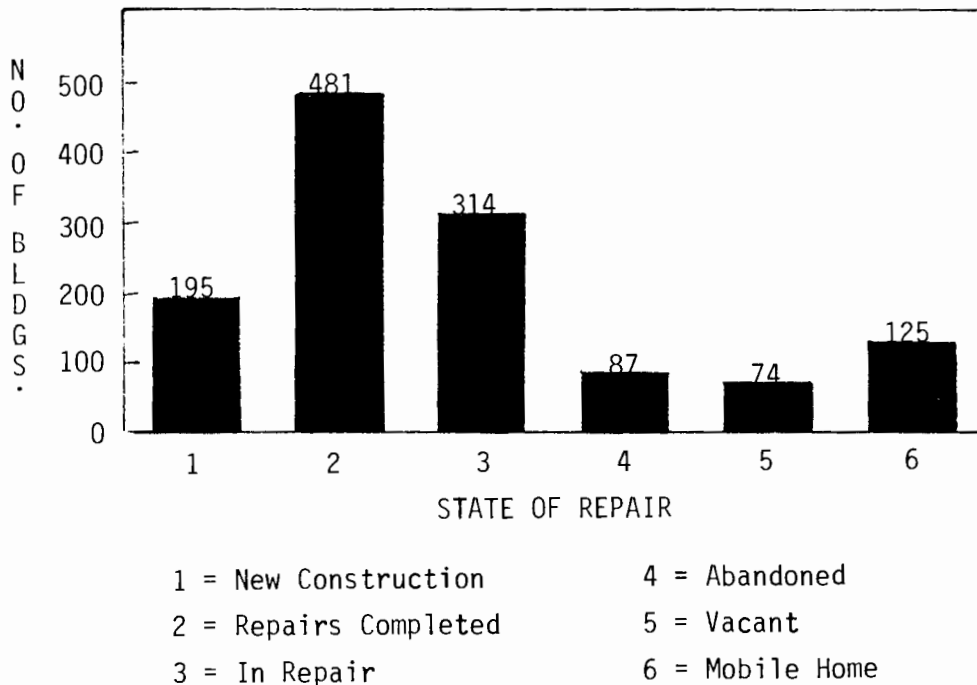


FIGURE 8
 STATE OF REPAIRS--JANUARY, 1984

The remaining one-quarter of the parcels had not been permanently restored at the time of the survey. Temporary mobile homes had been moved onto the largest number of parcels (about 10% of the total). The remaining 15% either contained abandoned structures or had been cleared and left vacant. This survey indicates that a large proportion of the structures damaged by the Coalinga earthquake had been either repaired or replaced in a matter of months. However, a significant number of parcels had not and probably would not be restored to pre-earthquake condition during the first year of recovery.

Figure 9 shows the spatial distribution of the lots in various stages of recovery as of January, 1984. Completed repairs, new construction, and temporary mobile homes seem to be scattered evenly throughout the city. The southeast seems to have the greatest concentration of repairs in progress, and the downtown area and the southeast part of town seem to have the greatest concentration of abandoned buildings and vacant lots.

To summarize, the rate of recovery was relatively rapid in the nine months following the Coalinga earthquake. As would be expected, mobile home installation occurred immediately after the earthquake; demolition and repair activity was concentrated in the summer months; and residential building peaked somewhat later in the fall. To date, business recovery has been quite slow, particularly in the downtown area.

Financing Recovery

There are four main sources of funding being used for rebuilding in Coalinga: (1) state and federal agencies, (2) the local redevelopment agency, (3) insurance companies and conventional commercial lenders and (4) charitable and civic groups. To date, no complete accounting of the role of each of these sources is available. However, this section will attempt to assemble what is known about each source.

The Federal Emergency Management Agency (FEMA) and the State of California have jointly funded much of the repair to the city's infrastructure and public facilities. As of January, 1984, \$2.3 million in aid had been approved, of which nearly 75% was provided by FEMA. However, it should be noted that considerably less than this total had actually been disbursed and that the total approved is less than half the total required by Coalinga. FEMA also provided 192 trailers to serve as temporary housing.

CITY OF COALINGA

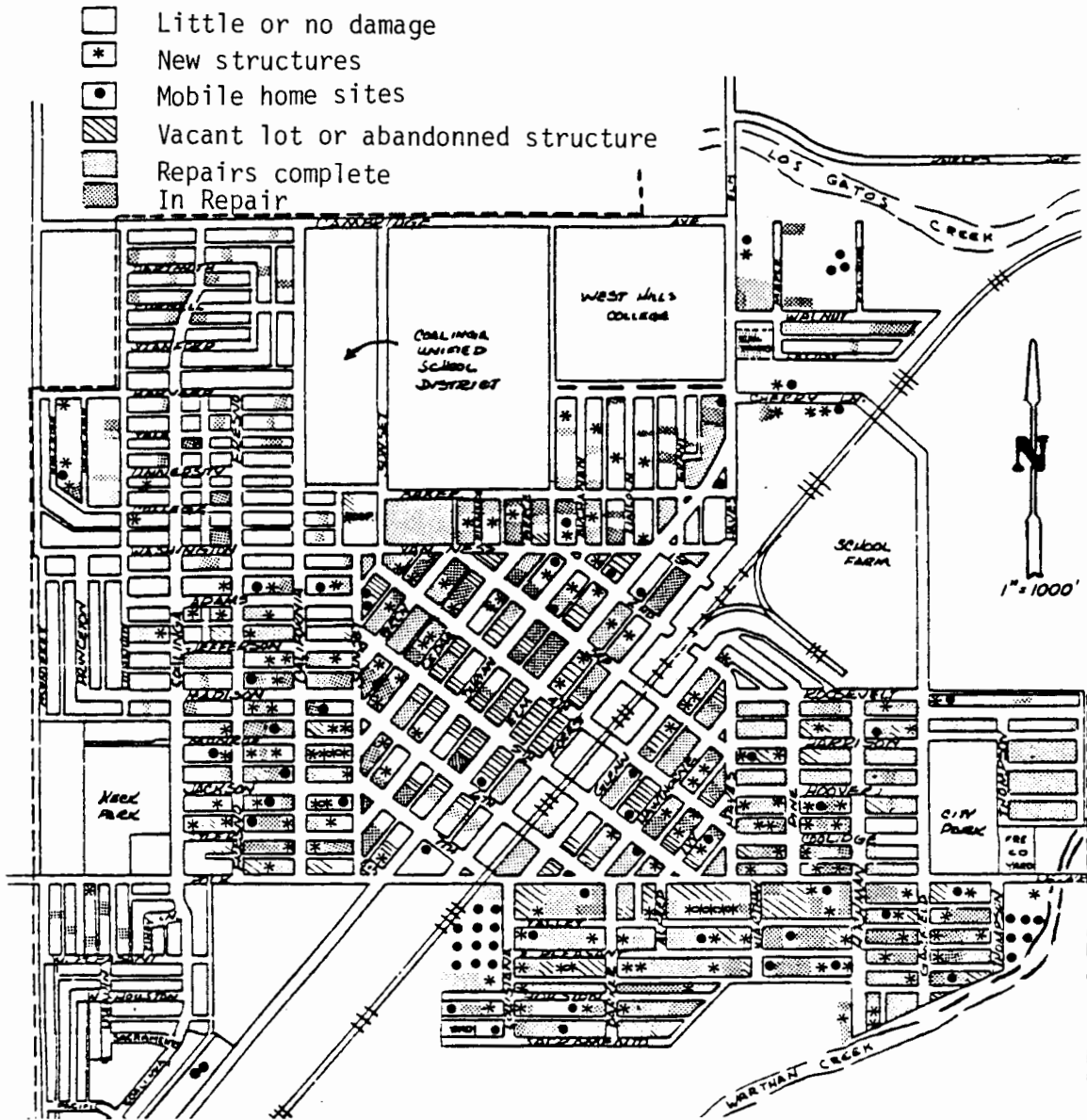


FIGURE 9
MAP OF REBUILDING AND REPAIR--JANUARY, 1984

The Small Business Administration (SBA) is another major source of federal funding. The SBA provides loans for both businesses and residences. Interest rates on these loans range from $5\frac{5}{8}\%$ to $11\frac{1}{8}\%$, with most being in the 9-11% range. As of January 20, 1984, the SBA had approved 256 residential loans in Coalinga, totaling \$3.3 million (Green, 1984). However, of this total, only about \$1 million was disbursed during the first six months of recovery (Willis, 1983).

As of January, 1984, the SBA had approved 83 business loans, totaling \$5.3 million. However, several points should be noted regarding these loans. First, only \$211,000 of this total was disbursed in the first six months of recovery. This may partially account for business' slow recovery relative to residences. Second, while \$5.3 million in business loans was approved, this was less than half of the \$13 million in loans requested. Finally, many borrowers found they could get loans at or below the SBA rate with more attractive repayment schedules from local banks. There were also widespread reports of "red tape" and delay associated with SBA loans. Due to these problems, there has been general dissatisfaction with the SBA loan program in Coalinga.

Another important source of federal funding is the Economic Development Administration (EDA). The EDA has approved a \$900,000 redevelopment project for downtown Coalinga. While construction on this project is not expected to begin until the spring of 1984, it is likely to be one of the most important elements in the long-term recovery of downtown Coalinga. It is managed by the Coalinga Development Agency and will consist of a 17,500 square foot mall intended to house 10 or 12 businesses. Once constructed, this commercial space will initially be leased to local merchants at about the cost of space before the earthquake. Rental rates will rise to market value over a number of years.

The redevelopment agency is also developing a plan for the entire downtown area which will set design standards for all new construction.

Coalinga was fortunate to have a development agency in place when the earthquake occurred. Since the earthquake, the redevelopment area has been expanded beyond its original boundaries to include the entire town, and the agency has become a vehicle for coordinating redevelopment and acquiring federal grant money. The redevelopment agency is also using tax increment financing to generate local funds to support the redevelopment. In Coalinga, tax increment financing allocates to the redevelopment agency any property tax revenues above those assessed on May 3, 1984--i.e., any revenue increases due to property improvement subsequent to the earthquake. Initial estimates are that some \$170,000 in tax increment funds will be generated in the first year of the recovery. Current plans call for these funds to be used in a revolving loan fund to assist local businesses with construction or replacement of lost inventory.

In addition to these public redevelopment programs, insurance payments have also played a major role in financing the recovery in Coalinga. As is often the case, most businesses or residences did not carry earthquake insurance on May 2, 1984. However, some loan programs, such as the Cal Vet program, required earthquake insurance as a condition of the loan. These claims seem to have been paid quickly after the earthquake. Some insurance payments were made under the collapse provision included in some policies. Other insurance payments also covered damage to automobiles and home furnishings. Current estimates suggest that insurance payments amounted to as much as \$6 million during 1984 (Steinberg, 1983). The first commercial building to be rebuilt downtown, the Service Pharmacy, was financed by insurance payments.

Conventional loans from local banks also provided an important source of funding for repairs and new construction. Several of the banks provided below market rate loans in the 9-11% range. In fact, one of the major criticisms of the SBA loan program was that local banks were providing loans at lower interest rates with longer pay-back periods than the SBA. Exact data on the total of such loans is not currently available.

Civic and charitable groups also provided significant amounts of funding as well as large amounts of volunteer help. Groups such as the Salvation Army, the Lions Club, and the Chamber of Commerce provided over \$2 million in relief aid during the first six months of recovery. The Chamber of Commerce raised nearly \$40,000 which was used to purchase trailers to temporarily house businesses. Local church groups provided volunteer labor and building materials to aid in residential rebuilding.

Through its Housing Assistance and Rehabilitation program, Fresno County had provided over \$700,000 in aid for construction of single family homes at the time of this study. The county is also helping to fund the construction of multiple family apartment buildings through the issuance of tax-free housing bonds.

Of course, the savings and earnings of Coalinga's residents were and still are another important source of funds for recovery. While no figures are available, it is clear that many residents were forced to use their own resources, especially in cases where repairs were necessary before homes could be reoccupied. While some questioned the economic justification for rebuilding Coalinga, given the age of the surrounding oil fields, local residents have shown a strong commitment to reestablishing their community.

CONCLUSIONS AND POLICY IMPLICATIONS

From this analysis, several things are clear about the recovery of Coalinga. First, it is clear that rebuilding began almost as soon as the dust had settled. It is also apparent that different types of construction activities peaked at different times: first came the repair of damaged utility services, followed by an influx of mobile homes and the demolition of damaged structures; then came repair of partially damaged structures and new residential construction. The rebuilding of the downtown retail area has been the slowest part of Coalinga's recovery. As of January, 1984, eight months after the earthquake, rebuilding was proceeding fairly evenly throughout Coalinga, with the exception of downtown. However, there were still a number of abandoned structures and vacant lots scattered throughout the city.

In the financing of recovery, private sources--particularly insurance payments and loans from local banks--seem to have fueled the initial stages of recovery. Of the public sector aid programs, the Small Business Administration's loan program seems to have been the least helpful to Coalinga businesses and residents. On the other hand, the Economic Development Administration, through a grant to the local redevelopment agency, is currently playing a central role in the rebuilding of the downtown area. The fact that Coalinga had an existing redevelopment agency in place prior to the earthquake seems to have facilitated the rebuilding of the downtown business district.

Few policy adjustments to mitigate the earthquake hazard are evident in the Coalinga recovery. However, there may not be a need for policy adjustments in this particular case. In terms of land use adjustments, there was no significant variation in the hazard within the

Coalinga area. Since ground motion, rather than landslide, liquefaction, or ground rupture, was the significant hazard, there do not seem to be any areas particularly more hazardous than others. Short of moving the entire town, land use adjustments do not seem applicable in this case. In terms of building code adjustments, because damage was concentrated among structures built under less stringent codes, and because structures built to current codes incurred only minor damage despite severe ground motion, current building codes seem to be adequate and stronger standards are probably not needed. However, it is likely that inspection efforts to insure compliance with these codes will be even more rigorous in the future. Coalinga has enacted a new sign ordinance intended to insure that signs are securely anchored to buildings and will not become dangerous missiles in the event of an earthquake. Nonetheless, Coalinga enacted few of the land use or building code adjustments that one might expect following such a disaster.

The essential mitigation measure underscored by the Coalinga experience was the reinforcement or demolition of existing hazardous structures--particularly unreinforced masonry buildings. Coalinga no longer has to worry about razing or retrofitting these potentially dangerous structures, since the May 2nd earthquake completely destroyed them all. Luckily, no one was killed in the destruction of the old brick buildings of downtown Coalinga. Thus, perhaps the most important lesson of the Coalinga earthquake for other communities is that they must see the danger posed by these types of structures and act to remove or reinforce them before their next earthquake.

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