A COMPARATIVE STUDY OF OCCUPATIONAL ACCIDENTS IN THE CONSTRUCTION INDUSTRY: CASE STUDIES OF THE JAPANESE AND THE U.S. CONSTRUCTION INDUSTRIES

by

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Abstract

Occupational safety is of great concern in the construction industries internationally due to financial losses, losses of human resources, legal liabilities, and moral responsibility. This thesis examines occupational accidents in the Japanese and the U.S. construction industries and compares management and measures implemented for occupational safety in each construction industry.

The thesis is composed of four parts. First, the thesis overviews the construction industry in Japan and the U.S., and specifies construction practices in the two countries. Second, the thesis examines the statistics on occupational accidents in the Japanese and the U.S. construction industries and reveal characteristics of occupational accidents in these two construction industries. The examination focuses on the number of occupational injuries and fatalities, the distribution of the injuries and fatalities by size of construction establishments and by age of construction workers, and so on. Third, the thesis discusses and compares the approaches to occupational safety of these two construction industries. The discussion includes incentives for safety, regulations and ordinances, governmental agencies, working conditions, labor management and relations, and safety education and training The comparison clarifies the advantages and disadvantages of their approaches. Based on the comparative analysis, the final section presents conclusions and recommendations for more effective safety control and management in the Japanese and the U.S. construction industries.

The thesis concludes with some findings including: (1) some characteristics of occupational accidents are common to the Japanese and the U.S. construction industries and others are different between them; (2) each industry has different incentives for occupational safety; (3) the scope of governmental administration is less expansive in the U.S. than in Japan; (4) labor relations, contractual relationships among contractors, and working conditions influence the characteristics of occupational accidents; and (5) safety management and safety activities implemented in these two countries differ significantly.

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To my dearest wife, Yachiyo, I dedicate this thesis.

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Chapter 1

Introduction

1.1 General Background

The construction industry plays an important role in supporting people's lives and industrial activities. It accounts for about 20 percent and 10 percent of the Gross National Product (GNP), employing about 10 percent and 6.5 percent of the total labor force in Japan and the USA, respectively. However, the construction industry causes about 1,000 fatalities a year in both countries, which roughly accounts for 40 percent and 15 percent of the total industrial fatalities in Japan and the USA, respectively. Both countries have been striving to reduce accidents, but their efforts have not been fully rewarded. Therefore, occupational safety in the construction industry is of great concern in both countries.

Many studies have been done of occupational accidents and safety control in the Japanese and the US construction industries to seek better management and to reduce the number of occupational accidents. One of the best approaches is to compare the safety control and management of construction industries in both countries and to identify the advantages and disadvantages of each industry. However, most of these studies analyze domestic accidents and examine domestic safety control and management; few comparative analyses have been conducted of the safety control and management of the industries in two countries.

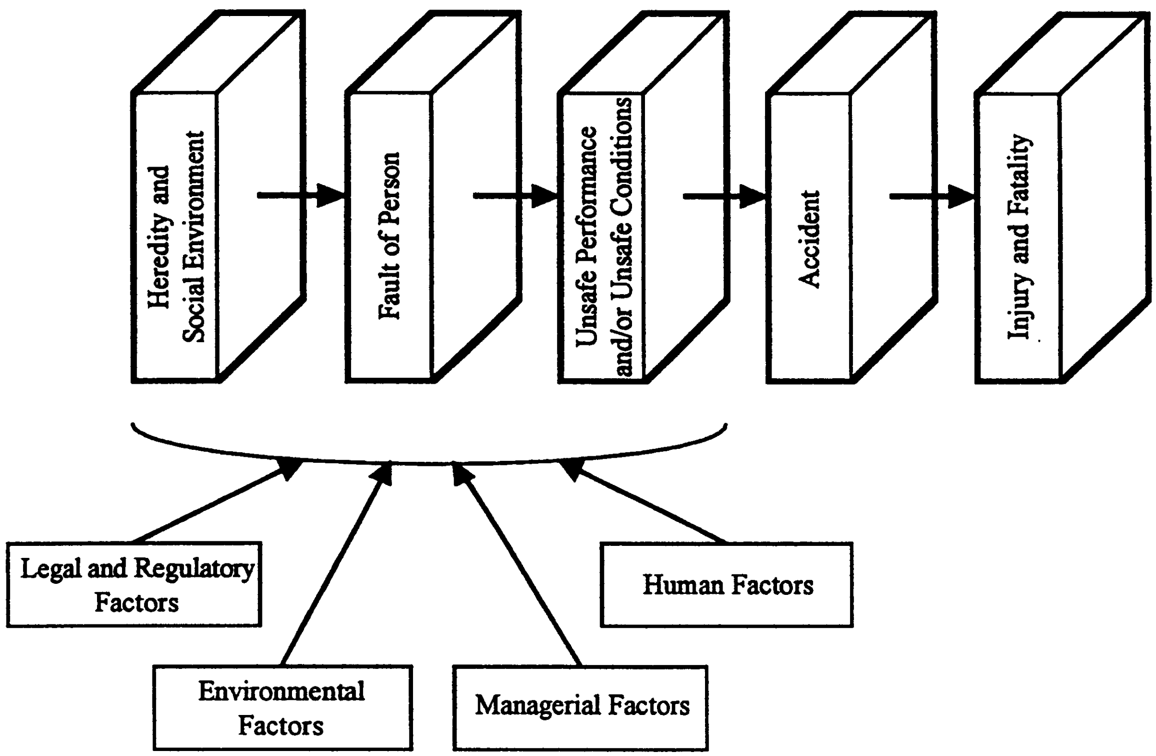
1.2 Occupational Safety in Construction

Occupational safety in construction is one of the most important issues for effective project planning and execution. It is an essential factor for successful and profitable companies in the competitive construction business. Accidents cause the following serious concerns for the project and the parties involved in it (Barrie and Paulson 1992):

- Humanitarian concern for victims and their families;
- Increase of the workers' compensation insurance rate;
- Medical expense and compensation for victims;
- Damage to materials, machinery, and equipment;
- Decrease in productivity and deterioration of morale;
- Project delay and interruption and schedule alteration;
- Loss of skilled labor force;
- Legal and regulatory sanctions by the government;
- Liability problems;
- Deterioration of the companies' images.

1.3 Past Studies of Occupational Accidents

Among studies of occupational accidents, Heinrich's study is notable for his foresighted analysis revealing the accident sequence that is known as the domino theory (Heinrich et al. 1980). He illustrated the sequence as a chain of accident factors: heredity and social environment, fault of person, unsafe performance of persons and/or unsafe condition, accident, and injury and fatality (see Figure 1.1). He also proposed a hierarchical structure of incidents: among 330 incidents, 300 incidents result in no injury, 29 cause minor injuries, and only one of these incidents causes serious injuries or fatality. Bird proposed the 1-10-30-600 relationship based on an analysis of about 1,750,000 accidents: among 641 incidents, 600 result in no visible injury or damage, 30 produce property damage, 10 causes minor injuries, and 1 causes serious or disabling injury (Heinrich *et al.* 1980). These studies demonstrate that actual accidents are only a small portion of incidents that have the potential to cause accidents, thus it is important to prevent unsafe acts and conditions that trigger accidents and injuries.



Source: Heinrich, H. W., Petersen, D., and Roos, N., *Industrial Accident Prevention*. 5th ed., McGraw-Hill, Inc., New York, N.Y., 1980.

Figure 1.1 Accident Sequence

Accidents cause huge economic damage directly and indirectly. The direct costs incurred, medical expenses for injured workers, and damaged materials, machinery, and equipment, are mostly reimbursed by insurance. However, the indirect costs resulting from lower productivity, deteriorated morale, project delay and interruption, loss of skilled labor force, governmental sanctions, and compensation for the victims and their families is not reimbursed by insurance, and the indirect costs can be several times the direct costs. Heinrich proposed that the indirect costs are four times the direct costs, and his successors estimate an even higher ratio (Heinrich *et al.* 1980).

In Japan, Hanayasu made a series of statistical analyses on occupational accidents in the Japanese construction industry (Hanayasu 1980, '82, '87, '89, '93, '94). In this series of studies, he demonstrated:

- many occupational accidents occur at random,
- the frequency distribution of their occurrence in a fixed time interval is a Poisson distribution, and
- the time intervals between successive accidents are exponentially distributed.

Based on these findings, Hanayasu also demonstrated that his statistical approach to occupational accidents can be used as a method of safety assessment.

Hanayasu and Igarashi made a historical review of the Japanese acquisition system for occupational accident statistics and an international comparison of the occupational accident indicators in different countries including Japan and the USA (Hanayasu and Igarashi 1990). Following this study, several studies compared occupational accidents in the construction industry among countries, based on the accident statistics and indicators (Kim and Kunishima 1992, Kim and Watanabe 1993, Okazaki *et al.* 1992, Watanabe and Hanayasu 1995). These studies are helpful in comparing occupational accidents and safety in the construction industry of each country. However, they are focused on the accident data, and not on the managerial, legal, or social background of the construction industry. Therefore, it would be significant to compare these aspects of occupational accidents and safety in the construction industry.

1.4 Objectives and Scope of Thesis

The main objectives of this research are to examine management implemented for occupational safety in the Japanese and the US construction industries, and to compare them by focusing on regulations and ordinances, labor environment, labor management, and labor relations concerning construction safety.

The goals of this research are as follows:

1. To review and analyze the statistics on occupational accidents in the Japanese and US construction industries, and comparing and contrasting the two countries;
2. To examine the management both construction industries have implemented for construction safety by surveying: incentives for safety, regulations and ordinances concerning occupational safety, affiliated governmental agencies, working conditions, labor management, labor relation between parties involved in construction such as owners, architects and engineers, and contractors in both construction industries, and education and training;
3. To compare the management of safety in both construction industries, and to identify the advantages and disadvantages that each construction industry has;
4. To propose ideas for more effective management of construction safety.

1.5 Outline of Thesis

Chapter 2 reviews the Japanese and the U.S. construction industries, and refers to their economic situations, historical backgrounds, and construction practices. Chapter 3 analyzes the statistics on occupational accidents in Japan and the USA to discuss the degree of occupational safety in the Japanese and the US construction industries. Chapter 4, based on the analysis in Chapter 3, examines management for occupational safety in both construction industries, and compares their management. The comparison focuses on various aspects of the industries such as pertinent laws and regulations regarding occupational accidents and safety, affiliated governmental agencies, working conditions, labor relations and labor management, and education and training offered to workers. The chapter also discusses the pros and cons of their safety management. Finally, Chapter 5 presents conclusions of this comparative analysis between these two construction industries and offers recommendations for better management to assure occupational safety in both industries.

Chapter 2

Overview of the Japanese and the U.S. Construction Industries

2.1 General

Since humans started building civilization on the earth, the construction industry has played an important role in implementing infrastructure in our civilized society. In the Roman Empire, roads and bridges were constructed, which enabled easy transportation of people and goods between cities. The ancient Chinese dynasties constructed canals, embankments, and diversion channels to protect people and crops from disastrous floods and to ensure their transportation. The dynasties built the Great Wall to protect their territory from the enemies' invasions. In feudal times in Japan, from the 16th to 19th centuries, the feudal lords in the various parts of the country strove to enrich their territory by various activities such as cultivating and irrigating land and embanking and diverting rivers. In modern times, the Industrial Revolution spurred the innovation of construction technology. Large-scale construction projects were completed with the introduction of innovative technology, such as the Panama Canal, the Empire State Building, the Golden Gate Bridge, and the dams of the Tennessee Valley Authority (TVA) project.

Today, the construction industry encompasses a huge range of construction: from small houses in suburbs to skyscrapers in cities; from subway tunnels to highways; from long span bridges over the ocean to large dams in the mountains; from small local airports to large international airports; from hydroelectric power plants to thermal and nuclear power plants. The industry links people in the world together in their social, economic, and political activities (Barrie and Paulson 1992).

The construction industry has the following unique features compared to other industries such as the manufacturing industry (Kohno 1978):

- Construction is executed outdoors on different sites;
- Construction is custom-built;
- Construction comprises many different work packages such as earth works, steel erection, concrete works, electric equipment works, and plumbing;
- Construction requires intensive labor despite the innovation of construction machinery.

Because of the above features, the construction industry is greatly influenced by natural, social, political, and economical conditions. Every construction is customized according to the client's request and different site condition; thus there are no identical construction projects. The vulnerability of the industry to the fluctuation of the economy hinders the prediction of future construction demands. Because construction workers are inevitably exposed to potential risks and accidents due to outdoor labor, construction is dangerous in nature and safety in construction is a serious concern in the industry. Consequently, the construction industry involves complexity and difficulty in all phases of the project: planning, designing, construction, and maintenance.

Therefore, the construction industry now seeks new strategies to tackle the increasing complexity involved in project organization and management.

2.2 Japanese Construction Industry

2.2.1 General Description of the Industry

The Japanese construction market is one of the largest in the world. The investment in construction was about 82.4 trillion yen ($ 824 billion)[1] in fiscal 1994[2], accounting for 17.5 % of the Gross National Product (GNP) of 472 trillion yen ($ 4.71 trillion) for the same fiscal year (see Figure 2.1). Of this investment, public and private investments were 37.8 trillion yen ($ 378 billion) and 44.6 trillion yen ($ 446 billion), spread 45.9 % and 54.1 %, respectively (see Figure 2.2). Note that the public investment was mostly made in civil engineering projects, whereas the private investment was largely made in building projects; the public investment for civil engineering projects was 30.0 trillion yen accounting for 79.3 % of the public investment, whereas the private investment for the architectural projects was 36.9 trillion yen accounting for 82.7 % of the private investment. According to the governmental prospective estimates, the investment will amount to 1,000 trillion yen during the decade between 2001 and 2010.

The Japanese construction industry is comprised of about 540,000 construction firms, ranging from small one-man operation firms to huge general contractors with more than 10,000 employees such as Kajima Corporation and Shimizu Corporation. The industry employed a labor force of 6.55 million in 1994, accounting for about 10 % of the total labor force in all Japanese industries (see Figure 2.3).

At present, the aging of employees is a serious concern to the construction industry (see Figure 2.4). The figure illustrates that the number of employees over 50 years old has increased in recent years; they accounted for 35.1 % of the total employees in the industry in 1994, whereas they accounted for only about 18.1 % in 1972. In

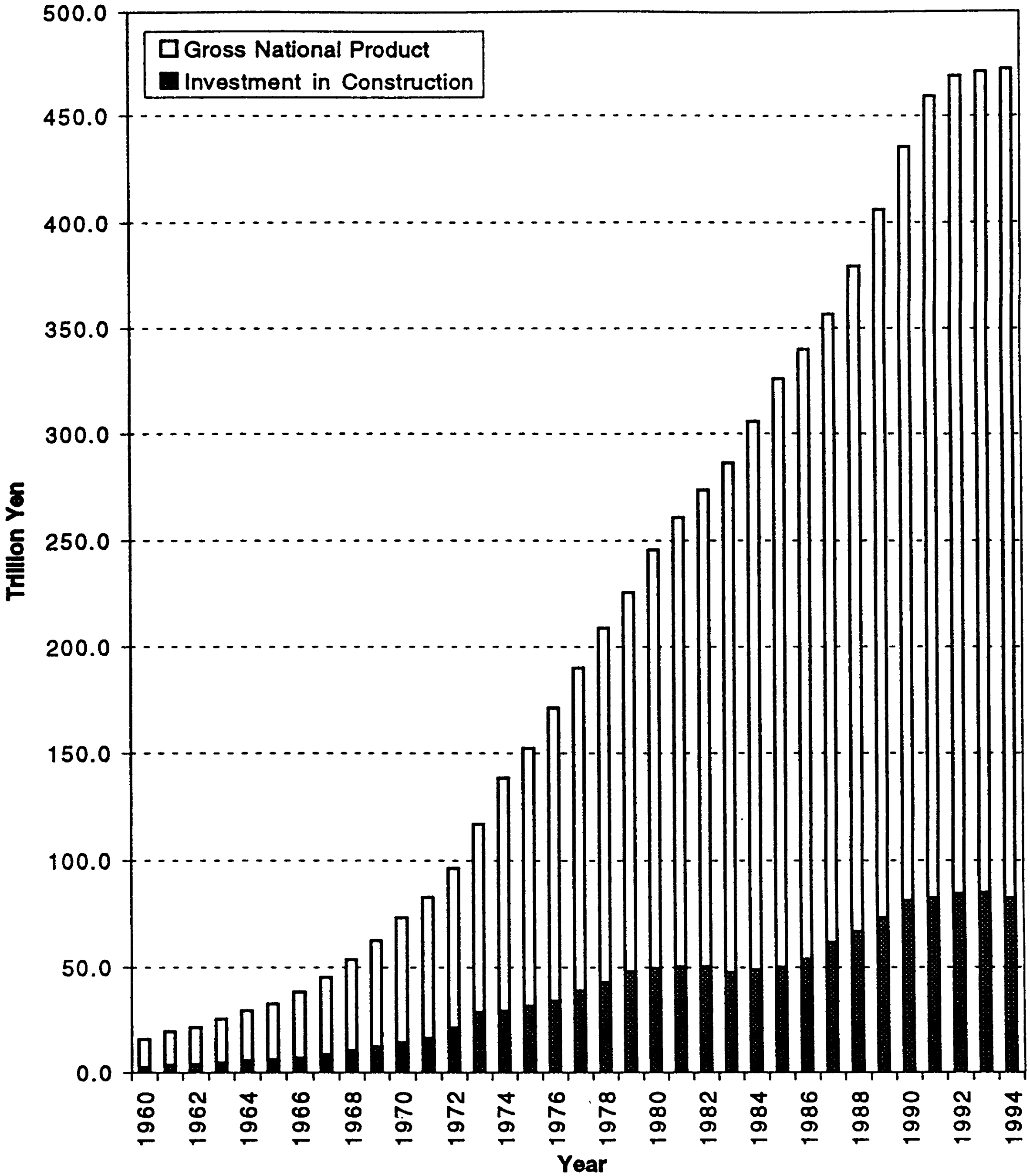
[1] In this thesis, the exchange rate is assumed to be 100 yen to the US dollar, which is approximately the prevailing rate in 1995.

[2] The Japanese fiscal year starts April 1 of an year and ends March 31 of the following year.

contrast, the number of employees under 40 years old is decreasing; their percentage decreased from 58.9 % in 1972 to 38.2 % in 1994, resulting from the employment decline of the young labor force. Although the aging of employees is a common concern to all industries in Japan, the construction industry is exposed to more rapid aging of employees than other industries[3]. Consequently, the aging labor force is a more serious problem for the construction industry than other industries.

To start a construction business in Japan, construction firms must obtain an official license issued by the Construction Minister or the prefectural governor, depending on the scale of their business. They are required to obtain a license from the Construction Minister if they want to perform nationwide construction work; and they are required to obtain a license from the prefectural governor if they want to perform construction work in the corresponding prefecture. Note that most of these construction firms are small; 73.8 % of the firms are capitalized at less than 10 million yen ($ 100,000), and about one third of the firms are operated by one man (see Figure 2.5). The firms capitalized at more than 100 million yen ($ 1 million) account for only 1 % of the nation's firms, including Kajima Corporation and Shimizu Corporation.

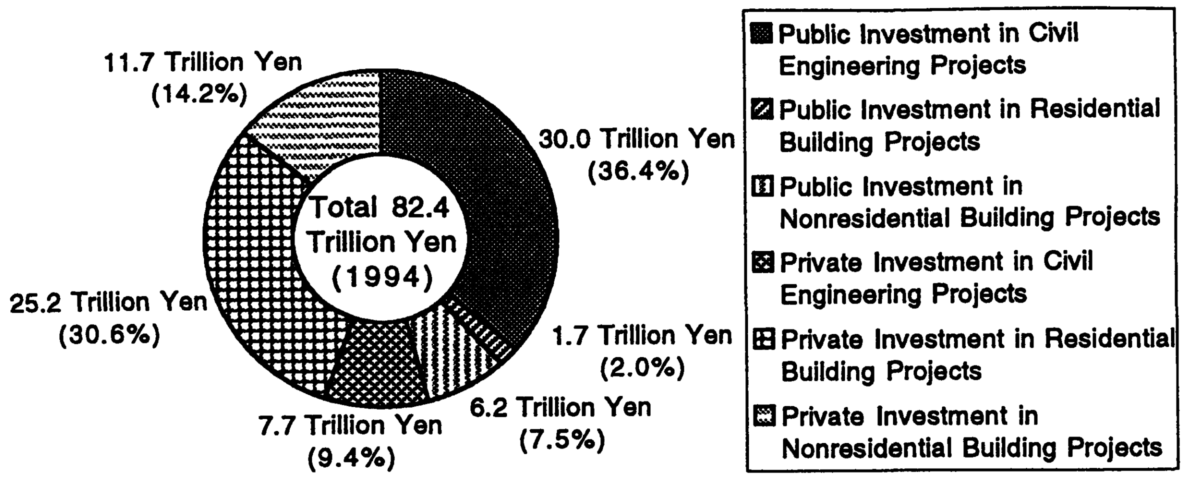
[3] The average percentage of employees over 50 years old in the Japanese industries is 21.8 % in 1972 and 32.7 % in 1994. On the other hand, the average percentage of employees under 40 years old is 56.3 % in 1972 and 42.2 % in 1994.



Source: The Ministry of Construction, *Kensetsu-Tokei-Yoran(Survey of Construction Statistics)*, Japan, 1970-1995.
The Economic Planning Agency, *Annual Report on National Accounts*, Japan, 1961-1995.

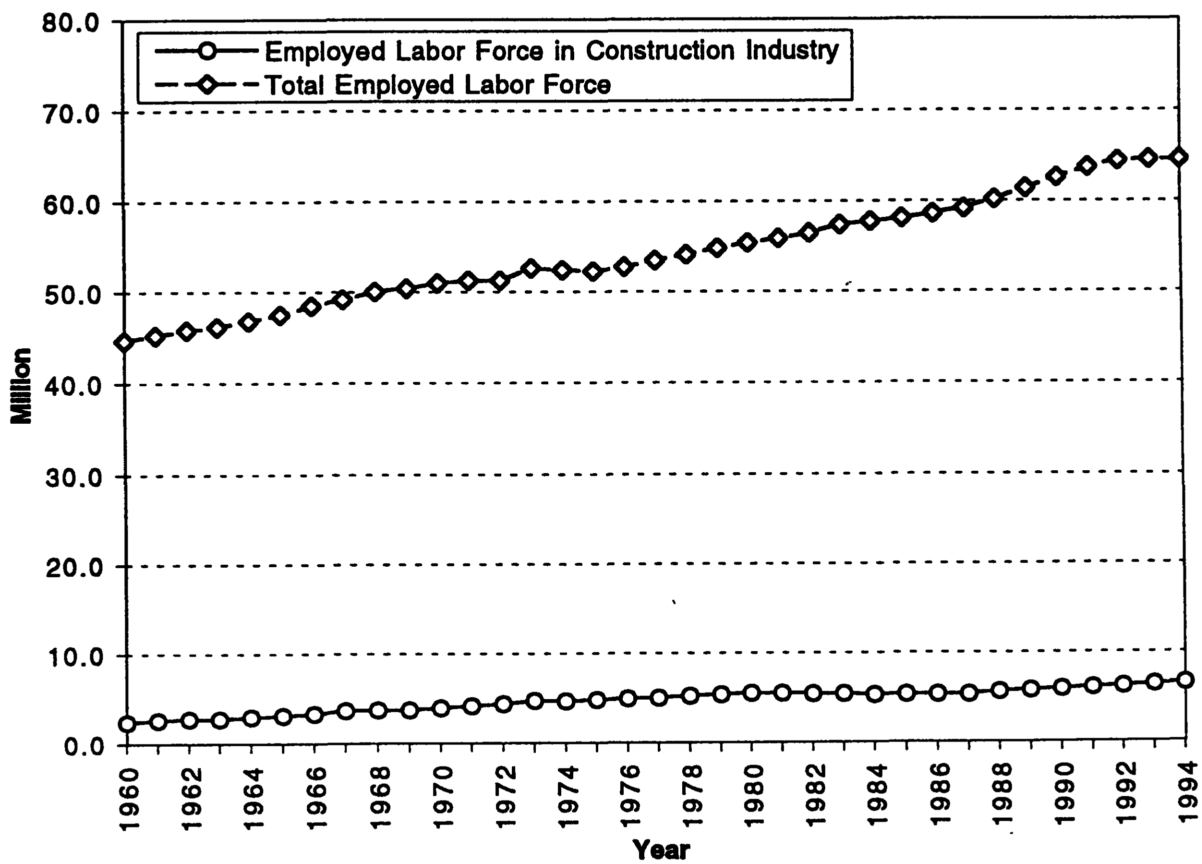
Note: The data from 1992 to 1994 are projected.

Figure 2.1 Comparison of Construction Investment with Gross National Product (GNP) in Japan



Source: The Ministry of Construction, *Kensetsu-Tokei-Yoran (Survey of Construction Statistics)*, Japan, 1995.

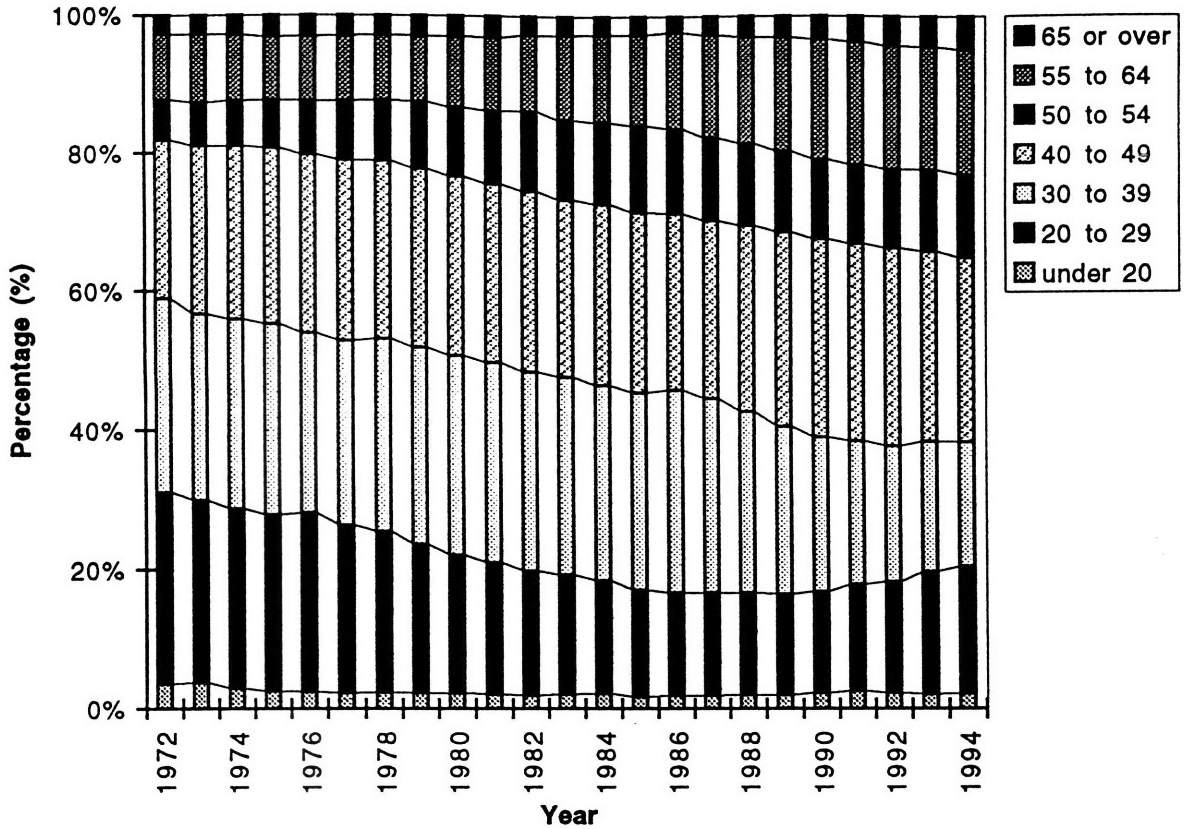
Figure 2.2 Breakdown of Japanese Construction Investment in 1994 (Projected)



Source: Statistics Bureau, Management and Coordination Agency, *Annual Report on the Labour Force Survey*, Japan, 1967-1995.

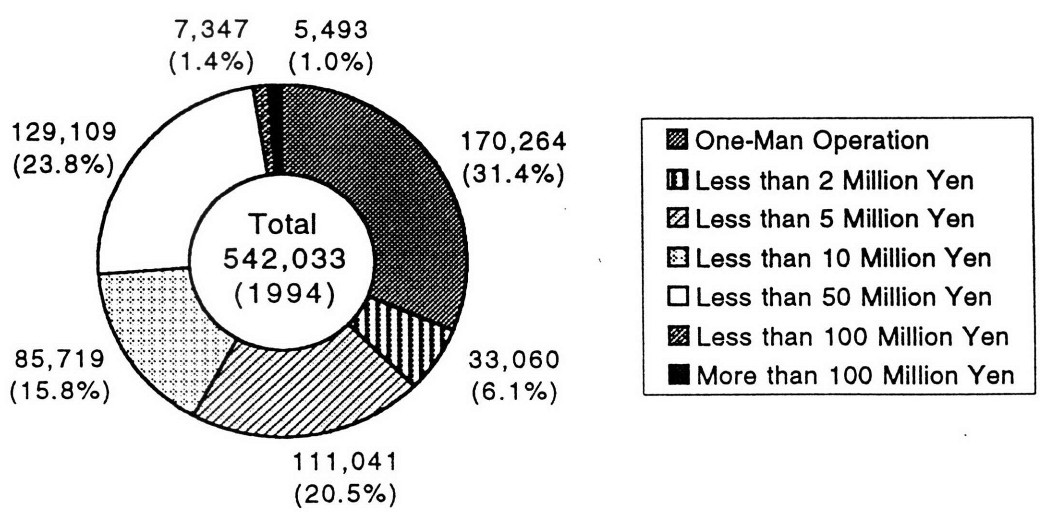
Note: Persons aged 15 years old and over.

Figure 2.3 Comparison of Employed Labor Force in Construction Industry with Total Labor Force in Japan



Source: Statistics Bureau, Management and Coordination Agency, *Annual Report on the Labor Force Survey*, Japan, 1973-1994.

Figure 2.4 Breakdown of Employed Labor Force in Japanese Construction Industry by Age



Source: The Ministry of Construction, *Kensetsu-Tokei-Yoran* (Survey of Construction Statistics), Japan, 1995.

Note: As of the end of March, 1994.

Figure 2.5 Breakdown of Licensed Construction Firms in Japan by Capital in 1994

2.2.2 Historical Background of the Industry

The Japanese construction contracting industry dates from the Edo era—1600 to 1867—the last feudal era (Kohno 1978). During this era, the feudal government, the Tokugawa shogunate, esteemed highly Confucianism as a political philosophy. This philosophy still has great influence on today's construction contracting in Japan.

In the subsequent Meiji era, after the drastic political change called the Meiji restoration of 1867, Japan emerged from being a feudal country as a new modern nation. The Japanese government endeavored to realize prompt industrialization by promoting and protecting modern industries under direct governmental management. Construction projects played an important role in this industrialization by implementing a modern industrial infrastructure. However, at that time, contractors were considered the labor force collectors (Kakoto *et al.* 1989). Therefore, the contracts for the construction projects were extremely unilateral in favor of the owners, such as the government and the municipal owners. This unilateral characteristic still lingers in today's contracts to some extent.

After World War II, the construction industry again played an important role in reconstructing the infrastructure ruined by the war. Since democracy prevailed in Japan, construction contracting was examined, and the contractual status of contractors improved under the Construction Industry Law enacted in 1949 (Kakoto *et al.* 1989). The construction industry has greatly contributed to the Japanese economy, accounting constantly for more than 15 % of the nation's GNP.

Today, the Japanese construction industry faces drastic changes: the industry is gradually opening its market which has been kept closed to foreign participants; the industry is revising the ways of bidding on public projects from a nominated bidding system to an open bidding system in order to prevent contractual corruption; a great deal of new investment is sought for future construction projects to boost up the recessive

Japanese economy. With these new changes, the Japanese construction industry will soon be exposed to more severe competition resulting from the increasing participation of foreign construction firms and to the unexpectedly quick internationalization of the industry as a whole.

2.2.3 Characteristics of Construction Practices

Several studies have been made of the Japanese construction industries. Paulson reviewed the Japanese construction industry and emphasized its similarities with the U.S. construction industry (Paulson 1980b). He also pointed out its strength in research and development and discussed the application of its approach to research and development in the U.S. construction industry (Paulson 1980a). Kakoto *et al.* examined public contracting practices in the Japanese and the U.S. construction industries and compared them (Kakoto *et al.* 1989). He presented some recommendations to Japanese contractors operating in the U.S. and to the U.S. contractors who would soon operate in Japan. Oyama wrote a M.S. thesis that compared the Japanese and the U.S. construction industries (Oyama 1991). He studied both industries with respect to several aspects: historical background, industrial organizations and structures, human resources, labor unions, and, finally, market trends that could be predicted. Kashiwagi *et al.* examined the legal aspects of contracting and construction practices of the two countries with respect to their legal systems and construction laws (Kashiwagi *et al.* 1988). Baba showed an interesting approach in another comparative study (Baba 1990). He introduced psychological analysis based on the theories of Carl Gustav Jung to explain the different management styles of the two countries.

Based on the afore-mentioned studies, the following summaries seem adequate to characterize construction practices in Japan, in comparison with those in the U.S.;

1) The Japanese construction industry depends heavily on long-term relationships based on mutual trust and 'a Confucian sense of social obligation' (Paulson 1980b) among the parties involved in construction projects. Owners, contractors, specialists, and suppliers have established these relationships through their cooperation over decades in working toward common objectives. These relationships still have a great influence on the Japanese joint surety system, which is generally used in public construction projects, instead of performance bonds that are generally used in the U.S. construction industry. In Japan, a contractor who is not involved in a project bid becomes the joint surety to guarantee project completion if the selected contractor of the project should fail to complete his/her job. The long-term relationships, however, yield ambiguity in contractual relationships among the parties involved in a project. In contrast to U.S. practices, the parties are not strictly bound by the contract itself in Japan. Consequently, it is difficult for them to specify their roles and responsibilities clearly only by examining the contract documents.

2) Like other Japanese industries, the construction industry relies more on a consensus approach to project management, to decision-making, and to dispute-settlement than the top-down authoritarian approach that is common practice in the U.S. construction industry (Paulson 1980b). Through the consensus approach, the parties involved in decision-making share responsibility for the decision. In this approach, negotiation plays an important role in achieving a consensus among them. The consensus approach, however, makes it difficult to specify individual responsibilities, which leads to the ambiguous relationship among the parties.

3) As mentioned above, negotiation is very important in Japanese project management and decision-making. Generally, contractual disputes are resolved by negotiation among the parties involved in the dispute, which presents a striking contrast to the litigious U.S. approach. In a typical Japanese construction contract, there are many provisions that require negotiation to settle contractual disputes, such as an alteration of the contract sum, or the project suspension or termination. The dispute settlement by negotiation, however, sometimes makes it difficult to clarify the liabilities that each party should bear and thus augments the afore-mentioned contractual ambiguity.

4) Because public and municipal owners have authority to give licenses, ranks, and protection to contractors, contractual relationships between the owners and the contractors are often unilateral. The contracts are one-sidedly in favor of the owners. Despite the remarkable improvement of contractors' contractual status by the Construction Industry Law, the unilateral relationships still remain in actual practice. Similarly, contractual relationships between general contractors and subcontractors are often biased in favor of the general contractors. There are many subcontractors that operate only for one general contractor in a paternalistic relationship. Under this captive contractual relationship, these subcontractors often seem to be mere labor force suppliers.

5) General contractors depend heavily on subcontracting. Virtually all the work in a project is directly performed by the subcontractors' labor force, not by the general contractors' labor force. This Japanese practice of subcontracting forms a remarkable contrast to the U.S. practice in which a substantial portion of the work is often performed by the general contractors' labor force (Kakoto 1989). This practice enables the general contractors to adjust their labor force

according to the trends in the construction market and it also helps them to foster long-term relationships with subcontractors. However, the heavy dependence on subcontracting lures the subcontractors into a captive reliance upon general contractors, and undermines their contractual status.

6) As mentioned above, Japanese construction firms rely on subcontractors for the labor supply, in contrast to the U.S. practice where the construction firms hire workers directly, generally from the labor unions.

7) Since labor unions in the Japanese construction industry are organized by industry sub-sectors such as housing contractors, heavy construction contractors, or employees of large contractors, virtually no jurisdictional or inter-union disputes arise (Oyama 1991). The labor unions lack strong bargaining power against employers for better job conditions because they do not serve to refer workers to employers and projects as sources of labor, but merely, supply workers with insurance plans. Moreover, no subcontractor is unionized; labor unions such as those of carpenters, plasterers, and masons do not exist in Japan (Hasegawa 1988).

8) Because of the absence of strong labor unions, job conditions in the Japanese construction industry are inferior to those in the U.S. industry; wages are lower and working hours are longer in Japan than in the U.S. Oyama examined wages and working hours in both industries (Oyama 1991). According to his study, the purchasing power of Japanese construction workers' income is 10 % lower and their annual working hours are 15 % longer than construction workers in the U.S.

9) The contractual status of private architectural and engineering (A/E) consultants in the Japanese construction industry is lower than that in the U.S. industry. In general, the public and municipal owners and major general

contractors have their own in-house architectural and engineering staff. They exhibit excellent expertise in design and engineering phases of projects based on their practical experience in the construction phase acquired when they move to the sites and supervise the projects. Although the private architectural and engineering consultants are increasingly awarded public contracts, they have no authority in decision making. Thus, in the trilogy of owners, (general) contractors, and architectural and engineering consultants, the involvement of the consultants in projects is more superficial than in the U.S. (see Figure 2.6).

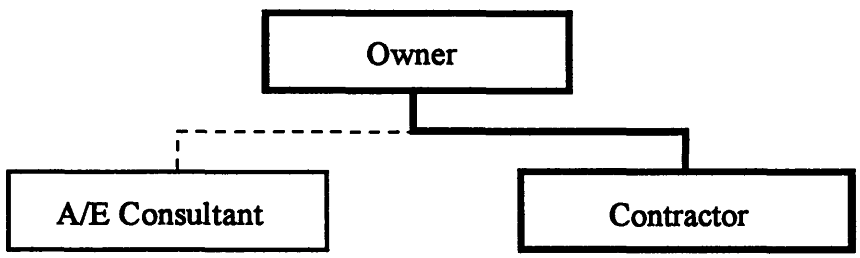


Figure 2.6 Contractual Relationships between Owner, Contractor, and A/E Consultant in the Japanese Construction Industry

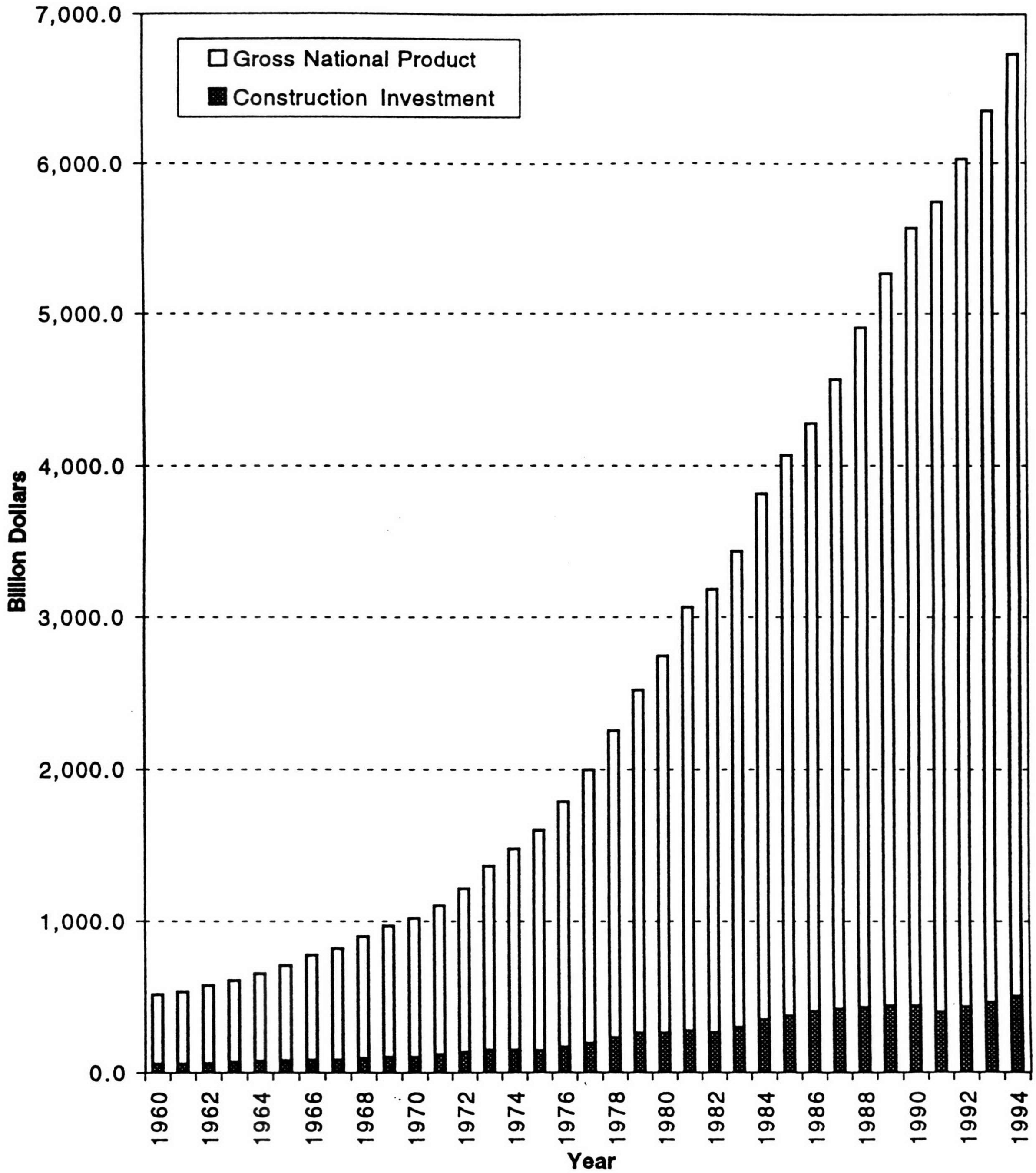
10) In the Japanese construction industry, great emphasis is placed on the quality of a project, its completion on time, and safety. Cost ranks lower than quality, time, and safety (Bennette 1991). In contrast, in the U.S. construction industry, project cost seems to have top priority.

2.3 U.S. Construction Industry

2.3.1 General Description of the Industry

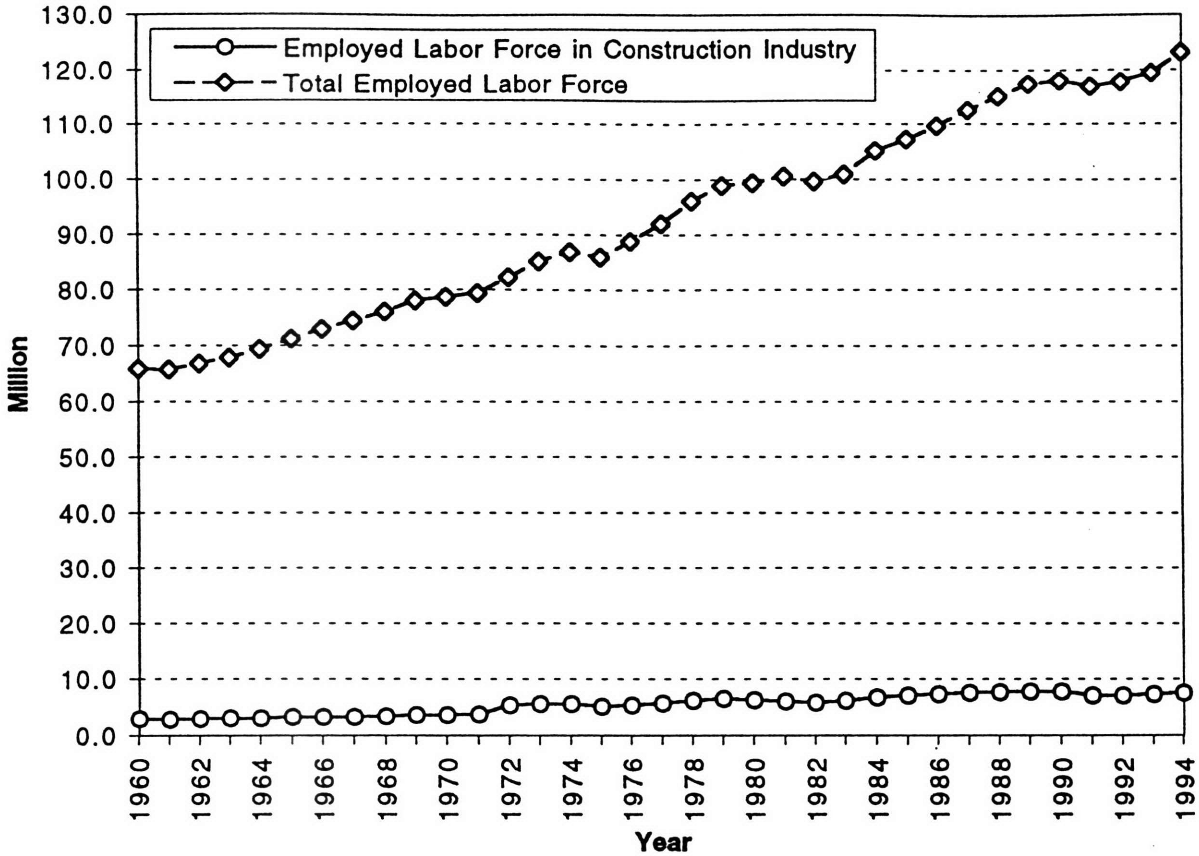
In 1994, the U.S. construction industry put new construction in place that was valued at $ 506.8 billion, accounting for 7.5 % of the GNP of $ 6.73 trillion. The industry employed 7.49 million workers, comprising 6.1 % of 119.3 million workers employed in all industries. Figures 2.7 and 2.8 illustrate the recent trend of the construction investment versus the GNP and of the labor force employed in the construction industry versus the total labor force, respectively. Based on a comparison of Figures 2.7 and 2.8 with Figures 2.1 and 2.3, it is clear that the construction industry has played a more important role in the Japanese economy than that in the U.S. economy. This is because since the end of World War II, the Japanese government has striven to replace the infrastructure ruined by the war. It has aimed for redevelopment at the level of the Western European countries and the U.S. Therefore, the Japanese government has been more energetic in construction investment than the U.S. government. Figure 2.9 exhibits that the U.S. public investment by the federal, state, and local governments represents only 25.6% of the total investment in 1994. This presents a striking contrast to the Japanese public investment accounting for 45.9 % of the total investment, as shown in Figure 2.2.

There is another remarkable characteristic of the U.S. construction industry in contrast to the Japanese construction industry. In the U.S., the vast majority of the investment is made in building projects such as construction of residential houses and nonresidential office buildings. Figure 2.9 reveals that the U.S. investment made in building projects accounted for 76.6% of the total construction investment in 1994. In Japan, by contrast, only 54.3% of the construction investment was made in building projects in 1994, as shown in Figure 2.2.



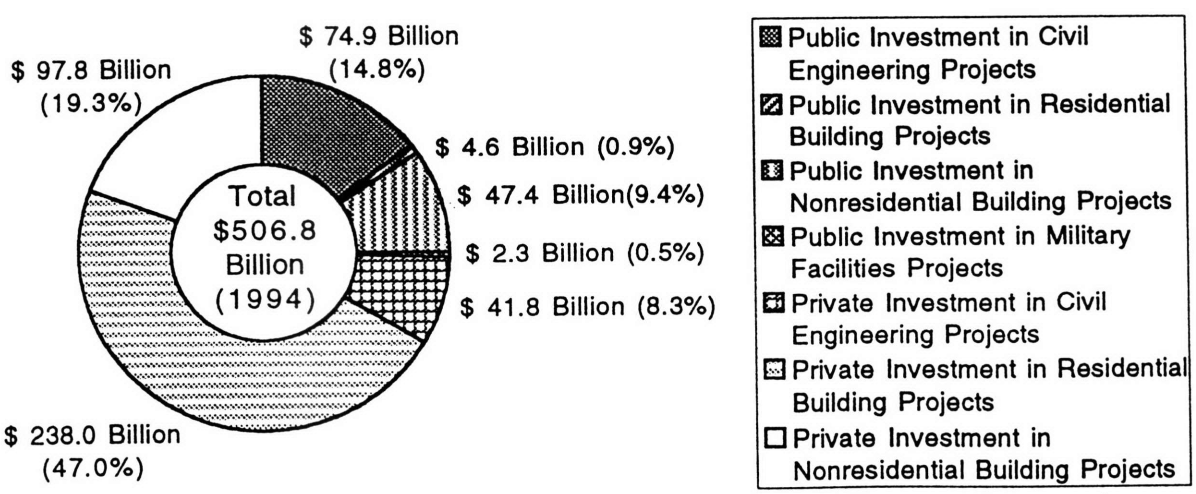
Source: U.S. Department of Commerce, *Business Statistics 1963-1991*, 1992.
U.S. Department of Commerce, *Survey of Current Business*, 1992-1994.
U.S. Department of Commerce, *Value of New Construction Put in Place*, 1978-1994.

Figure 2.7 Comparison of Construction Investment with Gross National Product (GNP) in the U.S.



Source: International Labour Office, Geneva, *Yearbook of Labour Statistics*, Switzerland, 1970-1995.
Note: The data are of civilian labor force aged 16 years old and over.
The data until 1969 are earners and salaried employees.

Figure 2.8 Comparison of Employed Labor Force in Construction Industry with Employed Total Labor Force in the U.S.



Source: U.S. Department of Commerce, *Value of New Construction Put in Place: December 1994*, 1994.

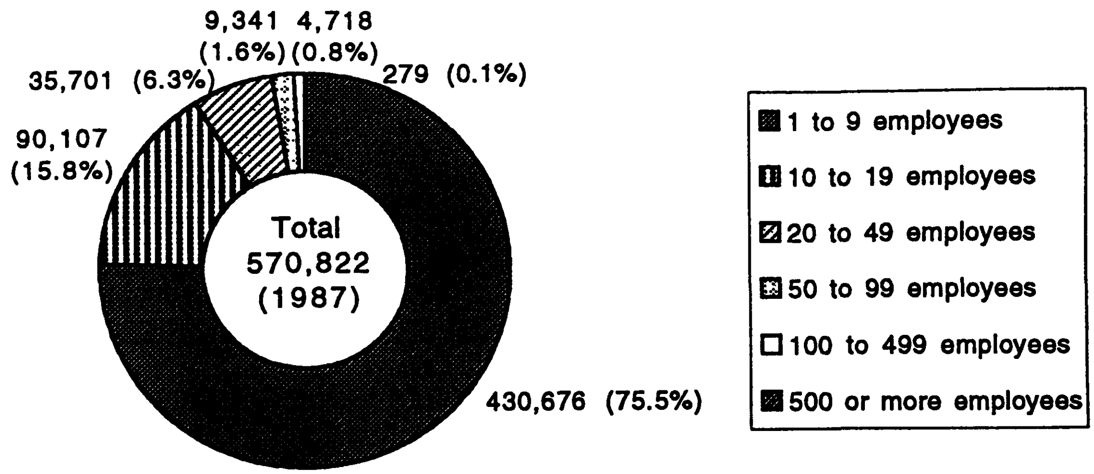
Figure 2.9 Breakdown of U.S. Construction Investment in 1994

The heavy dependence on building construction, especially on private residential building construction, causes the U.S. construction market to be susceptible to economic conditions. Demands for private housing fluctuate heavily depending on economic conditions. This dependence produces an environment in which the great majority of construction firms are small. Figure 2.10 showing the breakdown of U.S. construction firms by employment size illustrates this situation; in 1987, construction firms with fewer than 19 employees accounted for roughly 75% of the total number of construction firms, whereas construction firms with 100 or more employees accounted for less than 1 %.

Oyama examined the size of U.S. construction firms in comparison with the Japanese construction firms in his M. S. thesis (Oyama 1991). He concluded that the average size of the U.S. firms is one third that of the Japanese firms in terms of business receipts. This, he deduced, results from an increasingly large number of small firms involved in housing construction, maintenance, and repair work. Moreover, although both industries largely depend on a great majority of small firms and a small number of large firms, he pointed out that the distribution of firms by size is different in each country; in the U.S. industry, small firms account for a much larger portion of the total number of firms than in the Japanese industry. Yamada, an area manager of Obayashi Corporation[4] in the Central Artery/Tunnel (CA/T) Project[5] in Boston, also corroborated the impression of the U.S. construction firms (Yamada 1995).

[4] Obayashi Corporation, one of the top five construction companies in Japan, organized a joint venture with The Modern Continental Co., Inc., a local construction company in Boston, for the CA/T project.

[5] The CA/T project is to complete the interstate highway network in Boston. The project started in 1988 and is scheduled to be completed in 2004. The total construction cost is estimated to be $ 9.6 billion in 2004 (projected in 1995).



Source: U.S. Department of Commerce, *Census of Construction Industries 1987*, Washington, DC, 1990.

Note: The data include building construction contractors, heavy construction contractors, special trade contractors, and land subdividers and developers.

Figure 2.10 Breakdown of Construction Firms in the U.S. by Emplyment Size

2.3.2 Historical Background of the Industry

The U.S. construction industry originated in housing construction for immigrants from Europe. Since the Puritans first came from Europe, an increasing number of immigrants has supported constant demand for housing construction. Therefore, as discussed in the previous paragraph, housing construction still plays a very important role in the U.S. construction industry.

After achieving independence from England, the U.S. strove to expand her territory to the undeveloped West. The progression of the frontier urged immigrants to move to the West. This required fast, easy, and mass transportation systems such as the railroads. When the Civil War ended in 1865, railroad construction boomed. The first transcontinental railroad was completed in 1869, and early in the 20th century, most of today's railroad network was implemented.

The railroad construction was succeeded by road construction, after, in 1907, Henry Ford started mass production of the Model T, an affordable car for ordinary people. Thus, demands for road construction jumped. The increasing demand for railroad and road construction gave rise to the emergence of new construction firms. Many of the largest construction companies in the U.S. today were established in this period, such as the Bechtel Group Inc. (1898) and the M.W. Kellog Co. (1900).

In the beginning of the 20th century, the U.S. became a superpower in the world. The U.S. industries experienced a remarkable growth. After World War I, the GNP of the U.S. exceeded that of England, and an increasing number of immigrants became the source of labor to support this industrial growth. The construction industry contributed greatly to the nation's development by furnishing buildings and infrastructure such as bridges and dams. Many epoch-making construction projects were executed with the innovative technologies and economic power of the U.S., for example, the Empire State Building (1931), the Hoover Dam (1936), and the Golden Gate Bridge (1937).

After World War II, the U.S. strengthened her economic power. The construction volume increased steadily. However, in the 1970's, the construction industry suffered economic recession twice due to oil crises. To survive severe competition in the construction market, construction firms struggled to reform their organizational constitution through layoffs and financial operations (Oyama 1991).

Today, the U.S. construction industry is recovering its energies. Furthermore, the industry is challenging the new era of internationalization. Many U.S. construction firms have cooperated with foreign firms, like the Japanese, in domestic and overseas projects with great success. Now U.S. firms are striving to work with Japanese firms in the newly opened Japanese construction market.

2.3.3 Characteristics of Construction Practices

In comparison with the Japanese construction industry, construction practices in the U.S. are characterized as follows:

1) Labor unions in the U.S. are organized nation-wide by trades, not by industries, and have a great influence on the U.S. construction industry by: reference of workers to projects and employers as sources of a skilled labor force, collective bargaining power with employers for better job conditions, apprenticeship training for workers, insurance plans for unemployment, health, and accidents, and collective strikes. The nation-wide trade unions in the construction industry resulted from two situations. One was a chronic shortage of labor due to incredibly rapid development and industrialization of the U.S. The second was a strong requirement for a stable labor supply to construction projects in this huge country. A series of laws[6] were enacted to protect, yet control, the trade unions, and to enforce fair labor practices for both employers and unions. The unions have contributed greatly to the improvement of labor conditions in the construction industry (Oyama 1991).

2) The contractual relationships between the parties involved in a project such as owners, contractors, and architects/engineers are short-term oriented. This presents a remarkable contrast to the Japanese long-term relationships based on mutual trust (Kakoto *et al.* 1989). The U.S. short-term relationships can be seen between contractors and workers, because contractors employ union workers and/or non-union workers temporarily for the period of construction, and most workers are not permanent employees of contractors.

3) Under the U.S. labor law, U.S. construction firms operate a union shop or an open shop (non-union). Levitt *et al.* made many studies to compare union firms and open shop firms and revealed comparative advantages of open shop firms over union shop competitors: flexible coordination of workers and cost

[6] The Norris-La Guardia Act was promulgated in 1932, the National Labor Relations Act (Wagner Act) in 1935, Labor Management Relations Act (Taft-Hartley Act) in 1947, and the Landrum-Griffin Act in 1959.

benefit of lower wages. Because of these advantages, the number of open shop construction firms has been steadily growing, both in their share of the overall construction market and in geographic penetration throughout the U.S. (Barrie and Paulson 1992). The impact of this growth is not yet fully known, because unions have traditionally trained new workers.

4) The parties involved in a project are strictly bound by the written contract documents. The contract documents are the primary ground on which contractual disputes are resolved.

5) Individual and organizational duties and responsibilities are clearly specified and rigidly specialized, and project management and decision-making depend heavily on a top-down authoritarian approach, not on the consensus and negotiation approach that is common in the Japanese construction industry.

6) In general, architectural and engineering (A/E) consultants are independent from owners and contractors. They have equivalent contractual status to owners and contractors, and participate in all phases of a project as third parties. Owners, contractors, and A/E consultants form rigid contractual relationships (see Figure 2.11).

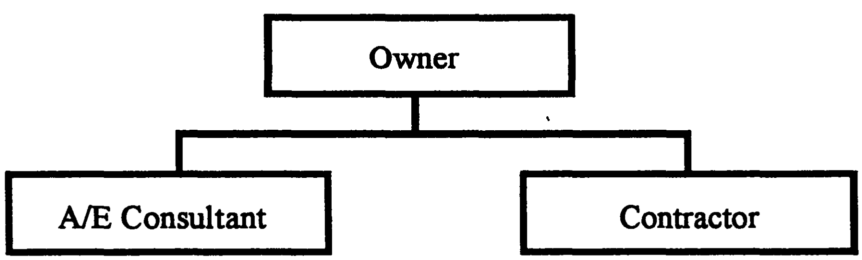


Figure 2.11 Contractual Relationship between Owner, Contractor, and A/E Consultant in the U.S. Construction Industry

Chapter 3

Analysis of Occupational Accidents in the Japanese and the U.S. Construction Industries

3.1 Definition of Occupational Accident

Occupational accidents are defined as accidents that cause deaths, injuries, or diseases to workers. The Resolution concerning statistics of occupational injuries adopted by the Thirteenth International Conference of Labour Statisticians held in Geneva in 1982 defines the occupational injuries and work (= occupational[7]) accidents as (*Yearbook of Labour Statistics 1995*, International Labour Office Geneva, 1995):

- Occupational injuries include deaths, personal injuries and diseases resulting from work accidents.
- Work accidents are accidents occurring at or in the course of work which may result in death, personal injury or disease.

The Japanese Industrial Safety and Health Law enacted in 1972 gives the following definition of industrial (= occupational[8]) accident in its Article 2 of Chapter 1, which depicts the nature of the accidents more clearly (*Labour Laws of Japan 1995*, Ministry of Labour, 1995):

> industrial accident: means that a worker becomes injured, contracts disease or is killed by buildings, equipment, raw materials, gases, vapours, particulate substances or the like which are related to the employment of the workers, or due to causes arising from work activities or other business affairs.

[7] This footnote is given by the author.

[8] Ditto.

3.2 Occupational Accidents in Japanese Construction Industry

3.2.1 Historical Review

In Japan, the collection and compilation of statistics on occupational accidents officially began after the promulgation of the Factory Law in 1911. Under this law, all factory employers were obliged to submit a monthly report of any accidents in the factories that had caused injuries to workers resulting in an absence of three or more days. This law, after its revision in 1923, obliged factory employers to report every accident.

However, the Factory Law applied only to those occupational accidents that occurred within factories, not to those in outdoor occupations such as construction work. It was not until the enactment of the Workmen's Accident Relief and Liability Insurance Law in 1931 that accidents in the construction industry were included in the list of occupational accidents officially collected for statistical analyses. Under the Workmen's Accident Relief and Liability Insurance Law, the collection of statistics on occupational accidents in the construction, quarrying, and transportation industries was initiated, and an annual report of the accidents in these industries was issued, beginning in 1932.

After a temporary break in data collection during World War II, the collection and compilation of statistics on occupational accidents resumed. This resumption was enabled by the establishment of new legislative background concerning occupational safety and health. The Ministry of Labour was established in 1947, and three major labour laws were enacted: the Labour Relations Adjustment Law in 1946, the Labour Standards Law in 1947, and the Trade Union Law in 1949. In addition, the Workmen's Accident Compensation Insurance Law was enacted in 1947. Further efforts to increase workers' safety and health resulted, in 1972, in the Industrial Safety and Health Law that was designed to secure the safety and health of workers, as well as to facilitate the establishment of comfortable working environments. Under this law, substantial revisions were added to the data acquisition and compilation system for occupational accidents; the range of accident statistics was enlarged to include accidents causing four or more days' absence of workers, instead of requiring eight or more days' absence; moreover, the classification of accident causes was revised to comply with the international system proposed by the International Labour Organization (ILO).

3.2.2 Statistics on Occupational Accidents in Japan

At present, several collections of statistics on occupational accidents are available through reports and/or yearbooks issued by the Ministry of Labour, the Labour Standards Bureau, the Labour Standards Inspection Offices, and the affiliated associations such as the Japan Industrial Safety and Health Association (JISHA) and the Japan Construction Safety and Health Association (JCSHA)[9]. The following two collections of statistics are the most representative:

1) *Statistics on Industrial Injuries under Workmen's Accident Compensation Insurance.*

   These statistics are compiled by the Ministry of Labour annually on the occurrence, etc. of industrial injuries (excluding accidents while commuting) to which the insurance was applied, and are based on the statistics of workmen's accident compensation insurance. Data are tabulated for the fiscal year and published in the "Annual Report of Statistics on Industrial Injuries under Workmen's Accident Compensation Insurance". Data for the calendar year are separately tabulated and presented in the "Yearbook of Industrial Safety and Health" published by JISHA.

[9] The Japan Industrial Safety and Health Association (JISHA) was established in 1964 under the Industrial Accident Prevention Organizations Law as a juristic organization to upgrade the standards of industrial safety and health. The member organizations of JISHA include the five Industrial Accident Prevention Associations, nationwide employers' organization such as the Japan Federation of Employers' Associations, and prefectural safety and health promotion organizations. The Japan Construction Safety and Health Association (JCSHA) was one of the five Industrial Accident Prevention Associations .

2) *Survey of Industrial Injuries.*

The survey has been conducted by the Ministry of Labour since 1952, and it is conduced twice a year now. The survey covers private, national government and public establishments that are engaged in the following industries: forestry, mining, construction, manufacturing, transportation and communication, electricity, gas, heat supply and water; and, in the service categories: laundries, automobile repair services, machine repair shops, building maintenance services and waste treatment services. Those establishments consisting of only managerial and clerical workers are excepted from the survey. The survey comprises two parts: Survey A covers about 16,000 sample establishments with 100 or more regular employees, and Survey B covers about 12,000 sample establishments with 10 ~ 99 regular employees.

3.2.3 Indices of Occupational Accidents in Japan

Relative measures are necessary to make comparisons of occupational accidents between survey periods, industries, and countries. In Japan, the incidence, frequency, and severity rates are used for this purpose, based on the recommendations by ILO in 1947 and 1962.

1) *Incidence Rate*

The rate refers to the frequency of occupational injuries and deaths expressed in terms of the number of the persons killed or injured per thousand workers in a year. Therefore, the rate is defined as:

$$\text{Incidence Rate} = \frac{\text{total number of injuries and deaths in a year}}{\text{average number of workers employed in a year}} \times 1{,}000$$

2) *Frequency Rate*

The rate refers to the frequency of occupational injuries and deaths expressed in terms of the number of the persons killed or injured per million man-hours worked during the survey period. Therefore, the rate is defined as:

$$\text{Frequency Rate} = \frac{\text{total number of injuries and deaths in a year}}{\text{total number of man} - \text{hours worked}} \times 1{,}000{,}000$$

3) *Severity Rate.*

The rate refers to the weight of occupational injuries and deaths expressed in terms of the number of working days lost per thousand man-hours worked during the survey period. . Therefore, the rate is defined as:

$$\text{Severity Rate} = \frac{\text{total number of working days lost}}{\text{total number of man - hours worked}} \times 1{,}000$$

The working days lost are calculated on the basis of the following assumptions:

a) Death is considered as 7,500 working days lost.

b) The working days lost for the permanent and total disability and permanent and partial disability are calculated according to the degree of the disability shown in Table 3.1:

Table 3.1 Lost Working Days for Grades of Physical Disability

Grades of Physical Disability	1	2	3	4	5	6	7
Lost of Working Days		7,500		5,500	4,000	3,000	2,200

8	9	10	11	12	13	14
1,500	1,000	600	400	200	100	50

c) The working days lost for temporal disabilities are calculated by multiplying the days of absence by $^{300}/_{365}$. (The figure below the decimal point is omitted and one day of absence is counted as one working day lost).

3.2.4 Analysis of Occupational Accidents in Construction Industry

3.2.4.1 Current Situation of Occupational Accidents

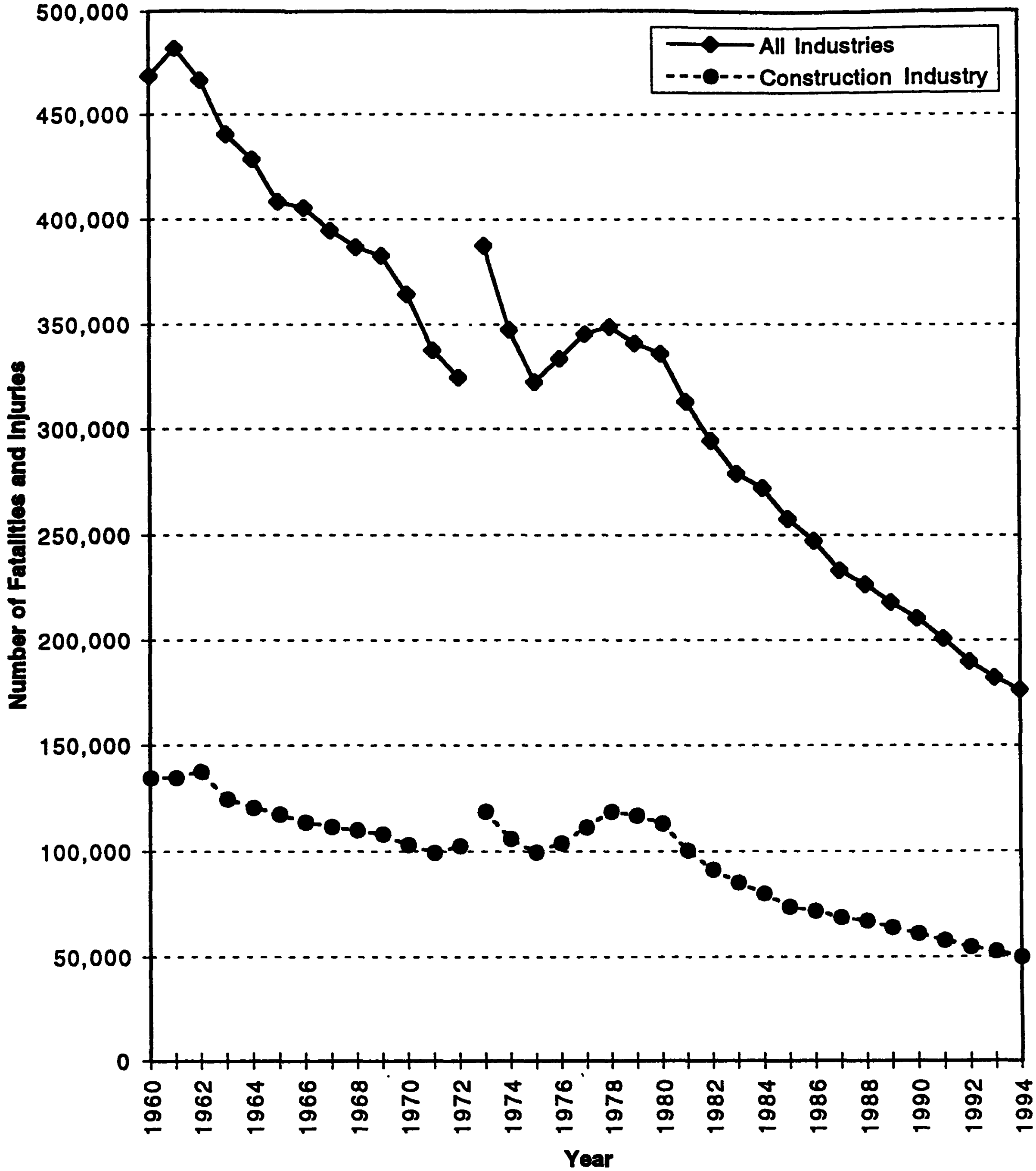
The trend of occupational accidents of the construction industry is illustrated in Figures 3.1 to 3.3, in comparison with that of all industries in Japan. Figures 3.1, 3.2, and 3.3 show the change in the number of deaths and injuries, the change in the number of deaths, and the change in the number of grave accidents involving three or more casualties at a time, respectively.

The number of deaths and injuries in the construction industry reached a peak of 137,282 in 1962, accounting for about 30 % of the total casualties in all industries in 1962[10] (see Figure 3.1). The number of deaths in the construction industry reached a peak of 2,652 in 1961, accounting for about 40 % of the total deaths in all industries in 1961 (see Figure 3.2). After this peak, it began to show a decreasing tendency until 1972. In 1972 when the Industrial Safety and Health Law was promulgated, the number of deaths and injuries jumped up, because the statistics were revised to include deaths and injuries requiring four or more days of absence. However, the enforcement of this law greatly reduced occupational accidents in Japan. The total number of deaths incurred in all industries dropped from 5,269 in 1973 to 3,302 in 1976, and the number of deaths in the construction industry also decreased drastically from 2,440 in 1973 to 1,451 in 1976 (see Figure 3.2). This is because the law plays a crucial role in establishing administrative plans and technical standards, promoting educational programs and training, clarifying and

[10] The number of deaths and injuries incurred at all industries was 466,126 in 1962. In the previous year, 1961, the number reached a peak of 481,686.

specifying responsibilities and liabilities incurred by occupational accidents, and stimulating voluntary activities to prevent occupational accidents and secure safety and health in workplaces. As the law infiltrated Japanese industries, the number of occupational accidents causing deaths and injuries decreased steadily.

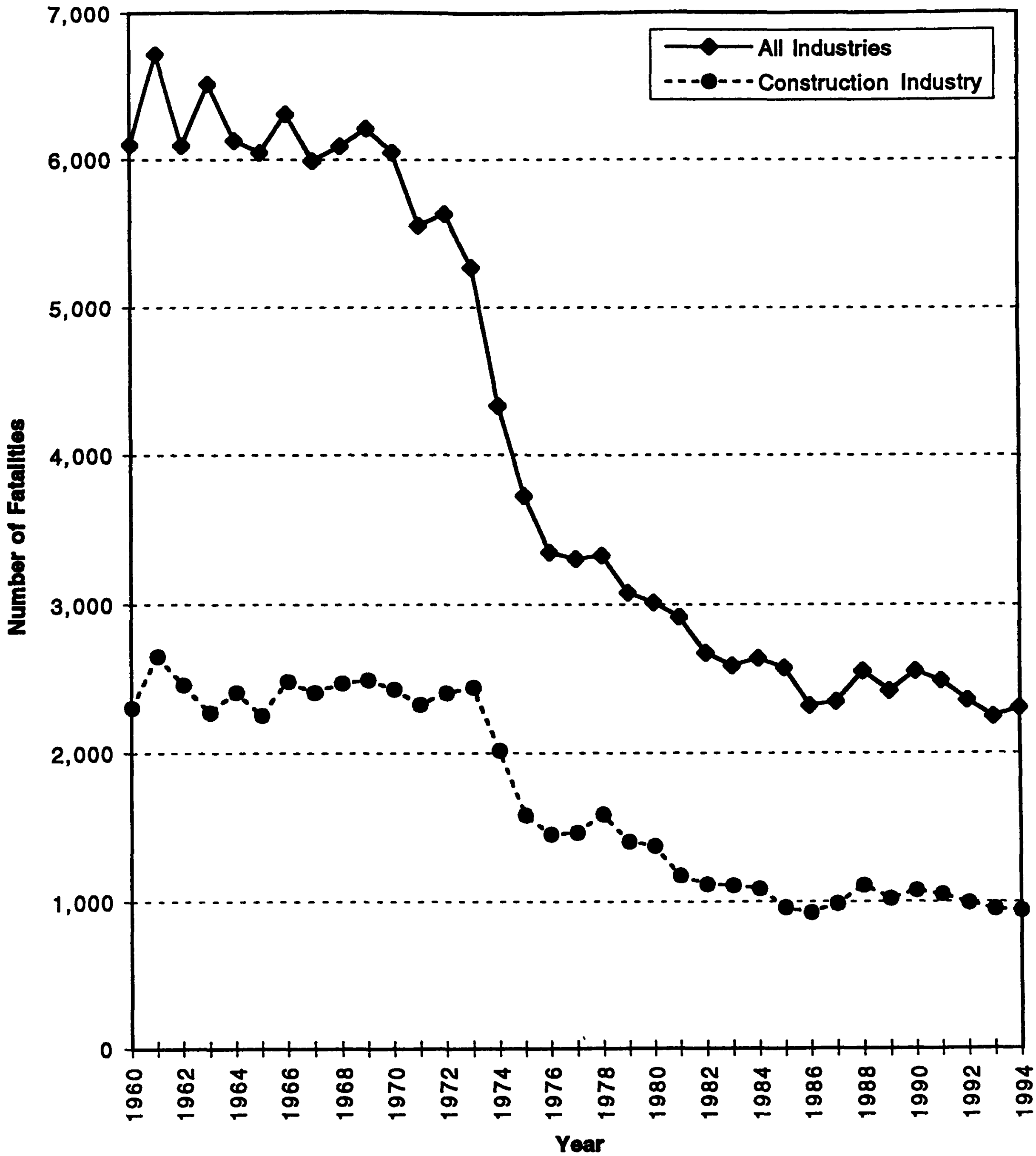
In 1994, the number of casualties requiring an absence of four or more days in all industries fell sharply to 176,047, of which the construction industry accounted for 49,788 (see Figures 3.1). The number of deaths caused in all industries also fell sharply to 2,301, of which 942 occurred in the construction industry. As for the number of grave accidents, all industries incurred 195 accidents, and the construction industry incurred 80 of that number (see Figure 3.3). Consequently, in 1994, the construction industry accounted for 28.2 % of the total casualties, 40.9 % of the total fatalities, and 41.0 % of the total grave accidents in all the types of industries in Japan. Note that the construction industry has caused the majority of occupational accidents, and this characteristic of the industry remains unchanged even after the enactment of the Industrial Safety and Health Law in 1972.



Source: Japan Construction Safety and Health Association (JCSHA), *Kensetugyo-Anzen-Eisei-Nenkan (Yearbook of Construction Safety and Health), 1995.*

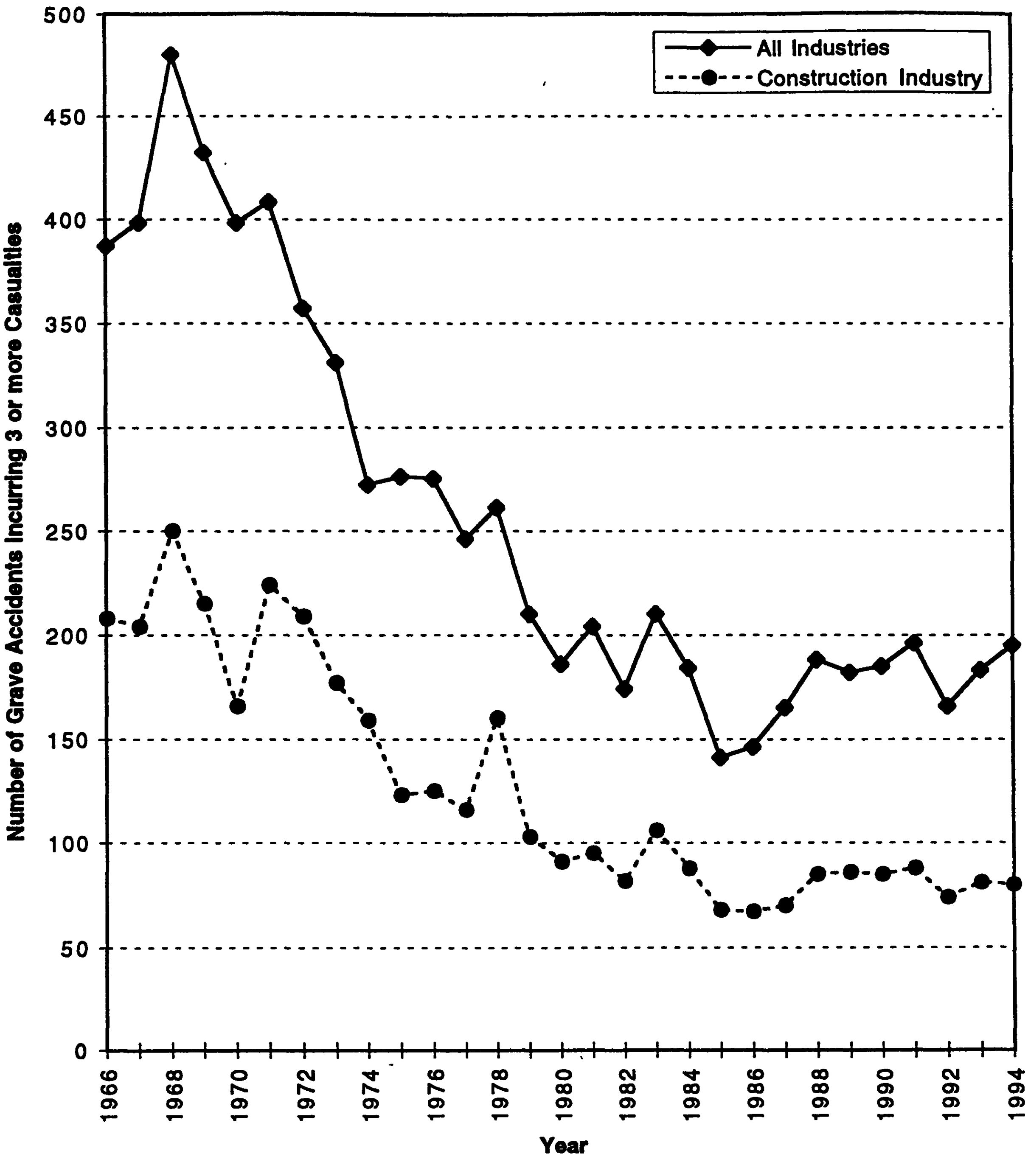
Note: The data cover deaths and injuries requiring an absence of 8 days or more from 1960 to 1972 and 4 days or more from 1973 to 1994.

Figure 3.1 Change in Number of Occupational Fatalities and Injuries in Japan



Source: Japan Construction Safety and Health Association (JCSHA), *Kensetugyo-Anzen-Eisei-Nenkan (Yearbook of Construction Safety and Health), 1995.*

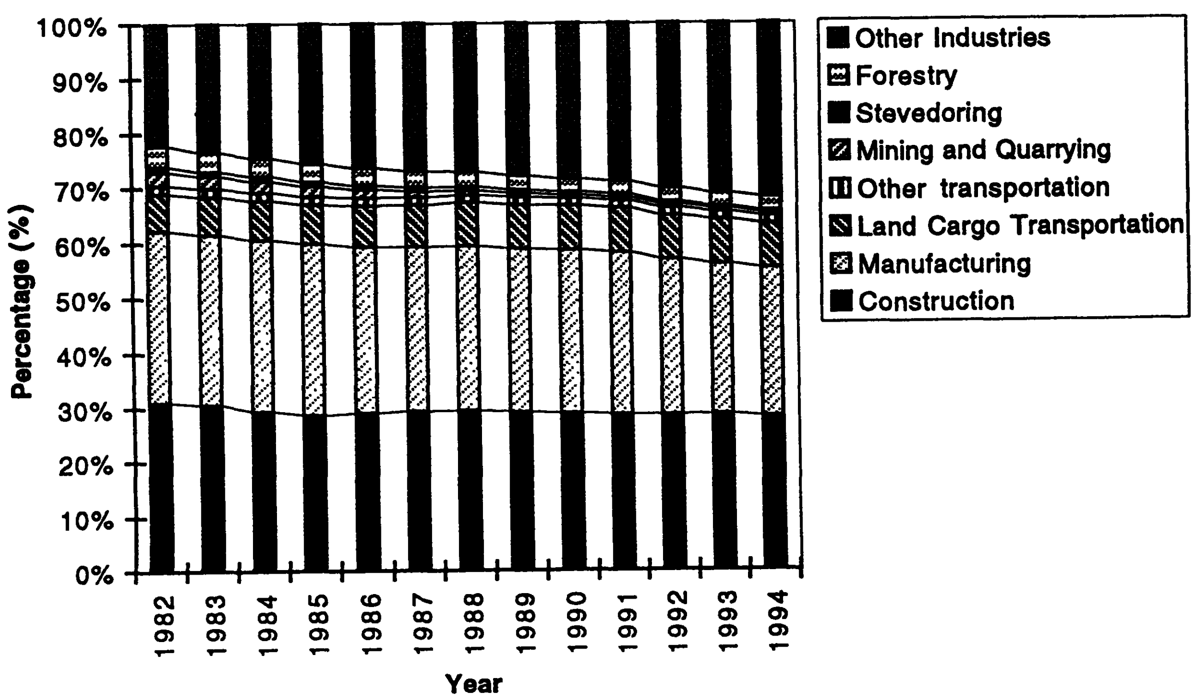
Figure 3.2 Change in Number of Occupational Fatalities in Japan



Source: Japan Construction Safety and Health Association (JCSHA), *Kensetugyo-Anzen-Eisei-Nenkan (Yearbook of Construction Safety and Health), 1995.*

Figure 3.3 Change in Number of Grave Accidents in Japan

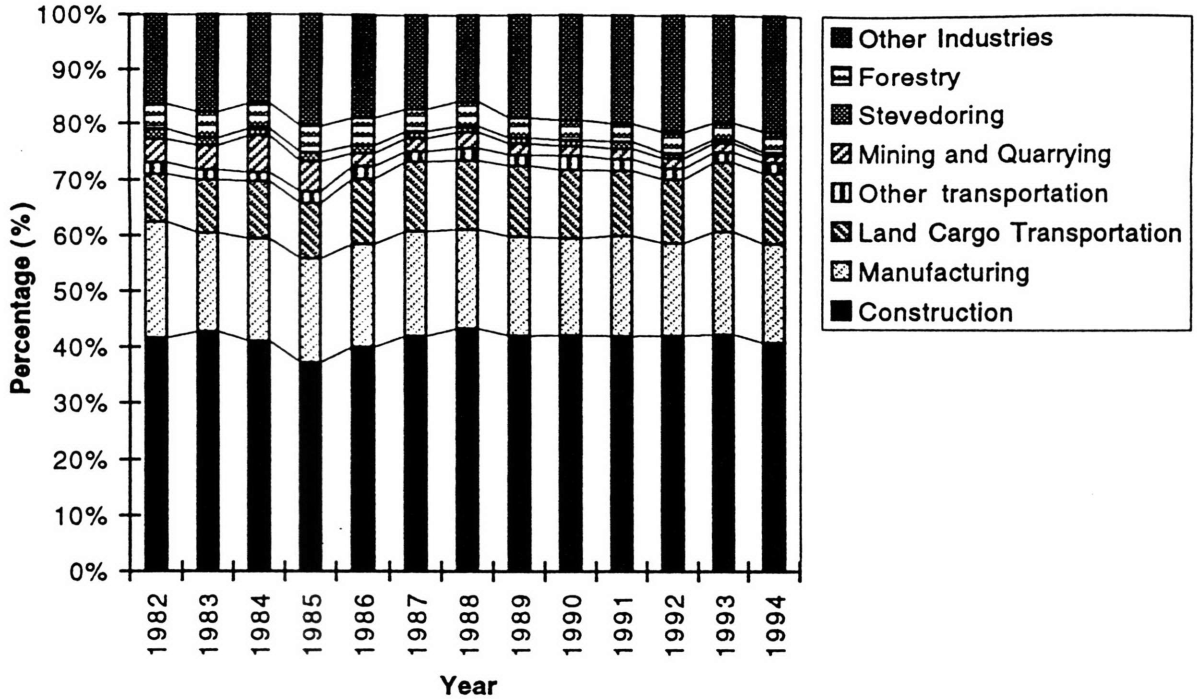
As mentioned above, the construction industry accounts for the major portion of occupational accidents in Japan. To illustrate this situation in comparison with other industries, Figures 3.4, 3.5, and 3.6 present the distribution by industry of occupational fatalities and injuries, occupational fatalities, and grave accidents causing three or more casualties at a time, respectively. These figures demonstrate that despite the remarkable decrease of occupational accidents, the construction industry has accounted for the largest portion of the accidents over the last decade: 30 % of the total casualties (see Figure 3.4), 40 % of the total fatalities (see Figure 3.5), and 40 % of the total serious accidents (see Figure 3.6).



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*

Note: Other industries include agriculture, fishery, commerce, financing, communication, etc.

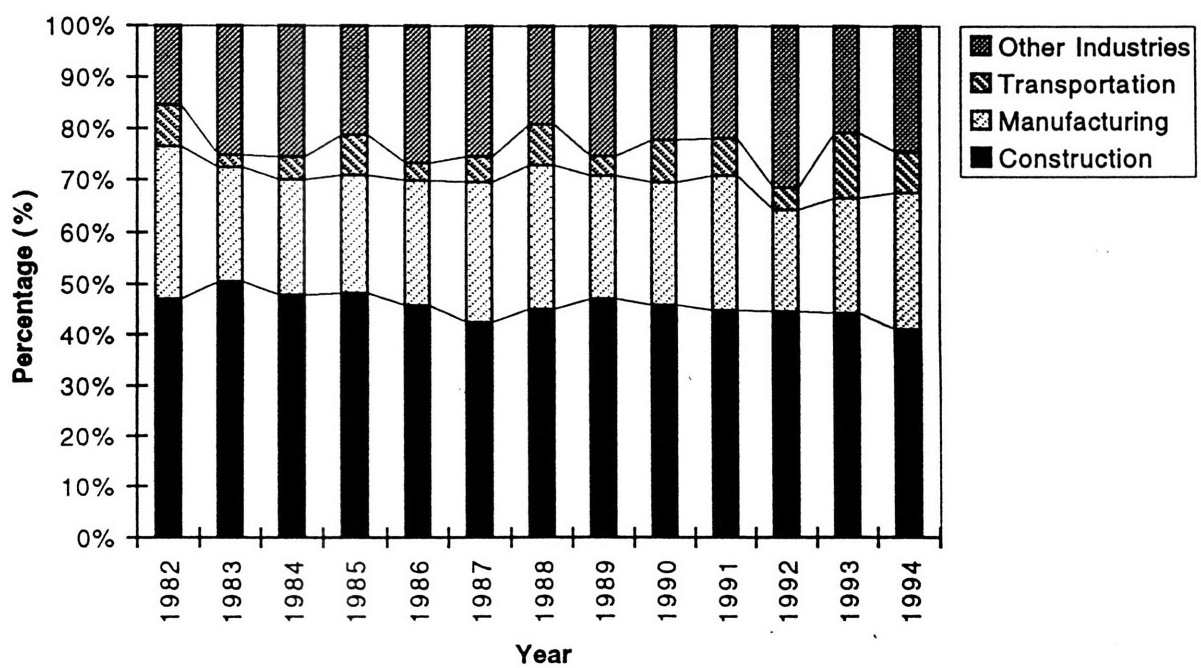
Figure 3.4 Change in Distribution of Occupational Fatalities and Injuries by Industry in Japan



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*

Note: Other industries include agriculture, fishery, commerce, financing, communication, etc.

Figure 3.5 Change in Distribution of Occupational Fatalities by Industry in Japan



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*

Note: Other industries include mining and quarrying, stevedoring, forestry, agriculture, fishery, commerce, financing, communication, etc.

Figure 3.6 Change in Distribution of Grave Accidents by Industry in Japan

This high vulnerability to occupational accidents of the construction industry is confirmed by the aforementioned indices: the incidence rate, the frequency rate, and the severity rate (see Figures 3.7 to 3.9).

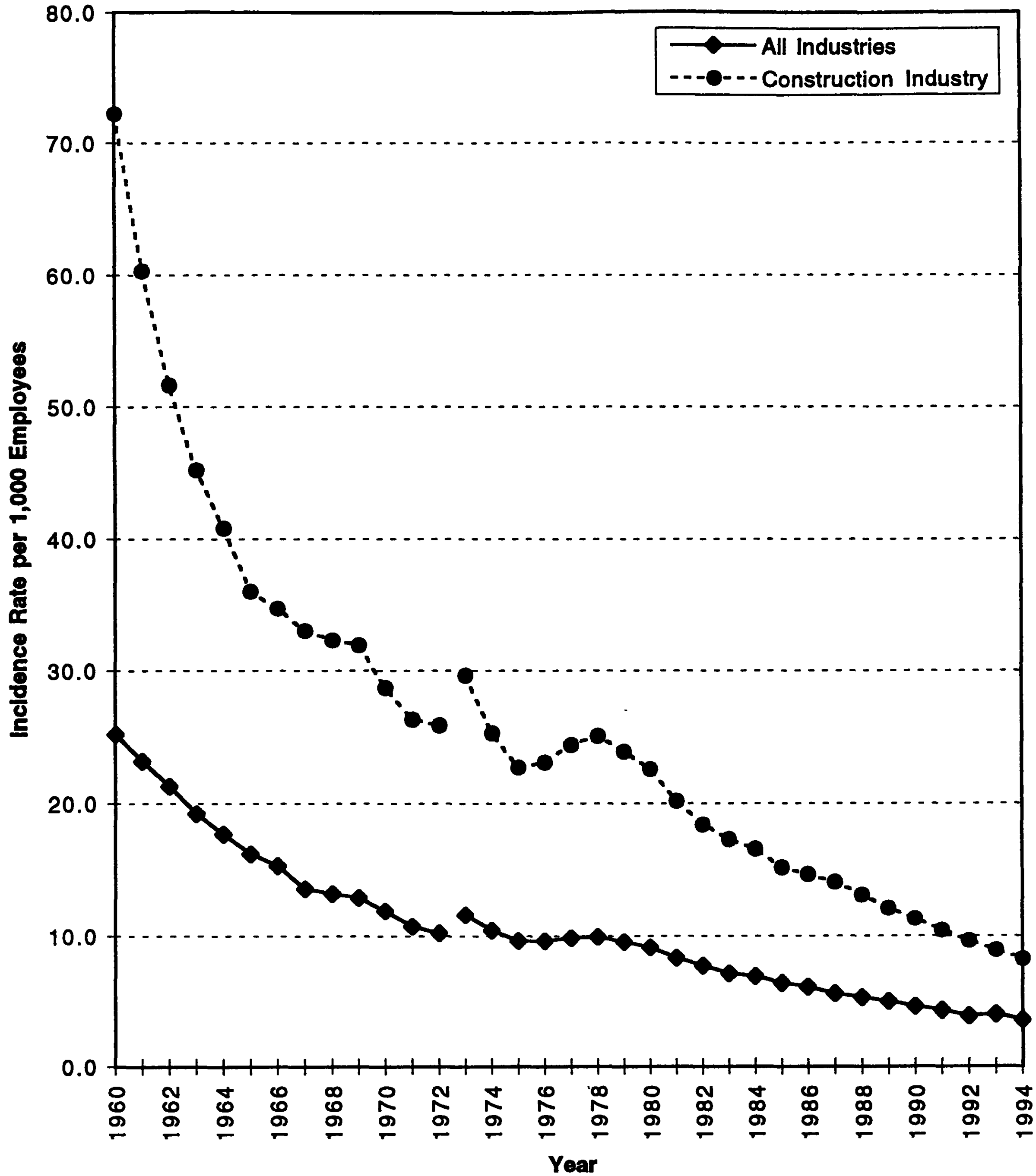
Figures 3.7 to 3.9 show the incidence rate, frequency rate, and severity rate of the construction industry in comparison with those of all industries, respectively. The rates show a tendency to decrease for both the construction industry and all industries, thus the rates of 1994 fall down to one-third to one-sixth of 1973. The frequency rate for the construction industry is almost the same as that of all industries.

Despite the remarkable improvement of occupational safety illustrated by these indices, the construction industry has shown the highest (two or more times as high as) incidence and severity rates of all industries. Moreover, the construction industry would have shown higher frequency rates than all industries if the rate were calculated to include establishments with fewer than 100 regular employees. More than 90 % of accidents are incurred by such small establishments in the construction industry, whereas about 80 % of accidents occur for small firms in all industries.

Consequently, the relative situation of occupational safety of the construction industry has not been improved in the Japanese industries. The construction industry still incurs the largest number of occupational accidents and casualties. It has higher vulnerability to occupational accidents, especially to fatal accidents, than other industries such as manufacturing, transportation, and energy and water supply industries[11].

---

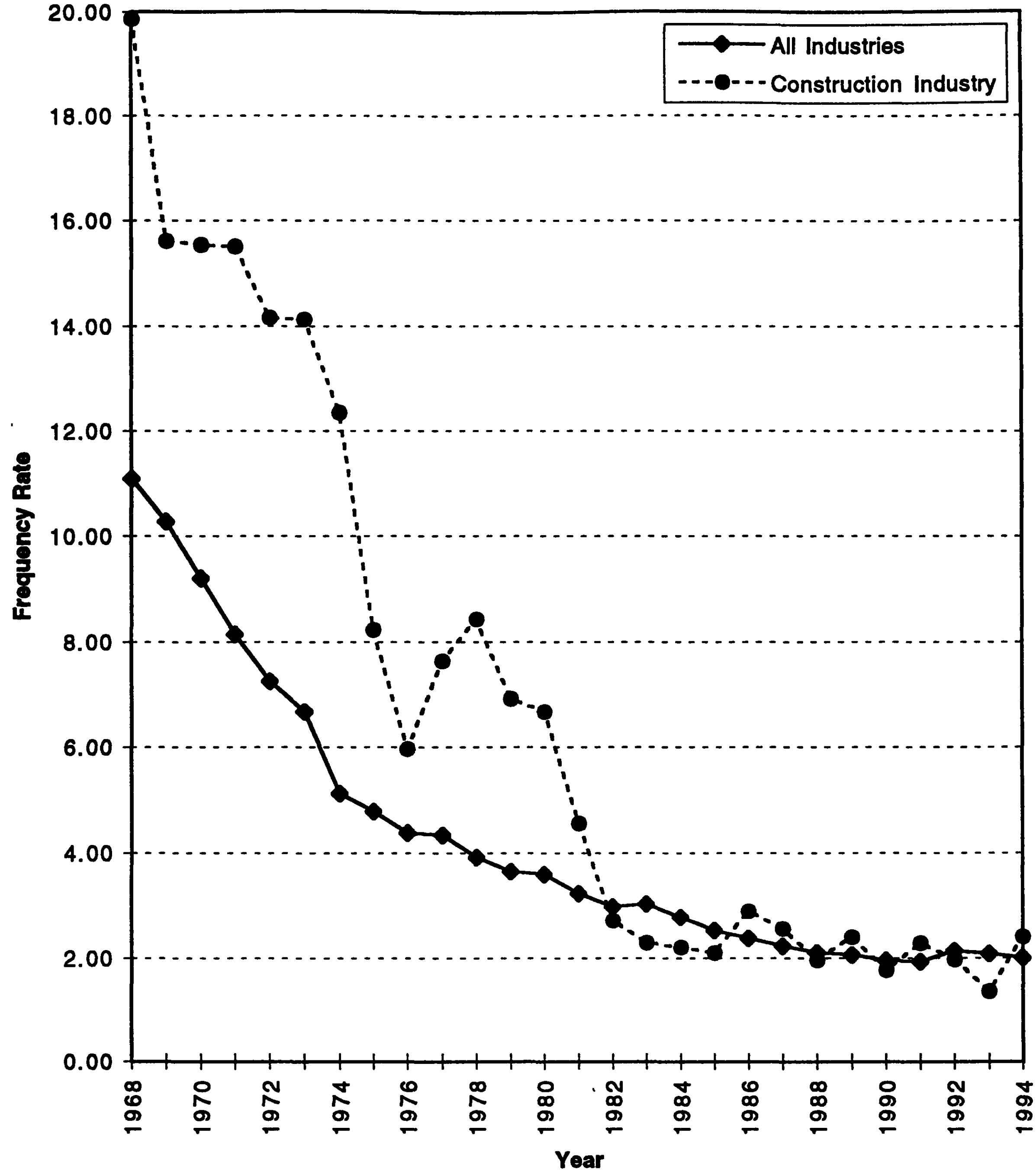
11 The mining and quarrying industry exhibits higher incidence, frequency, and severity rates than the construction industry. There are some industries that give higher values to either the incidence rate, frequency rate, or severity rate than the construction industry, for example, forestry and transportation industries. However, as for the frequency rate of fatal accidents, the construction industry presents the highest rate of all Japanese industries (see *Yearbook of Labour Statistics*, International Labour Office, Geneva, 1992, pp. 1044).



Source: Japan Construction Safety and Health Association (JCSHA), *Kensetugyo-Anzen-Eisei-Nenkan (Yearbook of Construction Safety and Health), 1995.*

Note: The data cover fatalities and injuries requiring an absence of 8 days or more from 1960 to 1972 and 4 days or more from 1973 to 1994.

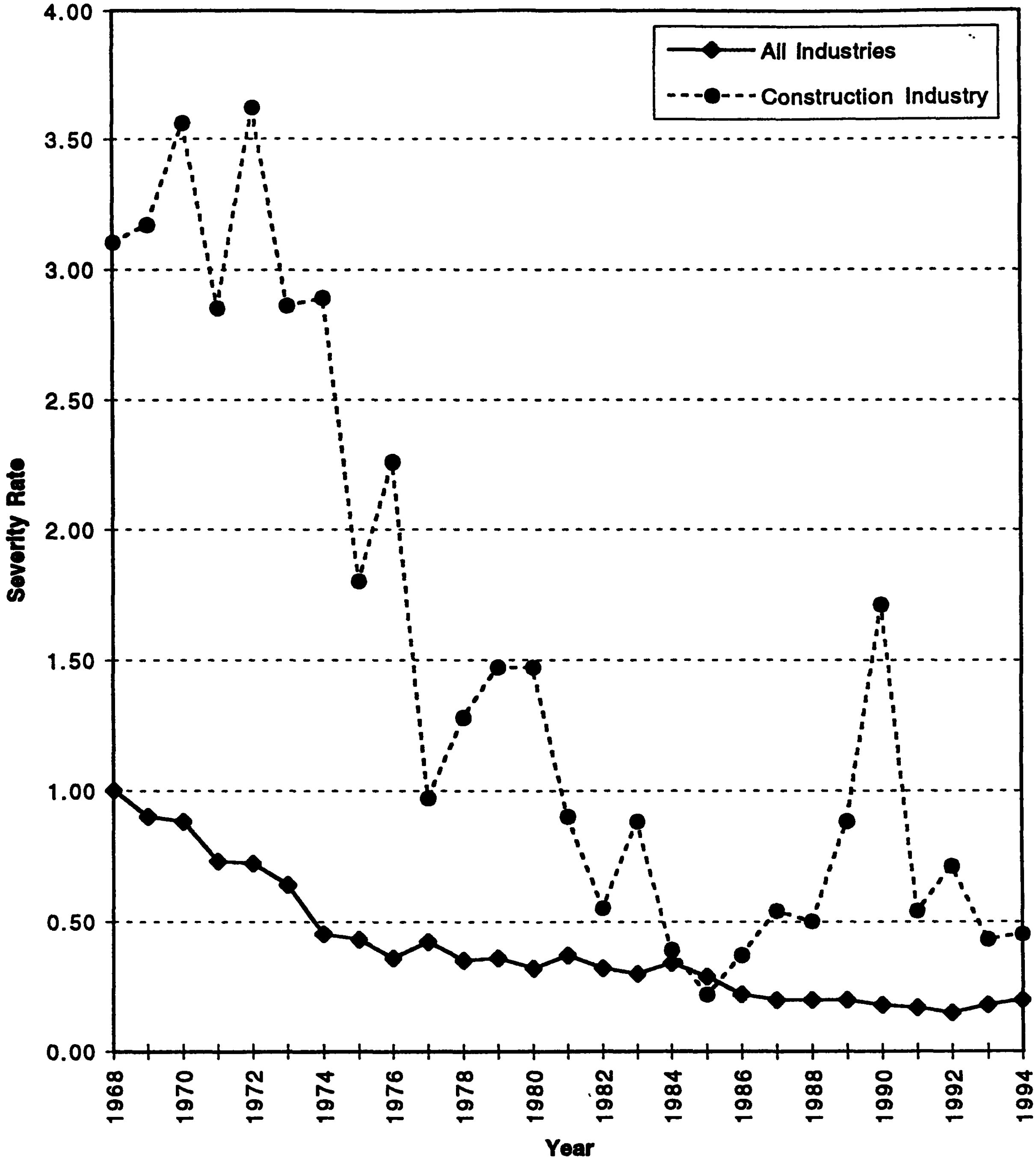
Figure 3.7 Change in Incidence Rates per 1,000 Workers Employed in Japan



Source: Japan Construction Safety and Health Association (JCSHA), *Kensetugyo-Anzen-Eisei-Nenkan (Yearbook of Construction Safety and Health), 1995.*

Note: The data are those of establishments with 100 or more regular employees about fatalities, loss of a part of body or partial bodily disability caused by accidents while working on duty, or suspension of business for one day or more.
Rates of the construction industry represent the rates of general construction, for which workmen's compensation insurance premium is 1,000,000 yen (600,000 yen from 1976 to 1983 and 200,000 yen until 1975) or more, or contract price is 120 million yen (90 million yen from 1976 to 1983 and 30 million yen until 1975) or more.

Figure 3.8 Change in Frequency Rates per 1,000,000 Man-Hours Worked in Japan



Source: Japan Construction Safety and Health Association (JCSHA), *Kensetugyo-Anzen-Eisei-Nenkan (Yearbook of Construction Safety and Health), 1995.*

Note: The data are those of establishments with 100 or more regular employees about fatalities, loss of a part of body or partial bodily disability caused by accidents while working on duty, or suspension of business foe one day or more.
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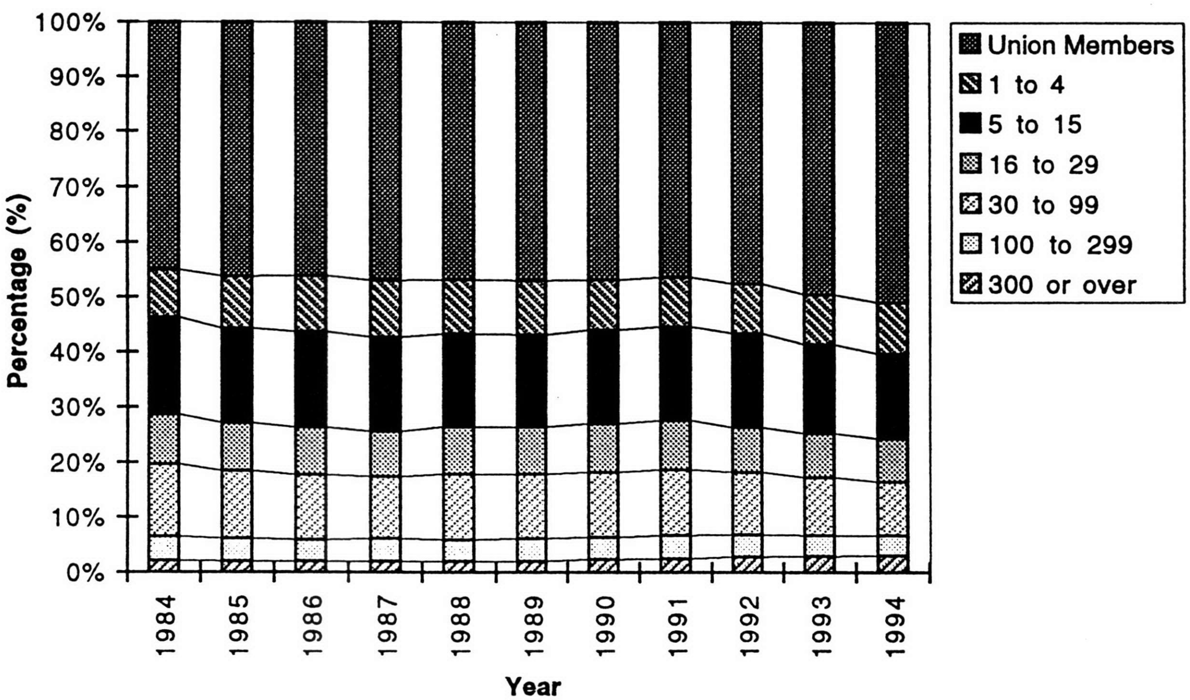
Figure 3.9 Change in Severity Rates in Japan

3.2.4.2 Characteristics of Occupational Accidents

It is recognized that small construction establishments experience occupational accidents more frequently than large establishments in Japan (Ishii 1995). Therefore, as shown in Figure 3.8, small establishments account for the majority of occupational accidents in the Japanese construction industry because most construction firms in Japan are run as small establishments (see Figure 2.4). Member companies of the Labour Insurance Affairs Union[12] and establishments with fewer than 100 employees share more than 90 % of the total casualties by occupational accidents in the industry.



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*

Note: The data cover fatalities and injuries requiring an absence of 4 days or more.
Union = Labour Insurance Affair Union (see Footnote below).

Figure 3.10 Change in Distribution of Occupational Fatalities and Injuries by Construction Establishment Employment Size

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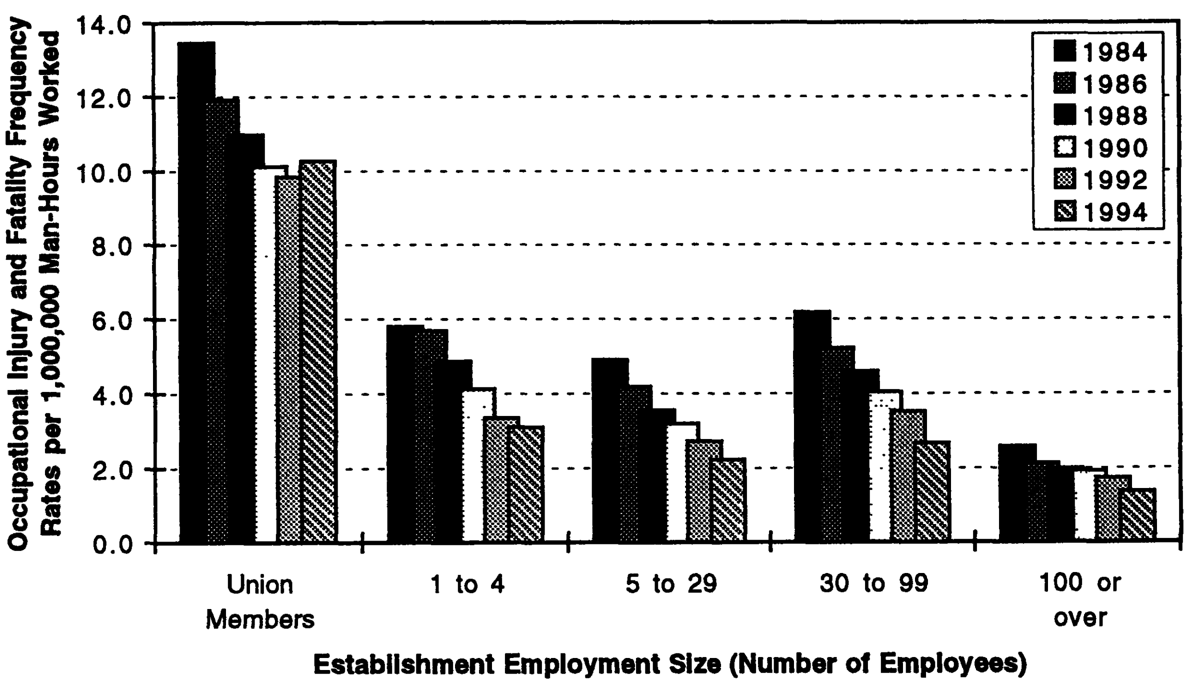
12 The Labour Insurance Affairs Union handles small businesses' labour insurance affairs such as collating and filing insurance premiums on behalf of such small businesses lacking enough skill and manpower, for example, self-employed companies. The task of the Union is substantially taken by employer's organizations accredited by the Ministry of Labour.

To demonstrate the high vulnerability to occupational accidents of small construction establishments, the frequency rates of occupational fatalities and injuries are calculated for five groups of construction establishments with different employment sizes[13]. The results of the calculations are shown in Figure 3.11. This figure reveals that small construction establishments incur higher frequency rates of occupational fatalities and injuries than large construction establishments; the member companies of the Labour Insurance Affairs Union incur the highest frequency rates, which are about five or more times higher than those of the establishments with 100 or more employees.



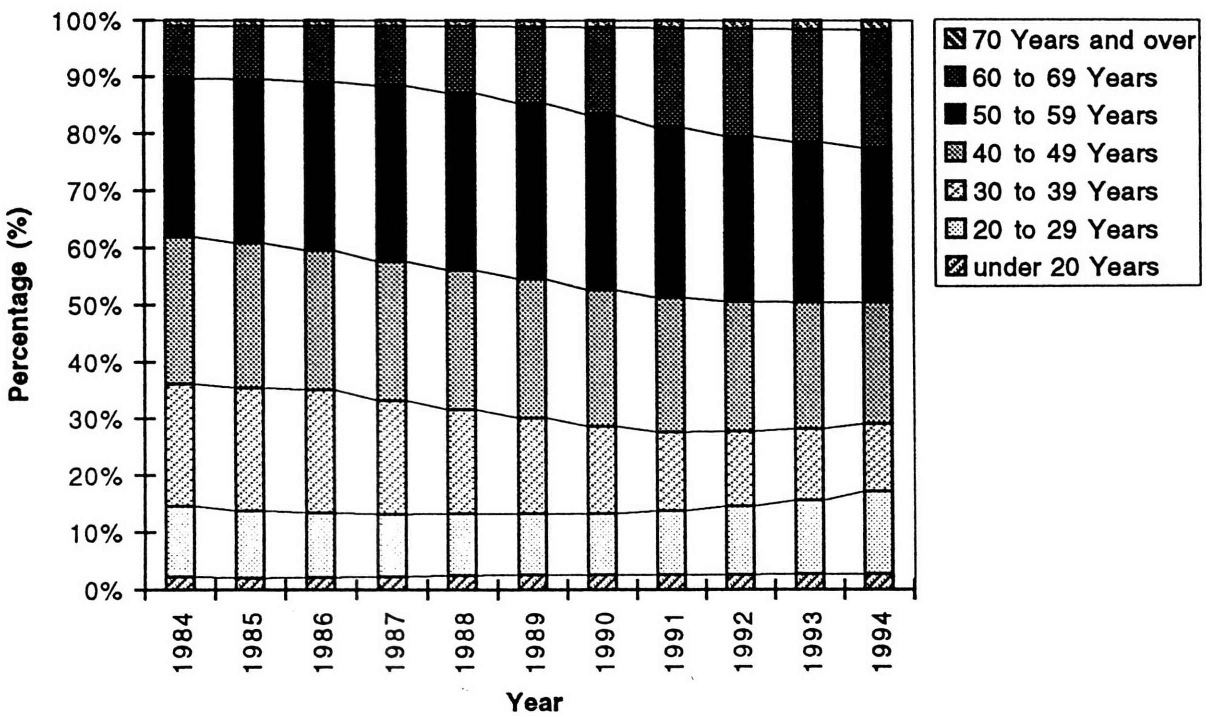
Reference: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*
Policy Planning and Research Department, Minister's Secretariat of Japan, Ministry of Labour, *Year Book of Labour Statistic, 1984-1994.*

Note: The data cover fatalities and injuries requiring an absence of 4 days or more.
Union = Labour Insurance Affair Union.

Figure 3.11 Distribution of Occupational Fatality and Injury Frequency Rates per 1,000,000 Man-Hours Worked by Construction Establishment Employment Size

[13] To calculate the rates, the author estimates the total annual man-hours worked by multiplying the total annual labor force by the average monthly working hours times 12 months. Note that there is negligible difference in the monthly working hours between establishments with different employment sizes.

Currently, because of the aging of construction workers mentioned previously in Paragraph 2.2.1, occupational accidents by older workers are a serious concern in the industry. Figure 3.12 illustrates that the percentage of occupational injuries and fatalities attributed to older workers is increasing year after year; in 1994, about 50 % are incurred by workers older than 50 years old. Moreover, based on a comparison of the incidence rates by age group[14] shown in Figure 3.13, workers older than 50 years old show the highest incidence rate, followed by workers under 20 years old. It is deduced that the physical decline of older workers and the inexperience of young workers result in their high vulnerability to occupational accidents.



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*

Note: The data cover fatalities and injuries requiring an absence of 4 days or more.
The data are tabulated for the fiscal year by JISHA.

Figure 3.12 Change in Distribution of Occupational Fatalities and Injuries by Age Group in the Japanese Construction Industry

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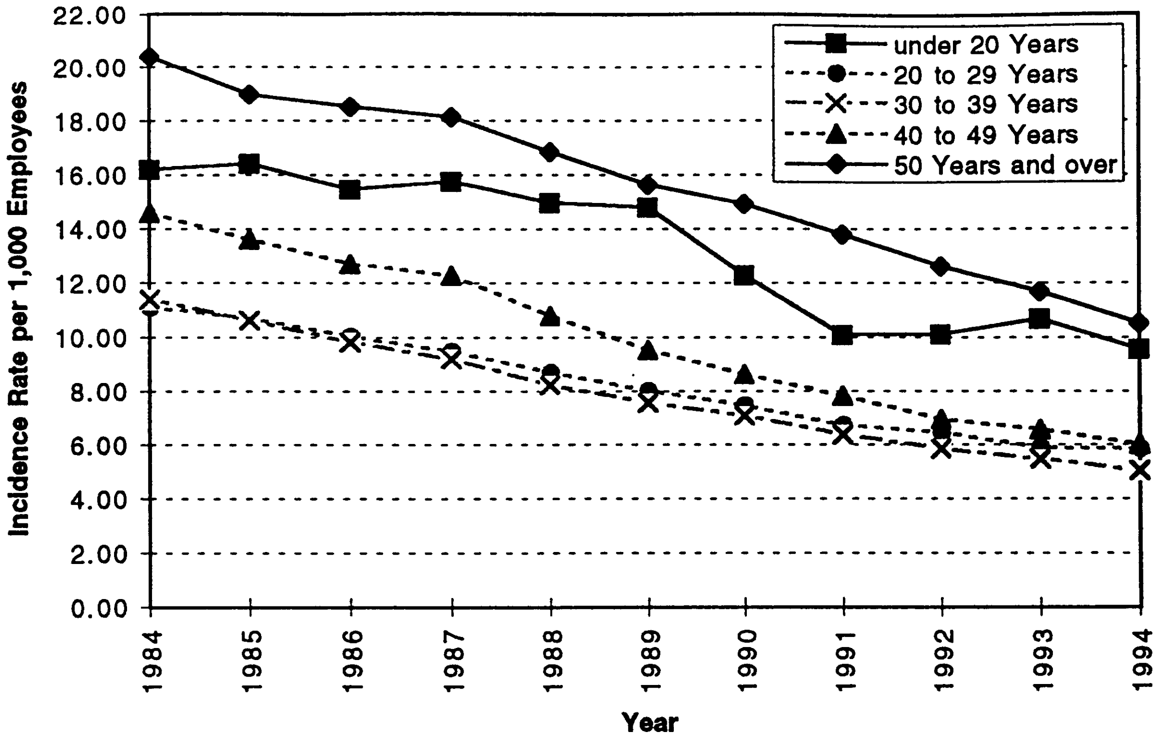
[14] Note that the data of casualties are tabulated for the fiscal year and the data of employees are tabulated for the calendar year.

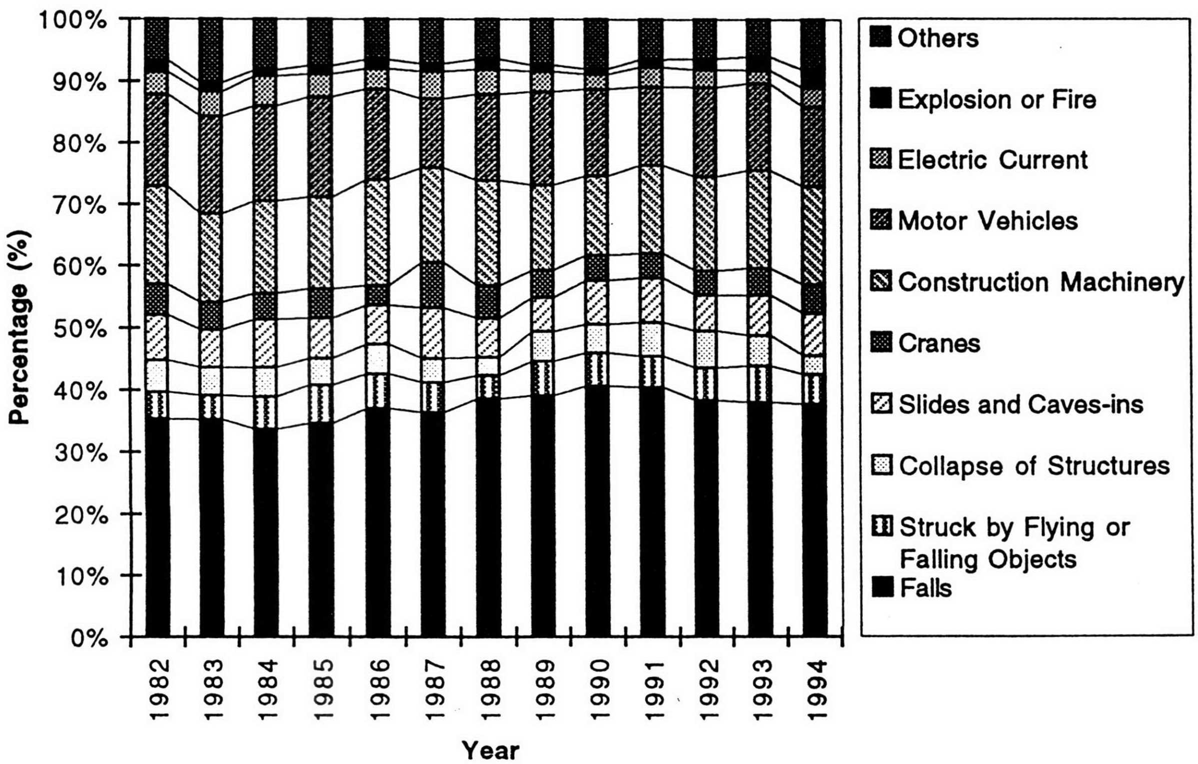


Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*
Policy Planning and Research Department, Minister's Secretariat, Ministry of Labour, Government of Japan, *Yearbook of Labour Statistics, 1970-1995.*

Note: Deaths and injuries require an absence of 4 days or more.
The number of fatalities and injuries is tabulated for the fiscal year by JISHA and the number of employees is tabulated for the calendar year by Statistics Bureau of Japan.

Figure 3.13 Change in Incidence Rates per 1,000 Workers Employed by Age Group in the Japanese Construction Industry

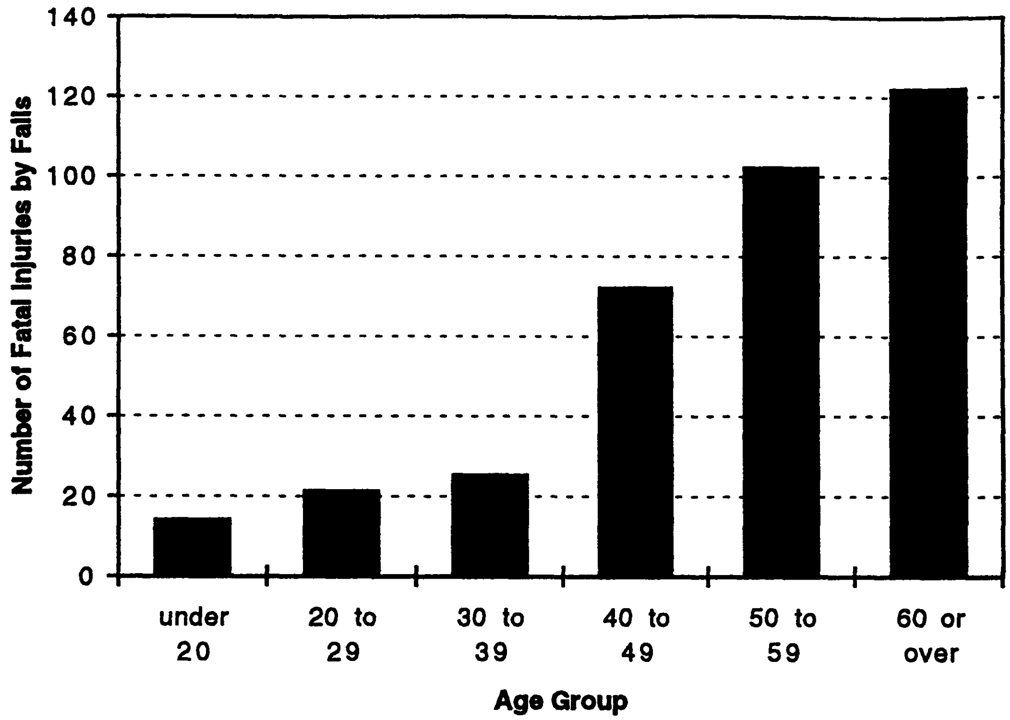
Figure 3.14 shows the distribution of fatalities by cause. Falls are the leading cause accounting for about 40 % of the total fatalities, which is also related to the aging of construction workers. In 1994, 356 fatalities were caused by falls; workers over 50 years old incurred 224 fatalities, accounting for 63 % of the fatalities by falls. In contrast, they accounted for only 38 % of the total labor force in the construction industry (see Figure 2.4). The heaviness of fatalities by aged workers is clearly illustrated by Figure 3.15, which shows the distribution of fatalities by falls of this year by age group; the number of fatalities jumps up as construction workers become old. As further aging is anticipated in the future in Japan, countermeasures to prevent occupational accidents by falls will be crucial to the industry. The next major causes of fatalities are construction machinery and motor vehicles. Fatalities by these three causes account for more than 60 % of the total. Note that fatalities by construction machinery have gradually increased in recent years. It is presumed that the introduction of large and innovative machinery for labor reduction and construction efficiency requires workers to acquire new skills and experience to maneuver them, and thus causes accidents by operators who are not skilled or experienced in properly operating the machinery.



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*

Note: Explosions and fires include CO_2 inhalations.
Others include heart attacks, drowning, and deaths from tetanus.

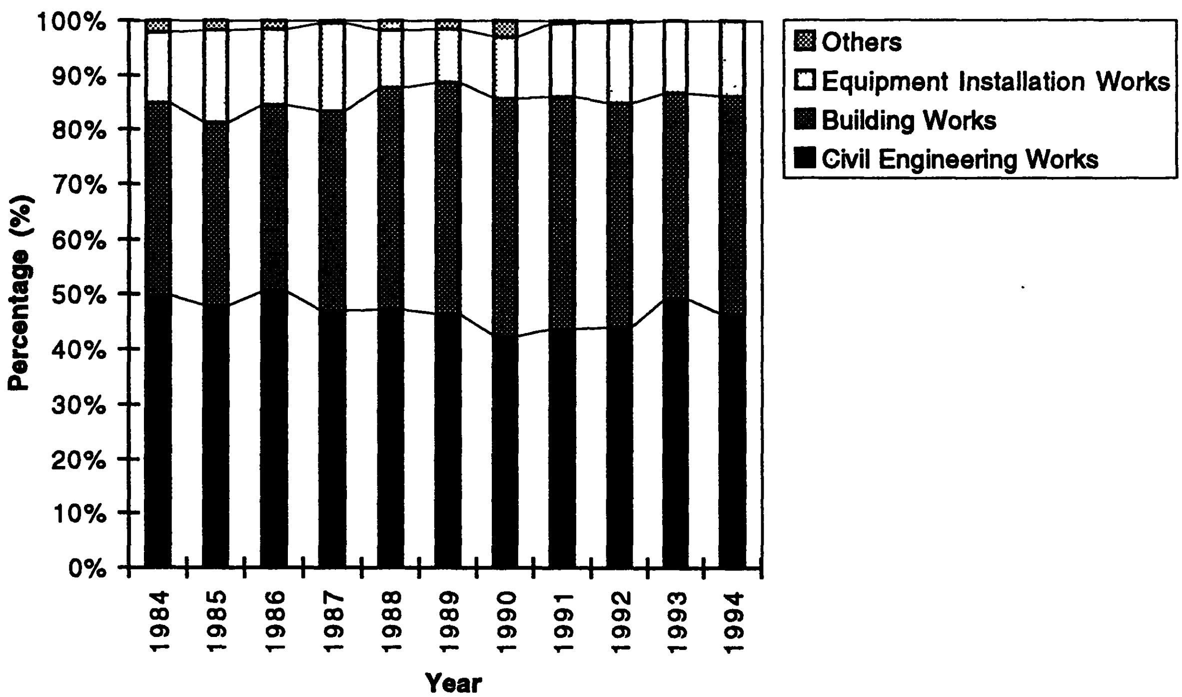
Figure 3.14 Change in Distribution of Occupational Fatalities by Cause



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1995.*

Figure 3.15 Distribution of Occupational Fatalities Caused by Falls in 1994 by Age Group

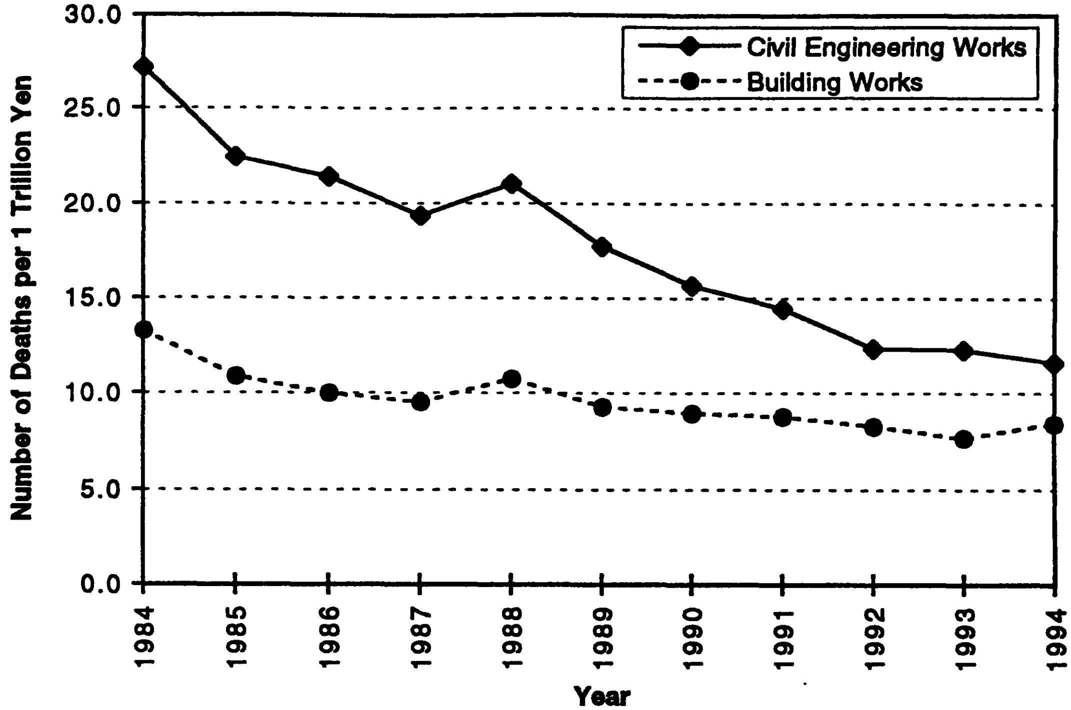
Finally, a comparison of occupational accidents is made between civil engineering works and building works. Figure 3.16 shows the breakdown of occupational fatalities by type of construction: civil engineering works, building works, and equipment installation works. As shown in this figure, the percentage of the accidents civil engineering works account for decreases, whereas the percentage building works account for increases. Civil engineering works and building works thus account for the almost the same percentage, say 45 % each in 1994. The situation changes, however, considering 45 % of the construction investment is allocated for civil engineering works, and the remaining of 55 % is allocated for building works (see Paragraph 2.2.1 and Figure 2.2). Figure 3.17 shows the number of fatalities per 1 trillion yen (≈ $ 10 billion) construction investment for civil engineering works and building works[15]. The figure illustrates that civil engineering works cause a larger number of fatalities than building works despite the recent declining trend. Consequently, workers engaged in civil engineering works are exposed to occupational accidents more frequently than those engaged in building works.



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health), 1985-1995.*

Figure 3.16 Change in Distribution of Occupational Fatalities by Type of Construction

[15] Note that the data of fatalities are tabulated for the calendar year, whereas the data of the construction investment are tabulated for the fiscal year.



Source: Japan Industrial Safety and Health Association (JISHA), *Anzen-Eisei-Nenkan (Yearbook of Industrial Safety and Health)*, 1985-1995.
Ministry of Construction, Government of Japan, *Kensetu-Tokei-Yoran*, 1985-1995.

Note: The data of deaths are tabulated for the calendar year by JISHA.
The data of the construction investment are tabulated for the fiscal year by the Ministry of Construction of Japan.

Figure 3.17 Change in Number of Occupational Fatalities per One Trillion Yen of Construction Investment

3.2.4.3 Summary

The characteristics of occupational accidents in the Japanese construction industry are summarized as follows:

1) Although the number of occupational accidents in the construction industry is decreasing, the industry still accounts for the largest portion of occupational accidents in Japan; 30 % of casualties, 40 % of fatalities, and 40 % of grave accidents involving three or more casualties.

2) The frequency rate of the construction industry is almost the same as the average rate of all industries. However, the incidence rate and the severity rate of the construction industry are higher than the average rates of all industries.

3) The rate of occupational accidents by small construction establishments is increasing. Member companies of the Labour Insurance Affairs Union account for about 50 % of the accidents. The member companies and establishments with fewer than 100 employees account for more than 90 % of the accidents.

4) The rate of occupational accidents by aged employees is increasing. In 1994, employees older than 50 years old accounted for roughly 50 % of the casualties in the construction industry.

5) The incidence rates of aged and young employees are high. One can deduce that this is because of the physical decline of aged employees and the inexperience of young employees.

6) Falls are the leading cause of fatal accidents, accounting for about 40 % of the accidents, and this preponderance of fatalities by falls results from the aging of workers in the industry. Falls, construction machinery, and motor vehicles are the major types of accidents, accounting for more than 60 % of all accidents.

7) In recent years, the rate of occupational accidents by construction machinery is increasing. This is presumably due to the introduction of innovative machinery requiring new skills and experience to maneuver.

8) Civil engineering works used to account for a larger portion of fatal accidents than building works. In recent years, however, the proportion of civil engineering works has decreased, whereas that of building works has increased. In 1994, civil engineering and building works accounted for about 45 % each.

9) A comparison of the number of fatalities per one trillion yen of construction investment shows that civil engineering works involve occupational accidents more frequently than building works.

3.3 Occupational Accidents in the U. S. Construction Industry

3.3.1 Historical Review

Because of the huge country and independent states with strong municipal power, the U. S. strove to establish nationwide occupational safety and health regulations for many years. In the U. S., the first occupational safety and health laws were enacted at the state level in the late 1800s, and after a series of state laws, the comprehensive federal regulation known as the Occupational Safety and Health Act (OSH Act) was promulgated in 1970.

The first coal mine inspection act passed in Pennsylvania in 1869. Eight years later in 1877, Massachusetts passed the first factory inspection law requiring employers to put barriers or guards around heavy machinery and requiring regular inspection by official inspectors of state factories (de Waziers 1977).

The Safety Appliances Act enacted in 1893 was the first federal safety and health regulation to secure the safety of employees engaged in interstate railroad systems. The movement toward federal regulations on occupational safety and health inspired several states to enact their own occupational safety and health laws. In 1913, the Department of Labor (DOL) was founded.

In 1936, the Walsh-Healey Public Contract Act was passed, prescribing health and safety standards for employees working under federal contracts. The Walsh-Healey Act was the first federal law under which health and safety in the construction industry was clearly specified.

The U.S. involvement in World War II caused heavy casualties from occupational accidents because many skilled workers were replaced by unskilled workers. This undesirable situation attracted great attention and concern about safety and health for employees.

Consequently, in the 1940s and 1950s, a series of political actions was conducted to establish nationwide safety and health regulations: the first Presidential conference on Industrial Safety was called by President Truman in 1948; a bill was introduced by Senator Hubert Humphrey in 1951 calling for uniform safety codes and enforcement; and a bill was introduced by Representative Lenore Sullivan in 1958 calling for mandatory standards for the safe use of hazardous materials in industry (Blosser 1992). Both bills failed to pass, but the upsurge of nationwide safety and health regulations continued through the 1960s, and finally led to the enactment of the OSHA in 1970.

In 1968, President Lyndon B. Johnson proposed legislation for a federal occupational safety and health regulatory program, but it failed to pass Congress. This failure spurred serious congressional debate in the two Houses between the Majority Democrats and the Administration Republicans on legislation to establish nationwide safety and health regulations.

In 1969, the House passed the Administration's bill (H.R. 19200) sponsored by Congressmen Steiger and Sikes as an amendment to the Majority's Bill (H.R. 16785) approved by the Committee. The Steiger-Sikes Bill was for the dilution of resolution authority, and proposed assignment of various responsibilities to three different agencies. In the Senate, the Majority's measure (S. 2193) was introduced by Democratic Senators Harrison Williams, Edward Kennedy, Walter Mondale, and Ralph Yarborough, proposing the concentration of authority such as standards setting, enforcement, and adjudication to DOL. After a series of amendments proposed by Senators Jacob Javits and Peter Dominick was accepted, the Majority's bill was passed by the Senate.

Eventually, a compromise between the two bills was attained through five sessions of the Joint Committee of the two Houses. The compromised bill was approved by the Senate on December 15, 1970, and by the House on December 17, 1970. On December 29, the bill was signed by President Nixon into the first nationwide safety and health law, the Occupational Safety and Health Act of 1970 (Pub. L. No. 91-596). Under this new law, the Occupational Safety and Health Administration (OSHA) and the Occupational Safety and Health Review Commission (OSHRC) were established independently in DOL for standards setting and enforcement and for adjudication, respectively. The OSH Act authorizes OSHA to regulate private employers in the 50 states, the District of Columbia, Puerto Rico, the Virgin Islands, American Samoa, Guam, the Trust Territory of the Pacific Islands, and other U.S. territories. According to the latest figures from DOL, the Act covers over 100 million workers. The Act also permits states and territories to adopt and enforce their own occupational safety and health plans with the provision that they must adopt standards identical to, or at least as effective as, those promulgated under the OSH Act, and their plans must be approved by the Secretary of Labor. Twenty three states and territories operate their own occupational safety and health regulations.

3.3.2 Statistics on Occupational Accidents in the U.S.

The OSH Act requires each employer to make, keep and preserve, and make available to the Secretary of Labor, Health, Education, and Welfare records on occupational injuries and illnesses. The Act also requires the Secretary of Labor, in consultation with the Secretary of Health, Education, and Welfare, to develop and maintain an effective program to collect, compile, tabulate, and analyze statistics on occupational injuries and illnesses. Therefore, DOL has conducted a nationwide annual survey on occupational injuries, illnesses, and fatalities on a sample basis by selecting about 280,000 private sector establishments. The results of the survey are presented in an annual bulletin, the *Occupational Injuries and Illness in the United States by Industry*, issued by the Bureau of Labor Statistics (BLS) of DOL. This sample survey, however, is incomplete in measuring correctly such relatively rare incidents as fatal occupational injuries[16]. Consequently, BLS, in cooperation with state and federal agencies[17], developed a comprehensive survey of fatal occupational injuries, *Census of Fatal Occupational Injuries (CFOI)*, in 1991, and has administered the census ever since. On the other hand, the National Safety Council (NSC) also annually collects, compiles, tabulates, and analyzes statistics on occupational injuries and illnesses submitted by its member establishments in accordance with the OSH Act. NSC presents the results of its survey in its annual report, the *Work Injury & Illness Rates*.

The Recordkeeping Requirements prescribed under the OSH Act define recordable occupational injuries and illnesses each employer must record as below (*Guidebook to Occupational Safety and Health: 1977 Edition*, 1977):

- Fatalities, regardless of the time between the injury and death, or the length of the illness; or,
- Nonfatal cases with lost workdays[18] in which a nonfatal injury or illness results in the loss of work by an employee for one or more days during which the employee would have worked but could not because of occupational injury and illness; or,
- Nonfatal cases without lost workdays in which a nonfatal injury or illness results in restriction of work activity: (1) transfer of the employee to another

[16] Occupational fatalities estimated by different organizations vary greatly from 3,000 to 11,000 nationally per year, for example 2,900 by BLS in 1990, 10,500 by NSC in 1990, and 5,700 by the National Institute for Occupational Safety and Health (NIOSH) in 1989.

[17] Thirty-two States and New York City compiled data on fatal occupational injuries in 1991, and all fifty States have participated in the census since 1992, to compile the data.

[18] Note that the day the employee sustains the injury or is taken ill is not counted as the lost workdays.

job, (2) discharge of the employee, (3) loss of consciousness, (4) restriction of work or motion, (5) the rendering of medical treatment excluding first aid to the employee, (6) a diagnosis of occupational illness.

3.3.3 Indices of Occupational Accidents in the U.S.

The Bureau of Labor Statistics and the National Safety Council calculate the incidence rate of occupational injuries (and/or illness), based on the statistics on: (1) Lost workday cases, (2) Cases involving days away from work, and (3) Cases involving days of restricted work activity.

1) *Incidence Rate*

The incidence rate represents the number of injuries (and/or illnesses), lost workdays, days away from work, or days of restricted work activity per 100 (or 10,000) full-time workers and are calculated as: (N/H) x 200,000 (or 20,000,000) where,

N = number of injuries (and/or illnesses), lost workdays, days away from work, or days of restricted work activity

EH = total hours worked by all employees during the calendar year

200,000 = base for 100 full-time equivalent workers (working 40 hours per week, and 50 weeks per year)

20,000,000 = base for 10,000 full-time equivalent workers (working 40 hours per week, and 50 weeks per year)

2) *Lost Workdays*

Lost workday cases are cases involving days away from work, or days of restricted work activity, or both. Therefore, lost workdays are the sum of days away from work and days of restricted work activity.

3) *Days Away From Work*

Days away from work represent the number of workdays (consecutive or not) on which the employee would have worked but could not because of occupational injury or illness.

4) *Days of Restricted Work Activity*

Days of restricted work activity represent the number of workdays (consecutive or not) on which, because of occupational injury or illness:

i) The employee was assigned to another job on a temporary basis; or,
ii) The employee worked at permanent job less than full time; or,
iii) The employee worked at a permanently assigned job but could not perform all duties normally concerned with it.

Note that the number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked although able to work.

3.3.4 Analysis of Occupational Accidents in Construction Industry

3.3.4.1 Current Situation of Occupational Accidents

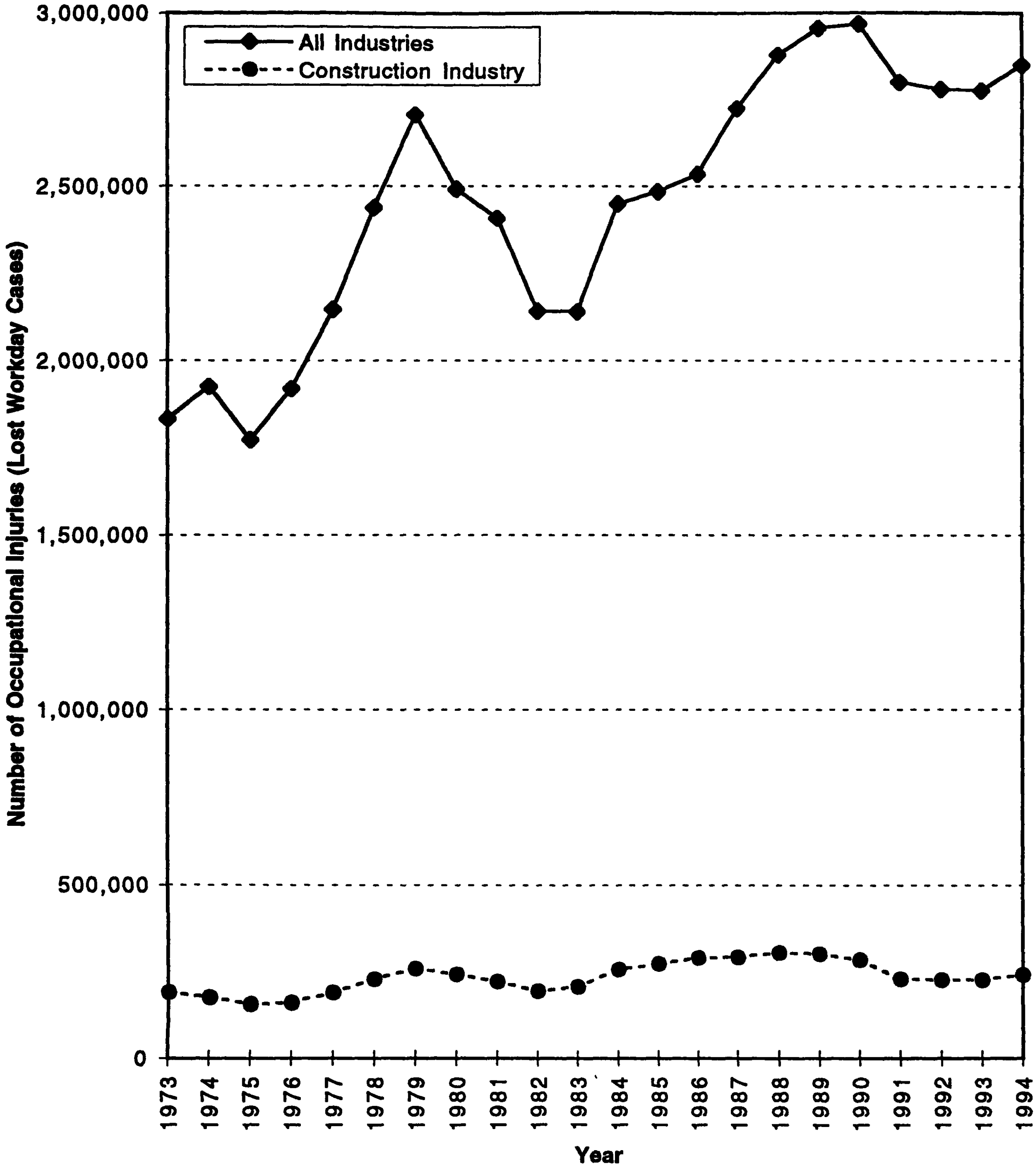
The trend of occupational accidents of the U.S. construction industry is illustrated in Figures 3.18 to 3.19, in comparison with the trend of all industries in the U.S. Figure 3.18 shows the change in the number of nonfatal occupational injuries with lost workdays, and Figure 3.19 shows the change in the number of fatal occupational injuries and illnesses[19]. Figure 3.18 demonstrates nonfatal occupational injuries in the U.S. have

[19] Data from 1973 to 1991 include fatal occupational illnesses, because the numbers of fatal occupational illnesses are not specified in the original data sources, *Occupational Injuries and Illnesses in the United States by Industry* administered by the Bureau of Labor Statistics (BLS). Based on the data shown in the data sources, it seems about 1 to 3 % of fatalities are caused by occupational illnesses resulting from heart attacks, gas inhalations, and so on. The numbers of fatal injuries from 1992 to 1994 are cited from Census of Fatal Occupational Injuries (CFOI) which has been administered by BLS in cooperation with state and federal agencies since 1991.

been on an upward trend since the promulgation of the OSH Act in 1970. The total number of occupational injuries with lost workday cases reached 2,848,300 in 1994, which is more than 1.5 times as many as that recorded in 1973. In 1994, the construction industry incurred 241,700 injuries, accounting for 8.5 % of the total injuries of this year. As shown in Figure 3.19, the Census of Fatal Occupational Injuries (CFOI) reveals fatal occupational injuries increased in the U.S. industries from 1992 to 1994. In 1994, 5,923 fatalities are rostered by the census for private sectors[20], of which the construction industry incurred 1,027 fatalities and accounted for 17.3 % of the total fatalities.

The U.S. situation of occupational injuries and fatalities illustrated by Figures 3.18 and 3.19 presents a remarkable contrast to the Japanese situation illustrated by Figures 3.1 and 3.2; occupational injuries and fatalities have decreased in Japan after the enactment of the Industrial Safety and Health Law in 1972, whereas in the U.S., they are increasing despite the enactment of the OSH Act in 1970. This comparison provokes a simple question: whether the OSH Act has been really effective in reducing injuries and fatalities caused by occupational accidents? OSHA exaggerates its success stories by saying that the overall occupational fatality rate has been cut in half and more than 100,000 workers' lives have been saved since 1970 because of the improvement of occupational safety and health by the Act. But, how does OSHA explain the increase of occupational injuries after the Act? The increasing occupational injuries provoke an ironical argument over OSHA's success stories.

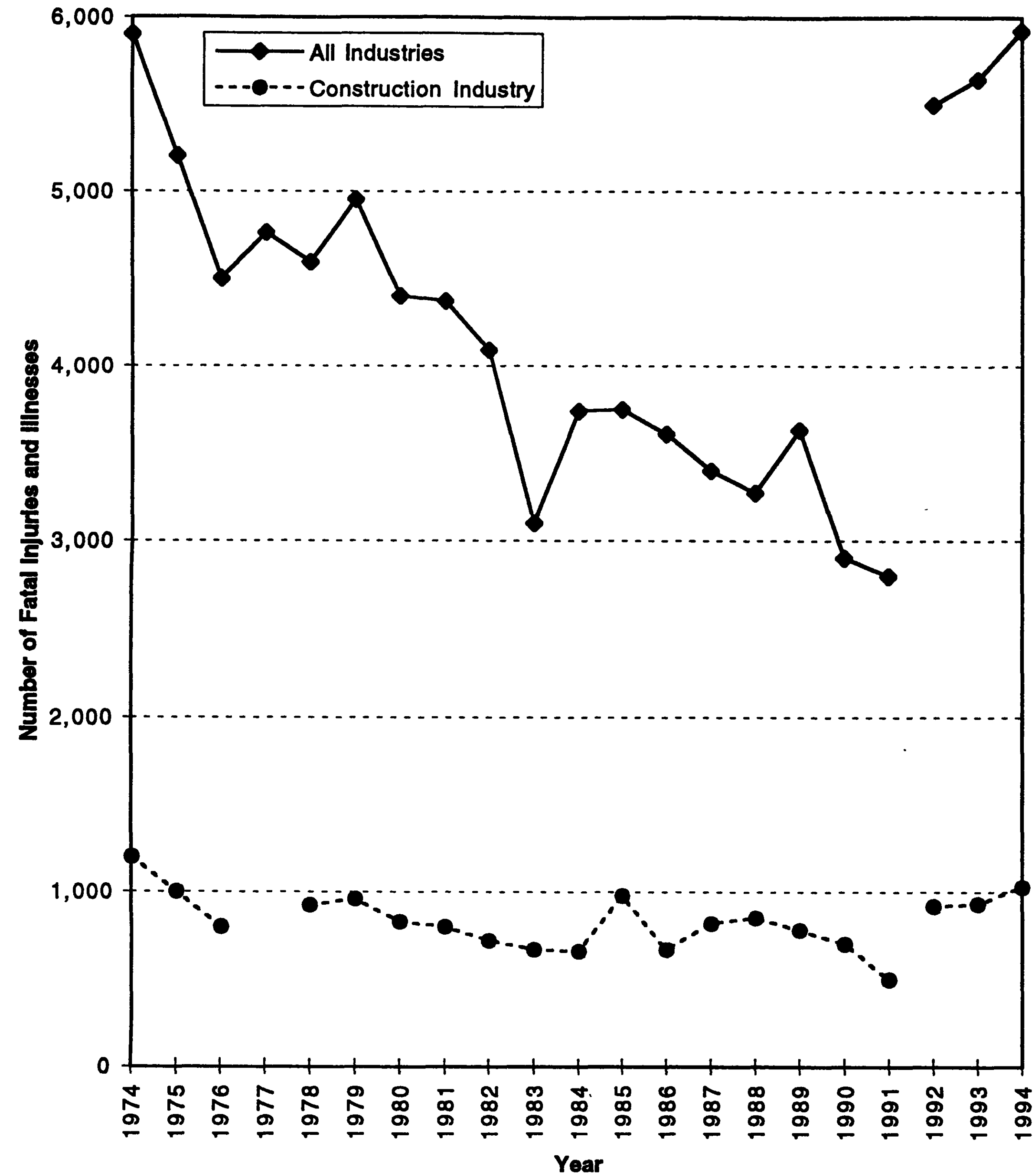
[20] CFOI includes the statistics on occupational fatalities by federal, state, and local governments.



Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States, 1973-1989*, *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992*, *Survey of Occupational Injuries and Illnesses, 1993*, and *Workplace Injuries and Illnesses in 1994*.
International Labour Office, Geneva, *Yearbook of Labour Statistics, 1980-1995*.

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

Figure 3.18 Change in Number of Nonfatal Occupational Injuries with Lost Workdays in the U.S.

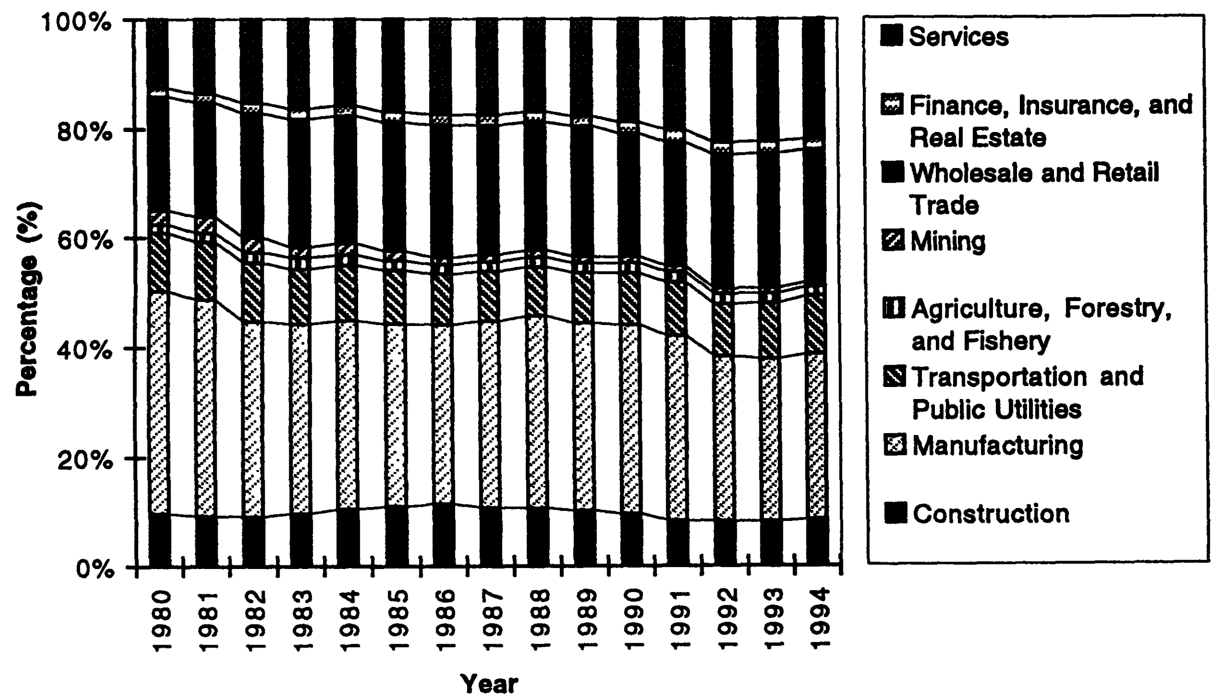


Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States by Industry, 1973-1989.*
Bureau of Labor Statistics, U.S. Department of Labor, in Cooperation with State and Federal Agencies, *Census of Fatal Occupational Injuries and Illnesses, 1992-1994.*
International Labour Office, Geneva, *Yearbook of Labour Statistics, 1981-1995.*

Note: Data from 1974 to 1991 are those of private sectors excluding firms with fewer than 11 employees, and include fatal occupational illnesses resulting from heart attacks and gas inhalations.

Figure 3.19 Change in Number of Fatal Occupational Injuries and Illnesses in the U.S.

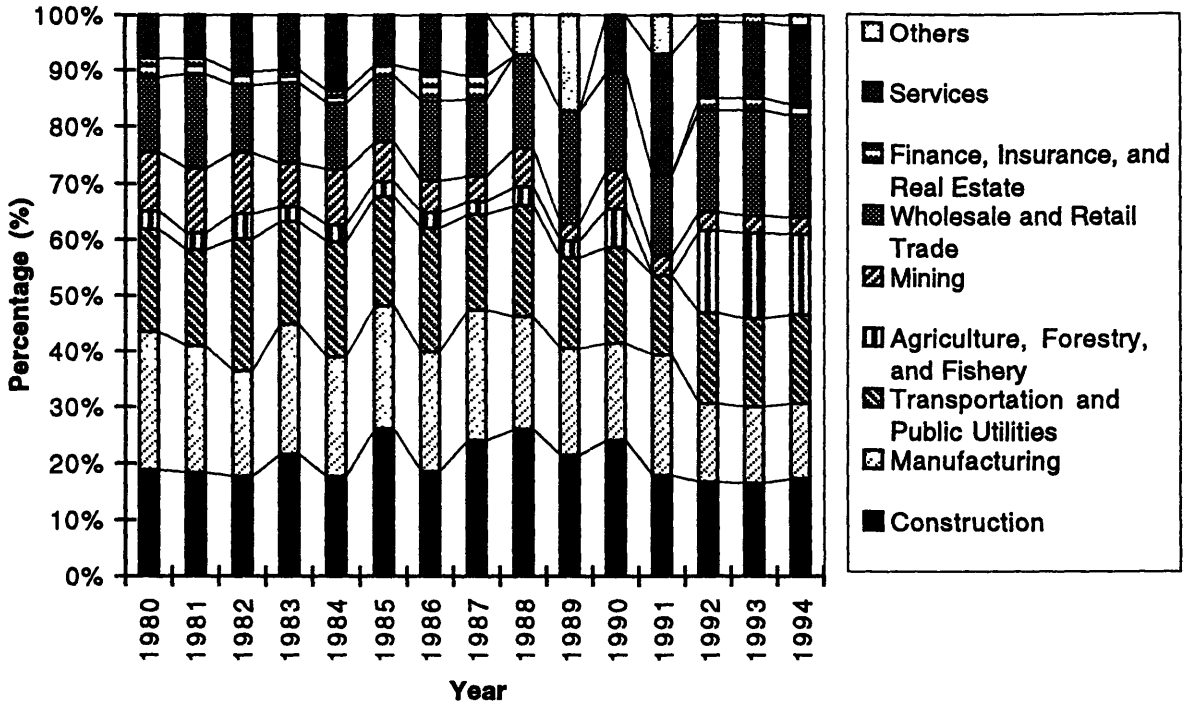
Figures 3.20 and 3.21 show the breakdown by industry of nonfatal occupational injuries with lost workdays and fatal occupational injuries and illnesses respectively. The U.S. construction industry accounts for about 10 % of nonfatal injuries and 15 to 20 % of fatal injuries, which are significantly lower than the percentages of these two categories that the Japanese construction industry accounts for (see Figures 3.4 and 3.5).



Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States, 1973-1989*, *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992*, *Survey of Occupational Injuries and Illnesses, 1993*, and *Workplace Injuries and Illnesses in 1994*.
International Labour Office, Geneva, *Yearbook of Labour Statistics, 1980-1995.*

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

Figure 3.20 Change in Distribution of Nonfatal Occupational Injuries with Lost Workdays by Industry in the U.S.



Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States by Industry, 1973-1989.*
Bureau of Labor Statistics, U.S. Department of Labor, in Cooperation with State and Federal Agencies, *Census of Fatal Occupational Injuries and Illnesses, 1992-1994.*
International Labour Office, Geneva, *Yearbook of Labour Statistics, 1981-1995.*

Note: Data from 1994 to 1991 are those of private sectors excluding firms with fewer than 11 employees, and include fatal occupational illnesses resulting from heart attacks and gas inhalations.

Figure 3.21 Change in Distribution of Fatal Occupational Injuries and Illnesses by Industry in the U.S.

Although the construction industry accounts for a relatively small portion of nonfatal and fatal occupational injuries of all the U.S. industries, the industry is subjected to high incidence rates of occupational injuries (see Figures 3.22 and 3.23). As illustrated in Figures 3.22 and 3.23, the construction industry incurs higher incidence rates of nonfatal and fatal occupational injuries than the average incidence rates of all industries. Although deviations of these incidence rates between the construction industry and all industries are shrinking with the years, the construction industry is subjected to higher incidence rates than all industries. In 1994, the nonfatal occupational injury incidence rate (per 200,000 man-hours worked or 100 full-time workers) incurred by the construction industry is 5.4, which is about 1.5 times as high as the average rate 3.5 of all industries.

Similarly, in 1994, the fatal occupational injury incidence rate (per 1,000,000 man-hours worked) of the construction industry is 0.071, whereas the average rate of all industries is 0.031[21].

Consequently, both in the U.S. and in Japan, the construction industry can be regarded as an industry that involves relatively high rates of occupational accidents. Figures 3.7, 3.9, 3.22, and 3.23 emphasize this characteristic of the construction industry.

To compare occupational safety between the U.S. and Japanese construction industries, fatal occupational injury incidence rates (per 1,000,000 man-hours worked) are computed for the industries[22] as shown in Figure 3.24. It is notable that both industries have drastically reduced the rates over the last two decades: from 0.160 to 0.071 in the U.S. and from 0.192 to 0.070 in Japan. Before 1970, the Japanese construction industry was subjected to the higher incidence rates than the U.S. construction industry. However, in the 1970s, the situation changed; the incidence rates of the Japanese construction industry fell slightly below the rates of the U.S. construction industry. Thus, from the late 1970s to 1980s, the incidence rates were higher in the U.S. than in Japan. It was not until 1991 that the U.S. construction industry reduced the incidence rate to the level on a par with its Japanese counterpart. In recent years, there have been no significant differences between the incidence rates incurred by the U.S. and Japanese construction industries.

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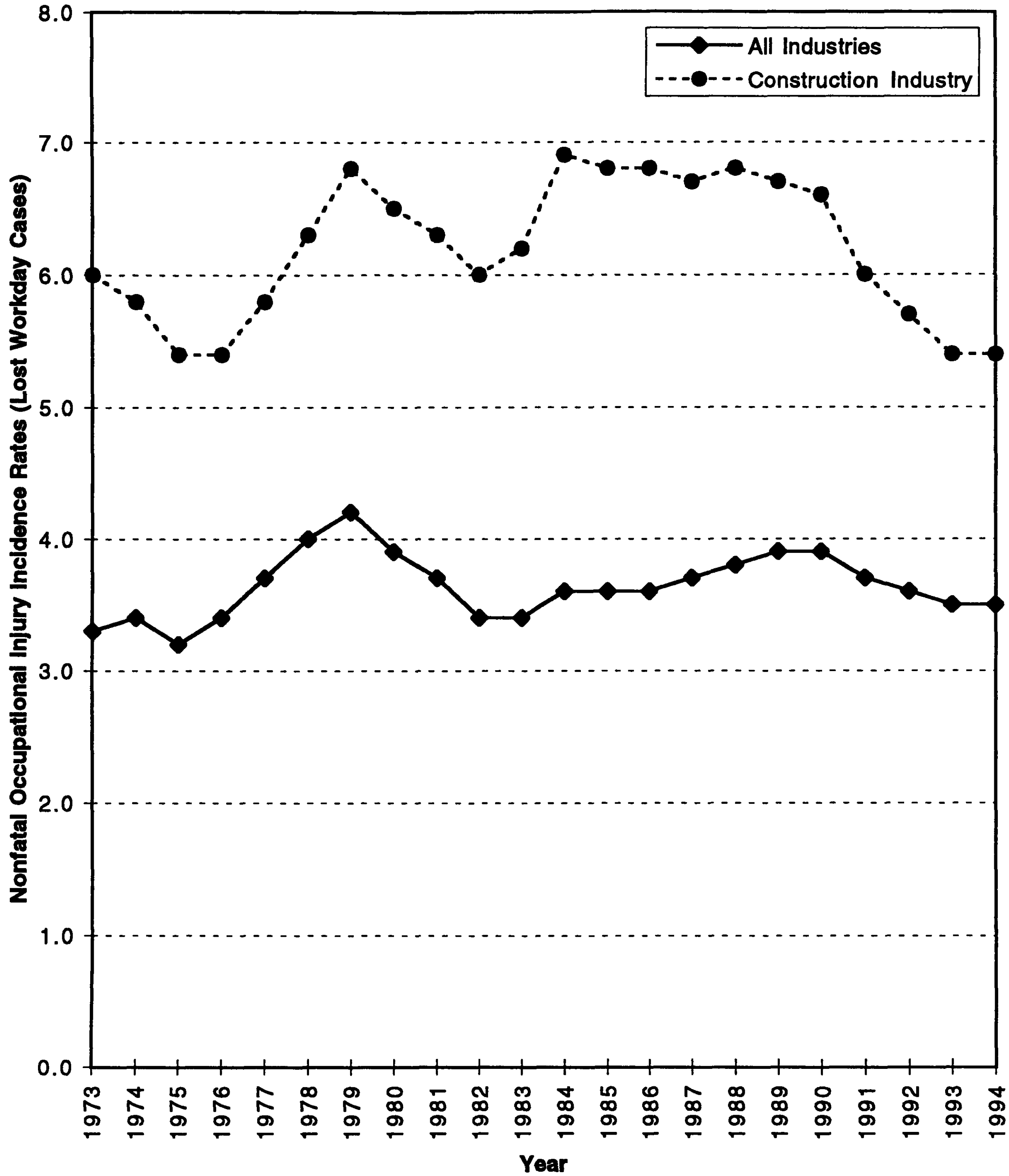
[21] The fatal occupational injury incidence rates per 1,000,000 man-hours worked are computed by the author for 1992 to 1994, based on fatalities presented in CFOIs of theses years. The author estimates the total annual man-hours worked by multiplying the total annual labor force by the average weekly working hours times 50 weeks.

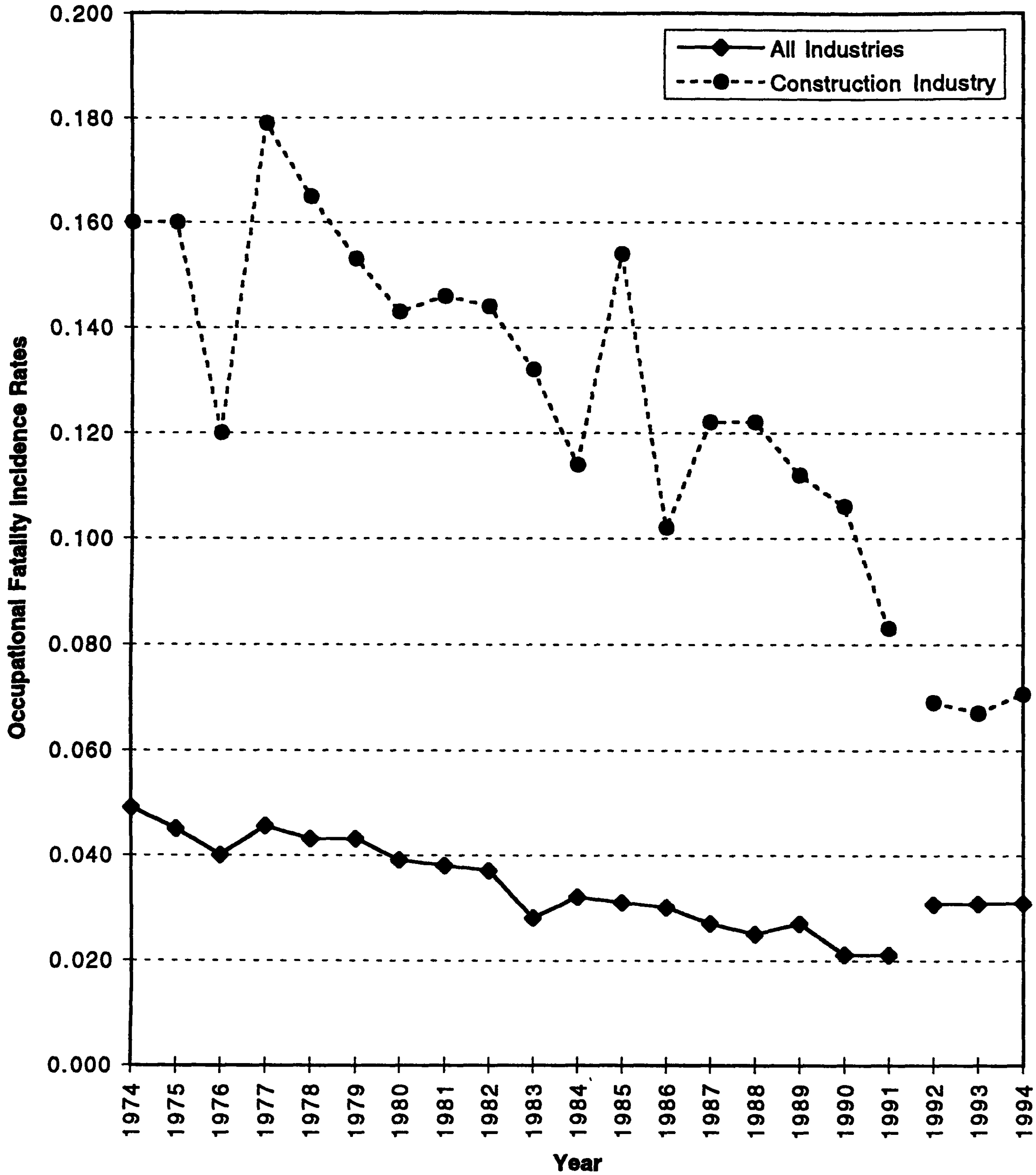
[22] The fatal occupational incidence rates for the Japanese construction industry are computed by the author. To compute the incidence rates, the author estimates the total annual man-hours worked in the same way used to compute the rates shown in Figure 3.11, i.e. by multiplying the total annual labor force by the monthly average working hours times 12 months. The incidence rates for the U.S. industry are identical to those computed for Figure 3.23 (refer to the Footnote above).



Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States, 1973-1989*, *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992*, *Survey of Occupational Injuries and Illnesses, 1993*, and *Workplace Injuries and Illnesses in 1994*.

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

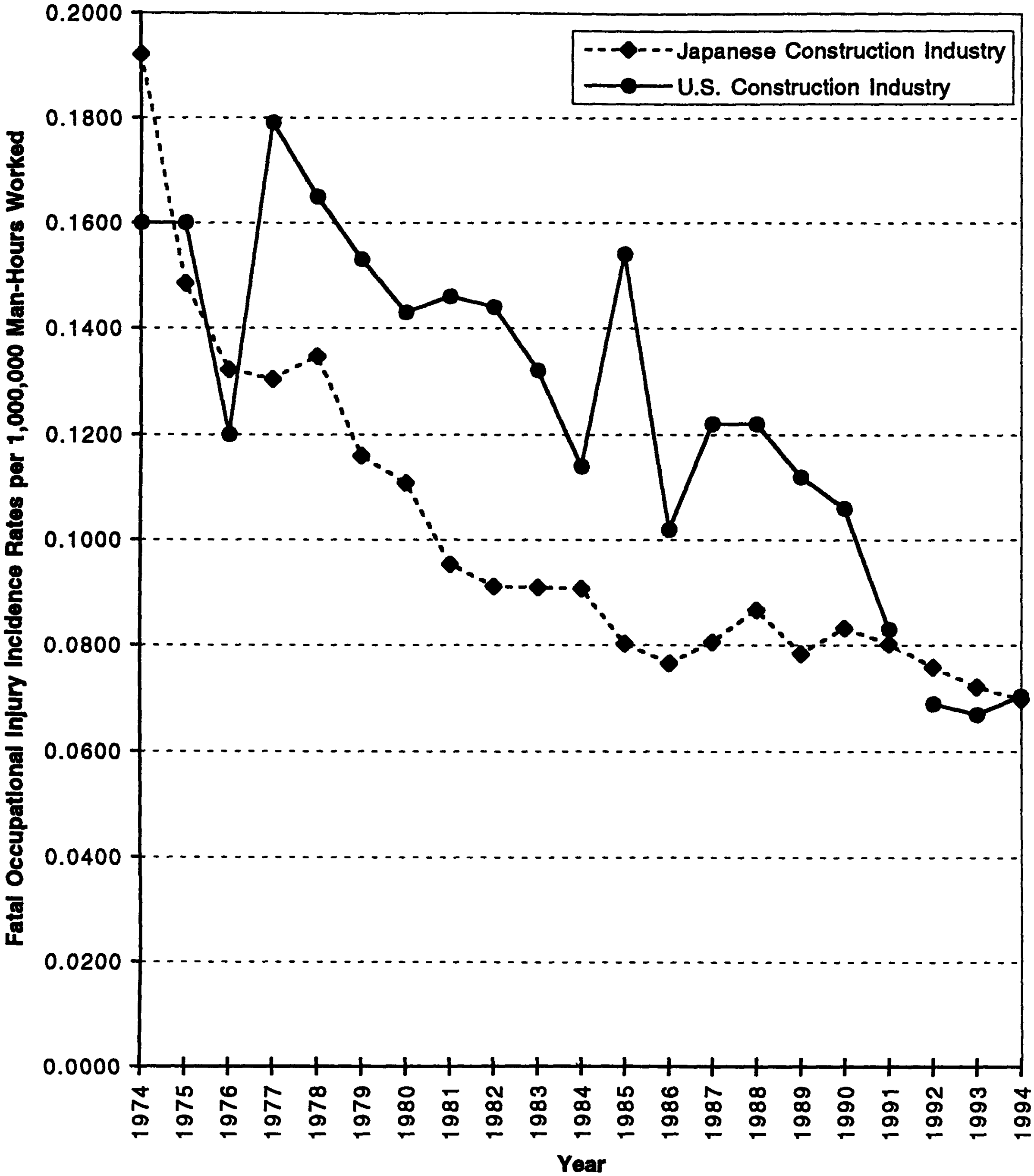
Figure 3.22 Change in Nonfatal Occupational Injury Incidence Rates per 2 00,000 Hours Worked (= per 100 Full-Time Workers) for Lost Workday Cases in the U.S.



Source: Bureau of Labor Statistics, U.S. Department of Labor, in Cooperation with State and Federal Agencies, *Census of Fatal Occupational Injuries, 1992-1994.*
International Labour Office, Geneva, *Yearbook of Labour Statistics, 1981-1995.*

Note: Data for 1974 to 1991 are those of private sectors excluding firms with fewer than 11 employees, and include fatal occupational illnesses resulting from heart attacks, gas inhalations, and so on. Fatal occupational injury incidence rates are calculated by the author for 1992 to 1994.

Figure 3.23 Change in Fatal Occupational Injury and Illness Incidence Rates per 1,000,000 Hours Worked in the U.S.

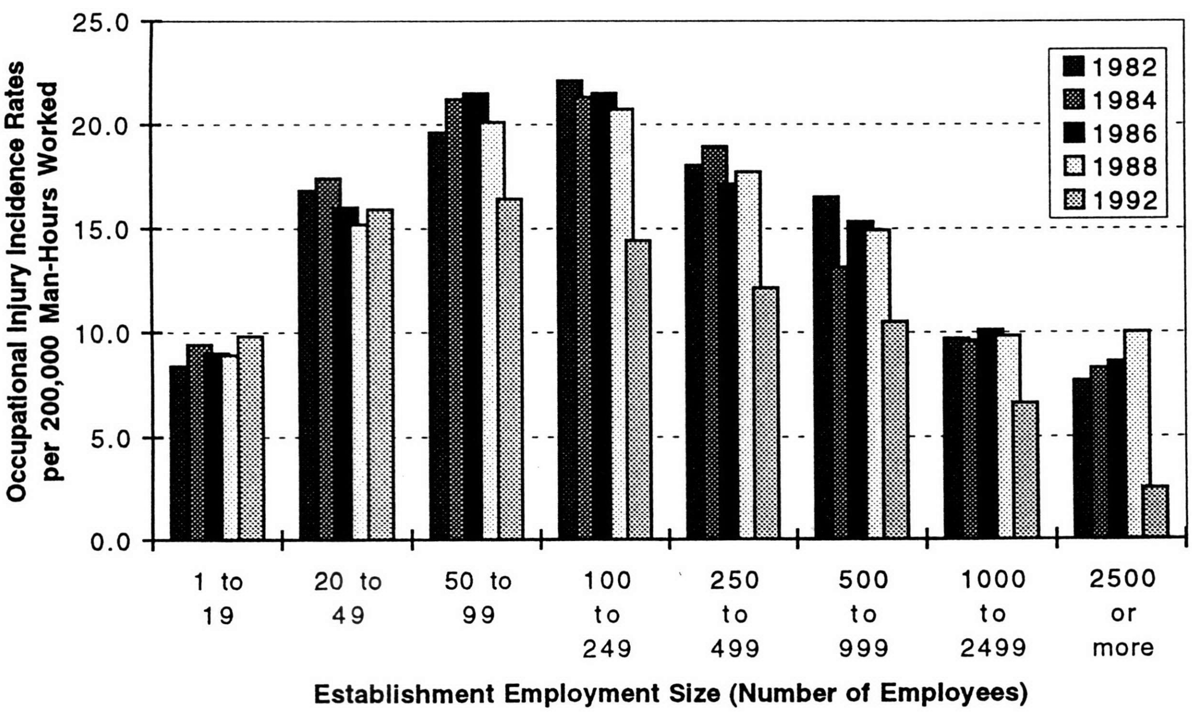


Source: Bureau of Labor Statistics, U.S. Department of Labor, in Cooperation with State and Federal Agencies, *Census of Fatal Occupational Injuries, 1992-1994.*
International Labour Office, Geneva, *Yearbook of Labour Statistics, 1981-1995.*
Japan Construction Safety and Health Association (JCSHA), *Kensetugyo-Anzen-Eisei-Nenkan (Yearbook of Construction Safety and Health), 1975-1995.*
Policy Planning and Research Department, Minister's Secretariat of Japan, Ministry of Labour, *Year Book of Labour Statistics, 1974-1994.*

Figure 3.24 Comparison of Fatal Occupational Injury Incidence Rates per 1,000,000 Man-Hours Worked between the U.S. and Japanese Construction Industries

3.3.4.2 Characteristics of Occupational Accidents

The U.S. construction industry differs in several characteristics of occupational accidents from those of the Japanese construction industry. One such characteristic is illustrated in Figure 3.25 which shows changes in occupational injury incidence rates per 20,000 man-hours worked (= per 100 full-time workers) for eight employment sizes of construction establishments. The figure reveals the incidence rates are low for small establishments with 1 to 19 employees and large companies with 1,000 or more employees, and high for middle size establishments with 50 to 500 employees. In Japan, in contrast, small construction establishments incur higher incidence rates than large ones (see Figure 3.11).

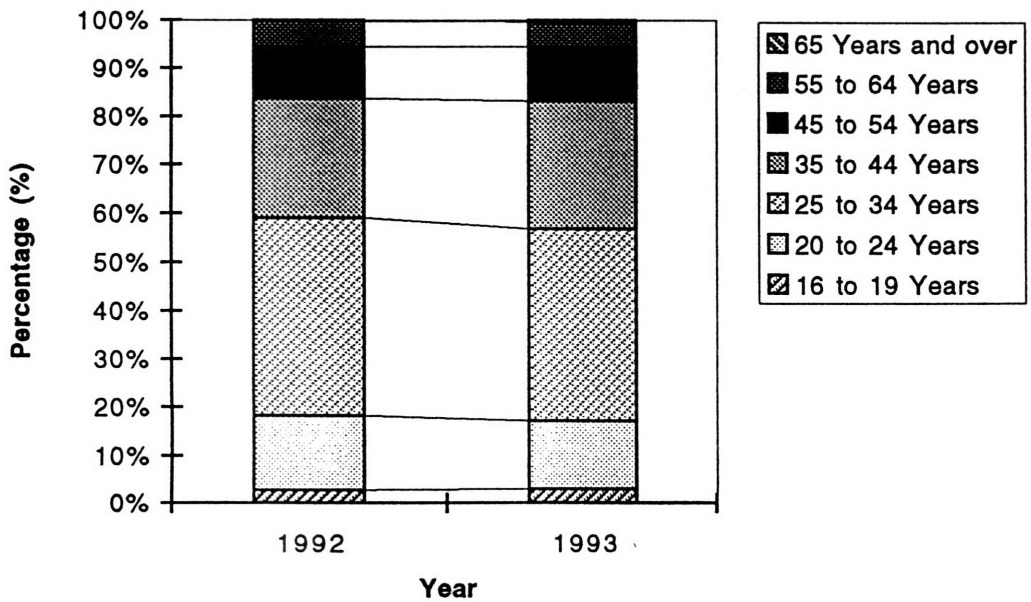


Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States, 1973-1989,* and *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992.*

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

Figure 3.25 Distribution of Nonfatal Occupational Injury Incidence Rates per 200,000 Man-Hours Worked (= per 100 Full-Time Workers) by Construction Establishment Employment Size

The distribution of occupational injuries by age group also presents a significant contrast to that of the Japanese construction industry. As shown in Figure 3.26, workers aged 55 years old and over account for only about 10 %, though workers aged under 35 years old incur about 60 % of nonfatal injuries in the U.S. construction industry. On the other hand, currently in Japan, about 50 % of occupational injuries (including fatal injuries) are incurred by workers older than 50 years old because of the rapid increase of aged workers in the industry (see Figure 3.12). In the U.S., the aging of workers is not so serious. Workers older than 50 years old account for less than 20 % and workers older than 60 years old account for only 6% in the U.S. in 1993, whereas they account for about 31 % and 13 %, respectively in Japan.



Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992*, and *Work Injuries and Illnesses by Selected Characteristics, 1993*.

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

Figure 3.26 Distribution of Nonfatal Occupational Injuries by Age Group

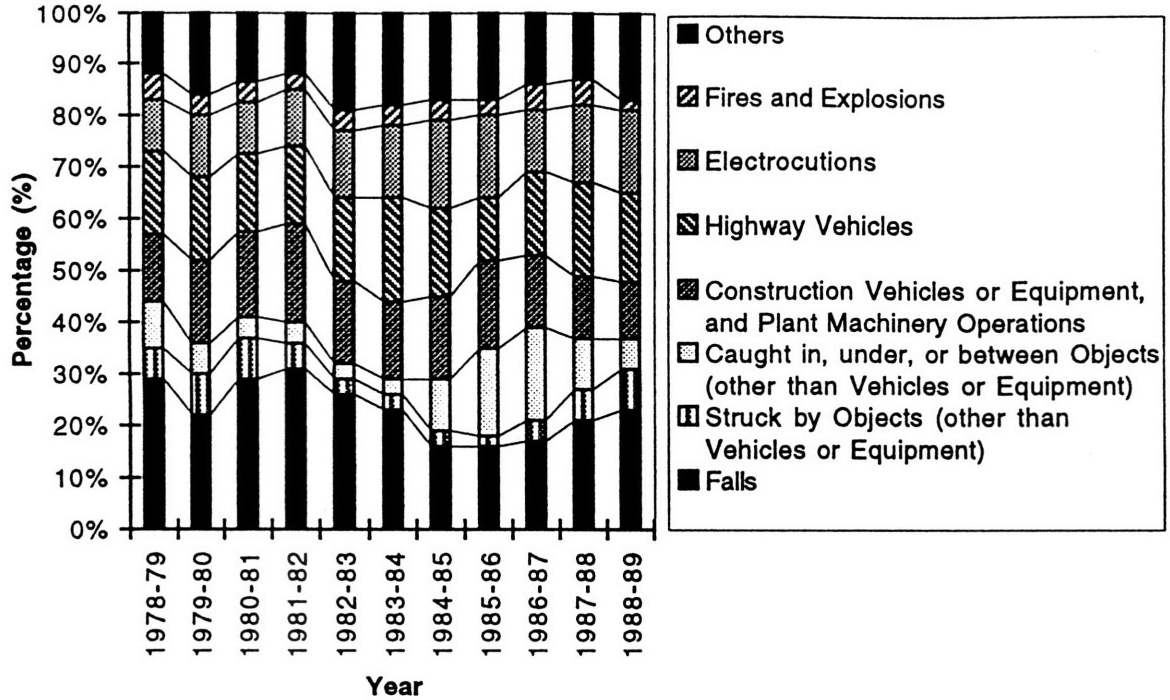
The next different characteristic of occupational accidents in the U.S. construction industry is illustrated by the distribution of fatal occupational injuries and illnesses by cause shown in Figure 3.27[23] [24]. In a comparison of Figure 3.27 with Figure 3.14, it is clear that falls account for smaller percentages of the fatalities, and electrocutions, fires and explosions account for larger percentages in the U.S. construction industry than the Japanese construction industry: 20 % to 30 % by falls (about 40 % in Japan) and 20 % by electrocutions, fires and explosions (about 5 % in Japan)[25]. Heavy fatalities by falls in the Japanese construction industry are attributable to the aging of construction workers (see Figure 3.15). In contrast, because the aging of workers is not so serious in the U.S. construction industry, fewer occupational fatalities result from falls in the U.S. industry. On the other hand, fatalities caused by electrocutions, fires and explosions generally result from inappropriate work performed by specialist workers such as welders, plumbers, and electricians. Therefore, it is crucial to examine the education and training given to these specialists in the industry to illustrate the number of accidents by these causes. Moreover, since welding and electrical work require confusing cabling and wiring for electricity, clean and tidy workplaces are necessary to prevent electricity-induced accidents. From the high proportion of fatality by electrocutions, it is deduced that cleaning and maintenance are not thoroughly undertaken in the U.S. construction industry[26].

[23] Data include fatal occupational illnesses resulting from heart attacks, gas inhalations, etc. See Footnote 18.

[24] Percentages that each fatality cause accounts for are the averages of the succeeding two years, because the original data presented in the sources, *Occupational Injuries and Illnesses in the United States by Industry (1973 to 1989)*, are the average of the two years. BLS comments that sampling errors are too large to provide reliable annual estimates at the industry division.

[25] Census of Fatal Occupational Injuries of 1993 administered by BLS indicates falls account for 29.5 % and electrocutions, fires and explosions account for 20.7 % of fatal occupational injuries occurred in the U.S. construction industry in 1993.

[26] The author has got this impression of cleaning and tidying in construction sites from his visits to the CA/T project and other building construction sites in Boston.

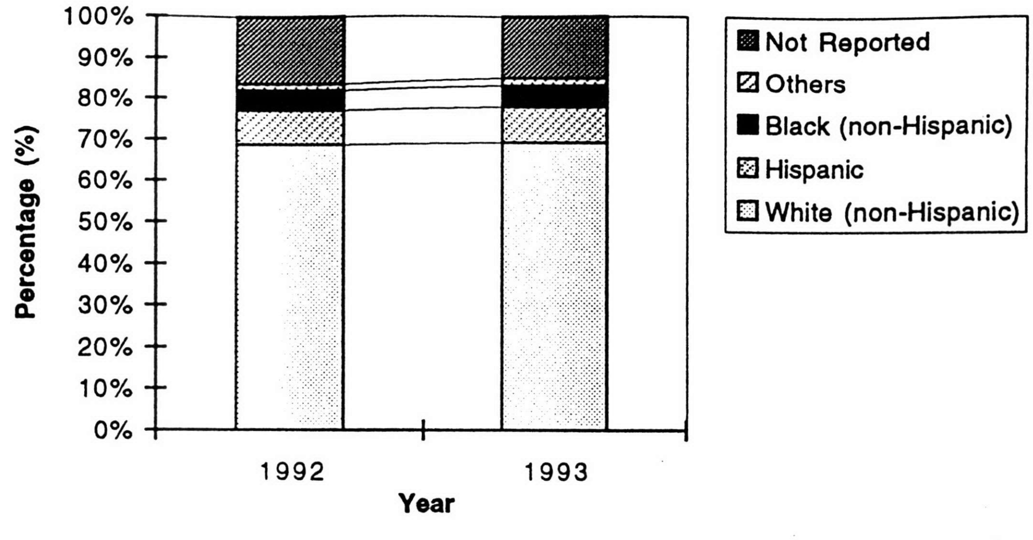


Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States, 1973-1989.*

Note: Data are those of private sectors excluding firms with fewer than 11 employees.
Data include fatal occupational illnesses resulting from heart attacks, gas inhalations, etc.

Figure 3.27 Distribution of Fatal Occupational Injuries and Illnesses by Cause

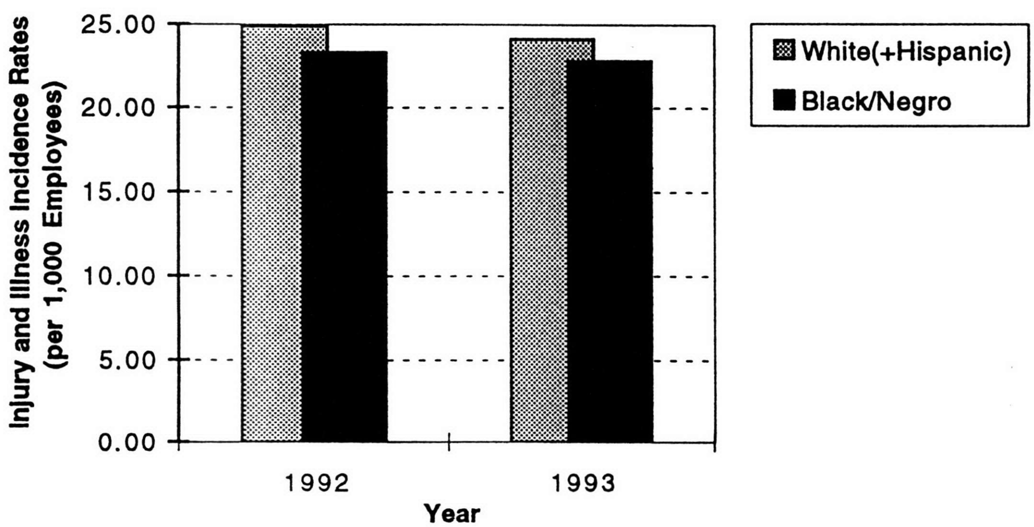
To examine racial characteristics of occupational injuries, Figure 3.28 shows the distribution by race of nonfatal occupational injuries and illnesses with lost workdays involving days away from work. White workers account for about 70 % of the total injuries, followed by Hispanic workers accounting for about 10 %. Black and other minority origin workers account for less than 10 % of the injuries. However, the high proportion of injuries and illnesses incurred by white and Hispanic workers does not necessarily mean their high vulnerability to occupational accidents. As shown in Figure 2.29, a comparison of occupational injury and illness incidence rates per 1,000 workers shows very slight difference between white and black workers. Note that it will be crucial for a comprehensive examination of the racial characteristics to calculate the incidence rates for White, Hispanic, Black, Asian, and other minority origin workers, respectively.



Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992*, and *Work Injuries and Illnesses by Selected Characteristics, 1993.*

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

Figure 3.28 Distribution of Nonfatal Occupational Injuries and Illnesses by Race with Lost Workdays Involving Days Away from Work



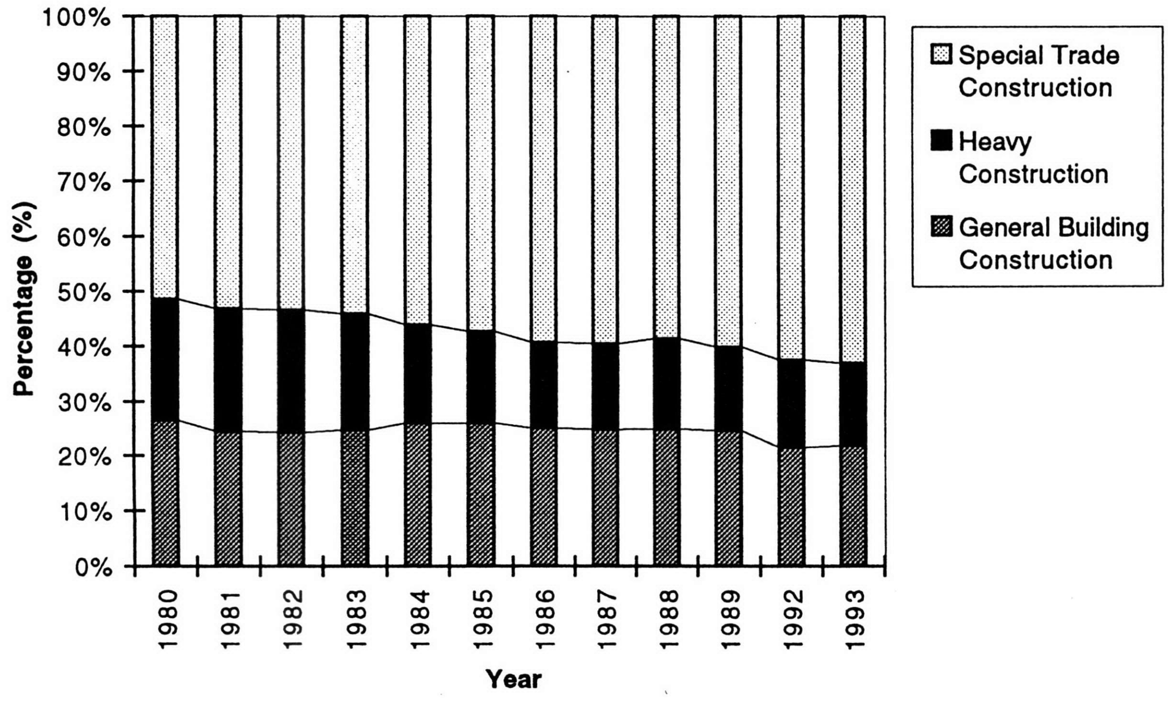
Source: Bureau of Labor Statistics, U.S. Department of Labor, *Labor Force Statistics from the Current Population Survey, Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992*, and *Occupational Injuries and Illnesses by Selected Characteristics, 1993.*

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

Figure 3.29 Nonfatal Occupational Injury and Illness Incidence Rates per 1,000 Employees by Race

Finally, occupational accidents in the U.S. construction industry are compared with respect to type of construction: general building construction, heavy construction (=

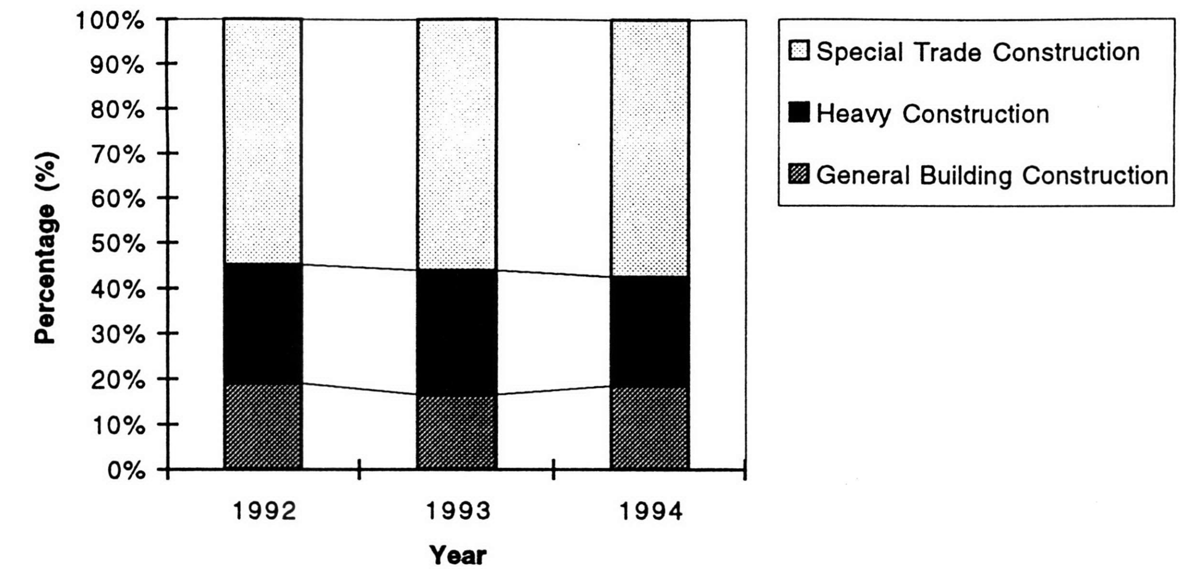
civil engineering works), and special trade construction (= equipment installation works) such as plumbing and electrical works. Figures 3.30 and 3.31 show the distribution of injuries with lost workdays and the distribution of fatal injuries and illnesses by type of construction, respectively. The figures illustrate that special trade construction incurs more than half of the total occupational accidents and the percentage it accounts for is increasing. The high percentage of occupational injuries and fatalities by special trade construction may result from the heavy fatalities caused by electrocutions, fires, and explosions as shown in Figure 3.27.



Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States by Industry, 1980-1989*, *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992*, and *Survey of Occupational Injuries and Illnesses, 1993*.

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

Figure 3.30 Change in Distribution of Occupational Injuries with Lost Workdays by Type of Construction



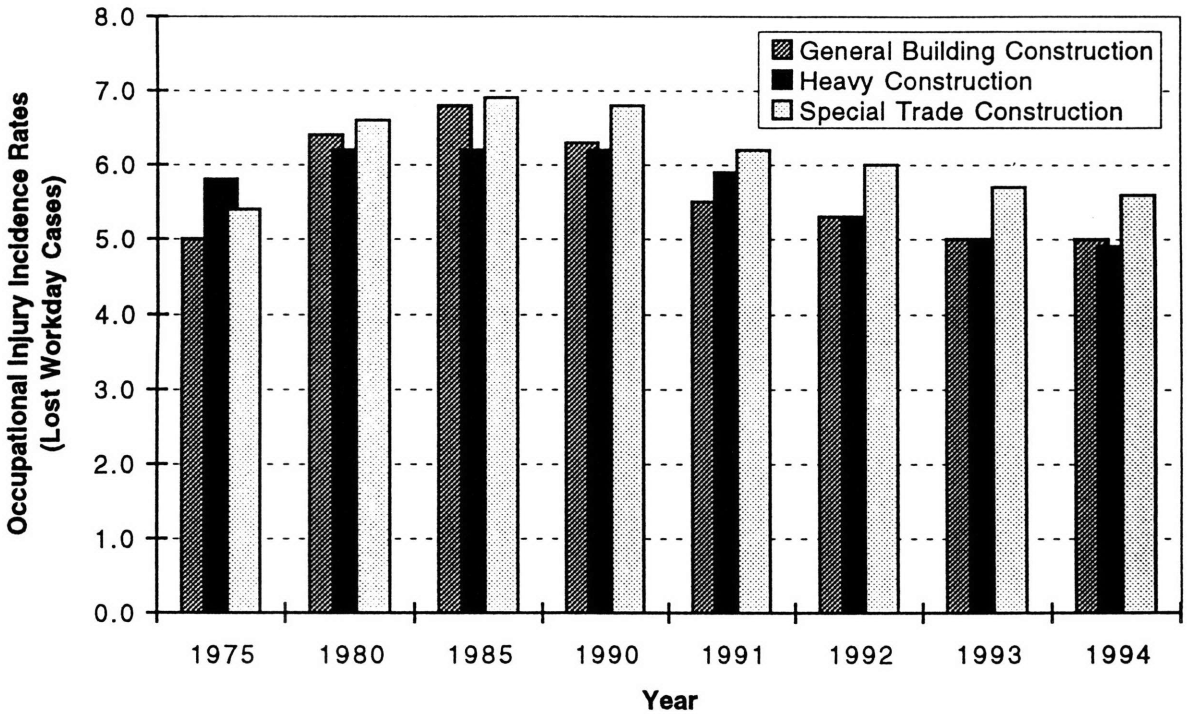
Source: Bureau of Labor Statistics, U.S. Department of Labor, in Cooperation with State and Federal Agencies, *Census of Fatal Occupational Injuries, 1992-1994.*

Note: Data include fatal occupational illnesses resulting from heart attacks, gas inhalations, etc.

Figure 3.31 Change in Distribution of Fatal Occupational Injuries and Illnesses by Type of Construction

Figure 3.32 shows incidence rates per 200,000 man-hours worked (= per 100 full-time workers) of nonfatal occupational injuries with lost workdays for the three types of construction. Although special trade construction shows higher incidence rates than general building and heavy construction for recent years, differences in incidence rates are small between the construction types. Therefore, there is little difference in nonfatal occupational injuries among the construction types, regardless of which construction works they are engaged in.

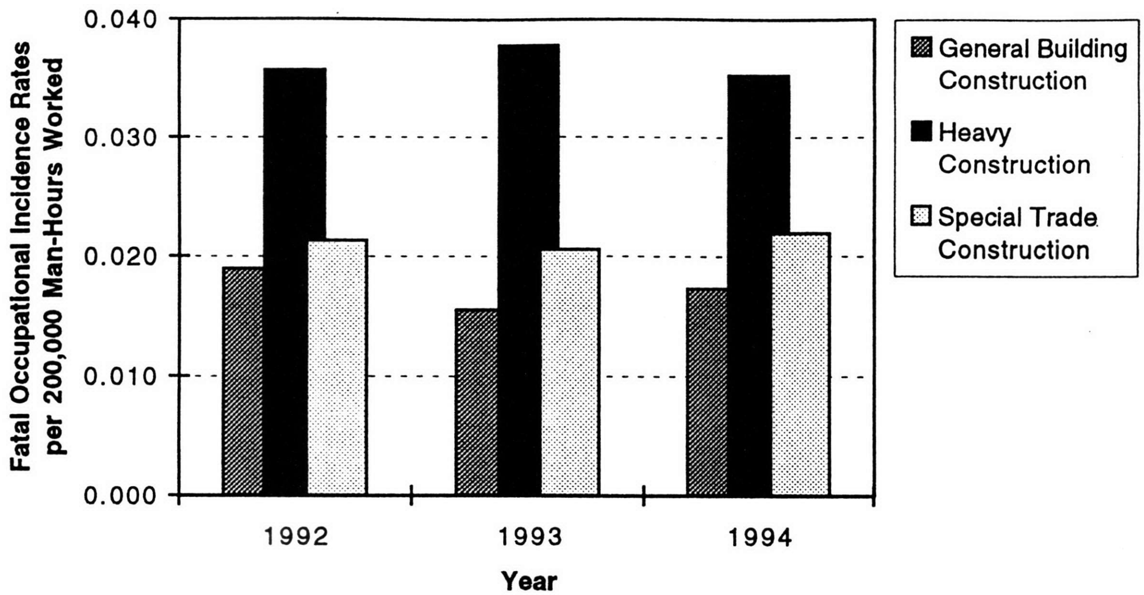
However, as shown in Figure 3.33, a comparison of fatal occupational injury and illness incidence rates reveals that heavy construction (= civil engineering construction) exposes workers more frequently to fatal injuries and illnesses than general building construction and special trade construction. The incidence rates of civil engineering construction are roughly twice the incidence rates of general building and special trade construction. The same can be said of the Japanese construction industry. As shown in Figure 3.17, the comparison of number of occupational fatalities per one trillion yen of construction investment demonstrates that civil engineering construction involves more fatalities than building construction in Japan. Consequently, high fatal accident incidence rates in civil engineering construction is valid for both the U.S. construction industry and the Japanese construction industry.



Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Injuries and Illnesses in the United States by Industry, 1973-1989*, *Survey of Occupational Injuries and* Illnesses, *1989-1993*, *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1992*, and *Workplace Injuries and Illnesses in 1994.*

Note: Data are those of private sectors excluding firms with fewer than 11 employees.

Figure 3.32 Change in Nonfatal Occupational Injury Incidence Rates per 200,000 Man-Hours Worked (= per 100 Full-Time Workers) by Type of Construction



Reference: Bureau of Labor Statistics, U.S. Department of Labor, in Cooperation with State and Federal Agencies, *Census of Fatal Occupational Injuries, 1992-1994.*

Note: Incidence rates are estimated by the author based on the statistics presented in the above references.

Figure 3.33 Change in Fatal Occupational Injury Incidence Rates per 200,000 Man-Hours Worked (= per 100 Full-Time Workers) by Type of Construction

3.3.4.3 Summary

The characteristics of occupational accidents in the U.S. construction industry are summarized in comparison with those of the Japanese construction industry as follows:

1) The number of nonfatal occupational injuries shows an increasing trend even after the promulgation of the OSH Act. The number of fatal occupational injuries (and illnesses) has also increased in recent years. The increasing trend of nonfatal and fatal occupational accidents of the U.S. construction industry presents a remarkable contrast to the decreasing trend of the Japanese construction industry.

2) The U.S. construction industry accounts for roughly 10 % of nonfatal occupational injuries and roughly 20 % of fatal occupational injuries caused in

all U.S. industries. These percentages are significantly lower than those of the Japanese construction industry: about 30 % of total occupational injuries (including fatalities) and about 40 % of total occupational fatalities.

3) The fatal occupational injury (and illness) incidence rates are drastically decreasing. The fatal incidence rate of 1994 was less than half of the rate two decades ago. However, the nonfatal occupational injury incidence rates have shown little improvement for the last two decades. The nonfatal incidence rates fluctuate between 3.0 and 4.0 (per 200,000 man-hours worked).

4) In recent years, there has been little difference in fatal occupational injury incidence rates between the U.S. and the Japanese construction industries. In this sense, occupational safety for fatal accidents of these two construction industries is comparable.

5) In comparison with the Japanese construction industry, the U.S. construction industry incurs fewer occupational accidents by small establishments. In the U.S., establishments with 50 to 500 employees incur the higher incidence rates, much higher than establishments with only 1 to 19 employees. On the other hand, there is a contrasting trend in Japan; the smaller construction establishments are, the more frequently workers are exposed to occupational accidents.

6) In the U.S. construction industry, older workers account for a significantly lower percentage of occupational injuries than in the Japanese construction industry. Because the percentage of older workers is not high in the U.S., in contrast to Japan, there are fewer occupational accidents incurred by the older workers. In contrast, young workers incur the majority of the accidents in the U.S.; workers younger under 35 years old account for about 60 % of nonfatal occupational accidents.

7) As for causes of occupational accidents, about 20 % of occupational fatalities result from falls in the U.S. construction industry, which is considerably lower than the percentage of falls (about 40 %) in the Japanese construction industry. In Japan, falls account for such a large percentage of occupational fatalities because the number of older workers is increasing rapidly and they become the major victims of fatal falls. Since such workers are apparently prone to lose equilibrium, they are extremely vulnerable to the risk of falls. However, the aging of workers is not so serious in the U.S. construction industry. Therefore, there are fewer occupational fatalities resulting from falls in the U.S. industry.

8) On the other hand, electrocutions, fires, and explosions cause a large number of occupational fatalities in the U.S. construction industry, accounting for about 20 % of the total fatalities. This presumably results from inappropriate work by unskilled or less experienced specialist workers such as welders and electricians, and incompleteness in cleaning and maintenance of workplaces.

9) White and Hispanic workers incur the majority (about 80 %) of occupational injuries in the U.S. construction industry. However, there is very little difference in the injury incidence rates between white workers (including Hispanic workers) and Black workers.

10) Workers engaged in special trade construction (= equipment installation construction) incur the majority of nonfatal and fatal occupational injuries.

11) There is little difference in the nonfatal occupational injury incidence rates among general building construction, heavy construction (= civil engineering construction), and special trade construction. Civil engineering construction, however, causes much higher fatal occupational injury incidence rates than the other two types of construction. Consequently, it is common to the U.S. and

Japanese construction industries that workers engaged in civil engineering works are most frequently exposed to fatal accidents.

Chapter 4

Comparison of Management of Occupational Safety: Japanese and the U.S. Construction Industry

4.1 General

This chapter discusses the management of construction safety in Japan and the U.S. and compares them with respect to the following: incentives for safety, pertinent laws and regulations, affiliated governmental agencies, working conditions for construction workers, labor relations and labor management for safety, and safety education and training for construction workers. The chapter also discusses the pros and cons of the Japanese and U.S. management of construction safety based on the results of the analysis of occupational accidents conducted in the previous chapter.

4.2 Management of Safety in the Japanese Construction Industry

4.2.1 Incentives for Safety

In Japan, there are several incentives for construction safety. Civil penalties imposed for the violation of the Industrial Safety and Health Law range up to a maximum of 3 million yen (≈ $ 30,000). The contractors also strive to reduce the insurance cost which they have to pay for medical treatments and hospital charges of their employees. However, the strongest incentives are governmental sanctions against prime contractors and the sanctions which prime contractors in turn impose upon their subcontractors.

Governmental sanctions such as the down-grading of the rank of contractors and the reduction or suspension of their bid designation are so serious that they endeavor to improve their safety records. On the other hand, subcontractors depend so heavily on their paternalistic prime contractors that sanctions imposed on them greatly influence their safety performance.

As briefly discussed in Chapter 2, public construction works account for about half of the huge construction investment made in the world's largest construction market. The public works agencies such as the Ministry of Construction, the Ministry of Transportation, public corporations, and municipal governments have the sovereign power over contractors in public works by ranking the contractors and designating bids to them. The Ministry of Construction and prefectural governors have authority to grant licenses to perform construction work. Moreover, under the Industrial Safety and Health Law, the Ministry of Labour administers the licensing of examinations, grants licenses, suspends licenses, and revokes licenses that are given to workers engaged in special works, such as gas-welding, blasting, and crane-operation.

Safety records greatly influence the ranking of contractors, the bid designation to the contractors, and the licenses granted to the contractors and workers. For example, if a contractor causes a significant number of occupational injuries and fatalities, the public works agencies lower its rank and refrain from designating future bids to it. Depending on the seriousness of the accidents, the agencies can suspend designations for several months or years.

Therefore, prime contractors are nervous about the safe performance of their subcontractors because accidents caused by the subcontractors reflect badly on their safety records. Prime contractors impose sanctions such as reduction or suspension of future subcontracts depending on the seriousness of the accidents. Subcontractors depend on prime contractors so heavily that these sanctions are crucial incentives for them to reduce occupational accidents.

Consequently, in the Japanese construction industry, governmental sanctions and sanctions which prime contractors impose on subcontractors are the strongest incentives for safe performance of contractors and workers and for reducing occupational accidents.

4.2.2 Laws and Regulations for Safety

The Industrial Safety and Health Law has played the most important role in preventing occupational accidents and securing comfortable and safe working environments for workers. The purpose of the law is quoted from Article 1 of Chapter 1 here (*Labour Laws of Japan 1995*, Ministry of Labour, 1995):

> The purpose of this law is to secure, in conjunction with the Labour Standards Law (Law No. 49 of 1947), the safety and health of workers in workplaces, as well as to facilitate the establishment of comfortable working environments, by promoting comprehensive and systematic countermeasures concerning the prevention of industrial accidents, such as taking measures for the establishment of standards for prevention of accidents and health impairment, the clarification of responsibility and the promotion of voluntary activities, with a view to preventing industrial accidents.

Note that the law stresses the importance of voluntary activities by both employers and employees to prevent occupational accidents. The law regulates the following areas:

- Responsibilities of employers and employees;
- Industrial accident prevention program prepared by the Ministry of Labour (Chapter 2);
- Safety and health management system for each workplace (Chapter 3),
- Measures to prevent occupational accidents and measures to promote safe and comfortable working environments, such as safety and health education and training (Chapter 4, 6, and 7);
- Regulations concerning machines and harmful substances (Chapter 5);
- Provisions for workers' licenses for particular types of work (Chapter 8);

- Safety and health improvement plans and industrial safety consultants and industrial health consultants (Chapter 9);
- Governmental review of project plans, safety and health inspections by government inspectors, and procedures to counteract imminent dangers in hazardous situations such as shutdown of operations (Chapter 10);
- Miscellaneous provisions including employers' responsibilities to preserve records and documents (Chapter 11); and
- Civil penalties against the violations of the law and the affiliated ordinances (Chapter 12).

The law has been updated by a series of amendments in 1977, '80, '83, '88,'92, and '94, of which the amendments in '80, '88, and '92 were developed for the purpose of implementing measures and standards to prevent workers, especially workers in the construction industry, from occupational hazards. Additionally, to implement practical regulations and standards for occupational safety, the law has been complemented by affiliated regulations, such as the Enforcement Order of Industrial Safety and Health (1972), the Ordinance on Industrial Safety and Health (1972), the Ordinance on Safety of Boilers and Pressure Vessels (1972), the Ordinance on Safety of Cranes and Other Similar Equipment (1972), the Ordinance on Safety of Gondola (1972), the Ordinance on Authorized Inspection Agencies, etc. (1972), the Ordinance on Examination of Machines and Other Equipment (1972), and the Ordinance on Industrial Safety Consultants and Industrial Health Consultants (1973).

Note that the following three provisions are unique to these Japanese laws and regulations concerning occupational safety and health and similar provisions are not found in the OSH Act in the U.S.:

1) the employers' duty to appoint a general safety and health director for each workplace who takes charges of safety supervisors and health supervisors (Chapter 3),
2) the authority of governmental agencies for the administration of workers' licenses such as granting, suspending, and revoking the licenses (Chapter 8), and
3) employers' duty to notify governmental agencies of their project plans and authority of the governmental agencies to review the plans and to make necessary recommendations or requests to the employers (Chapter 10).

The first provision demands that employers establish an in-house safety and health management system, comprised of the director, safety supervisors, and health supervisors, which helps promote both employers' interest and their involvement in activities to protect employees from accidents. On the other hand, the last two provisions bestow upon the governmental agencies such as the Ministry of Labour strong authority over employers and employees. This authority, accompanied with penalties imposed by governmental agencies, motivates both employers and employees to reduce occupational accidents.

4.2.3 Governmental Agencies for Safety

The Ministry of Labour is the primary central government authority administrating occupational safety and health in Japan. It corresponds to the U.S. Department of Labor. Under the administration of the Ministry of Labour, many governmental agencies at several levels work for occupational safety and health throughout Japan: the Labour Standard Bureau, 47 Prefectural Labour Standards Offices, and 343 Labour Standards Inspection Offices. Figure 4.1. illustrates the structure comprising these governmental agencies.

1) At the central government level, the Labour Standard Bureau in the Ministry of Labour, administers various activities concerning occupational safety and health, such as safety and health policy planning, promotion of occupational safety and health programs, technical standards and guidelines setting, and labor inspection programs (Hanayasu 1990). The Bureau corresponds to the OSH Administration of the U.S. The bureau is composed of the Industrial Safety and Health Department, the Wage and Welfare Department, the Inspection Division, the Workers' Accident Administration Division, and the Compensation Division.

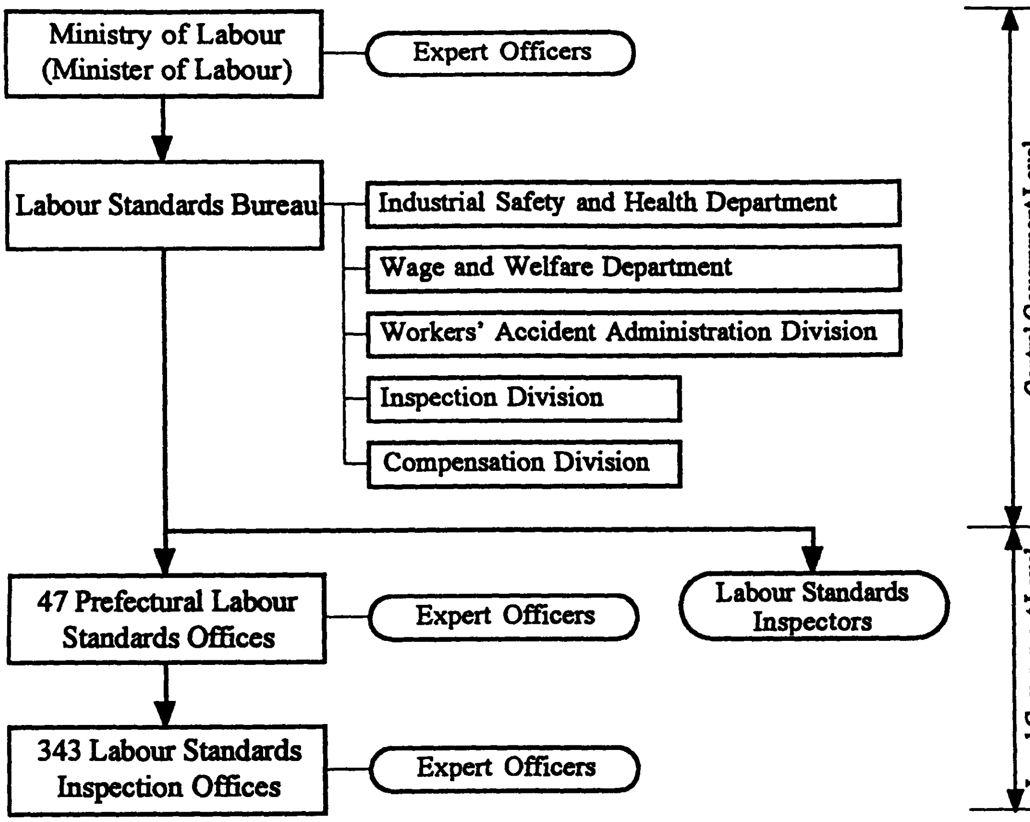
2) At the local government level, a Prefectural Labour Standards Office is located in each prefecture, and thus there are 47 Prefectural Labour Standards Offices throughout Japan. These offices, in a corporation with the Ministry of Labour, take charge of the administration of workers' licenses and the review of employers' project plans which discussed in the previous paragraph.

3) In addition to the Prefectural Labour Standards Offices, 343 Labour Standards Inspection Offices are located nationwide to supplement their activities.

4) Under the direct supervision of the central government, about 4,000 Labour Standards Inspectors are responsible for inspection. They may enter and examine workplaces, where and when they deem it necessary to enforce standards and regulations developed under the Industrial Safety and Health Law. They correspond to OSHA Inspectors in the U.S.

5) In addition to the inspectors, Expert Officers on occupational safety and health are assigned to the Ministry of Labour and nationwide inspection offices.

Therefore, these governmental agencies form a hierarchical structure ranging from nationwide labour standards inspection offices to the Ministry of Labour.



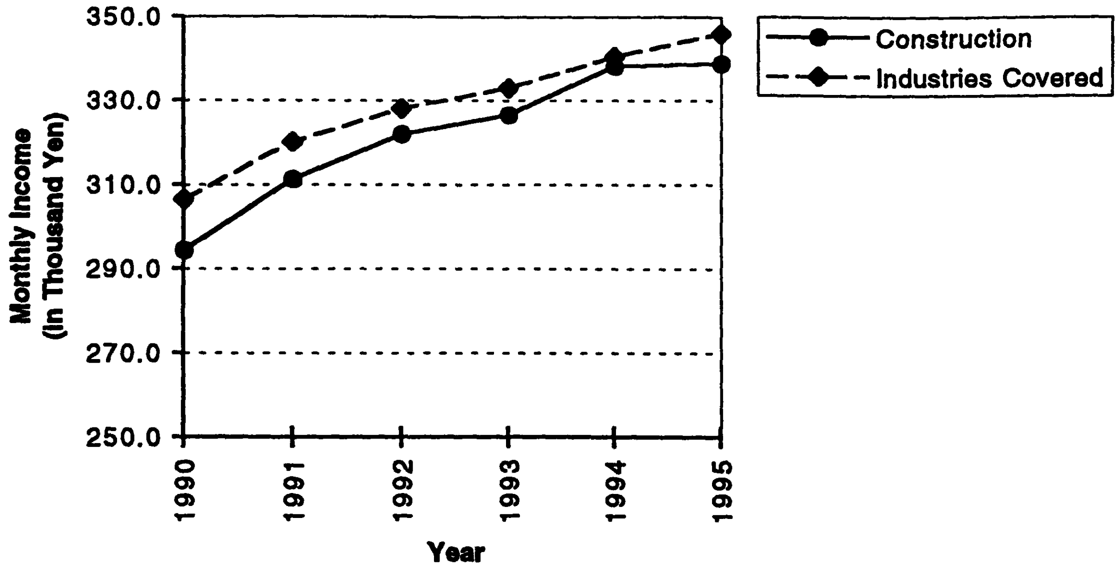
Note: Data are those of establishments with five or more male employees on a regular basis.
Source: Japan Industrial Safety and Health Association, *Safety and Health Data Book: 1994 Edition*, Tokyo, Japan.

Figure 4.1 Governmental Agencies for Occupational Safety and Health in Japan

4.2.4 Working Conditions for Safety

Working conditions such as wages and working hours have negative influence on preventing workers from occupational accidents.

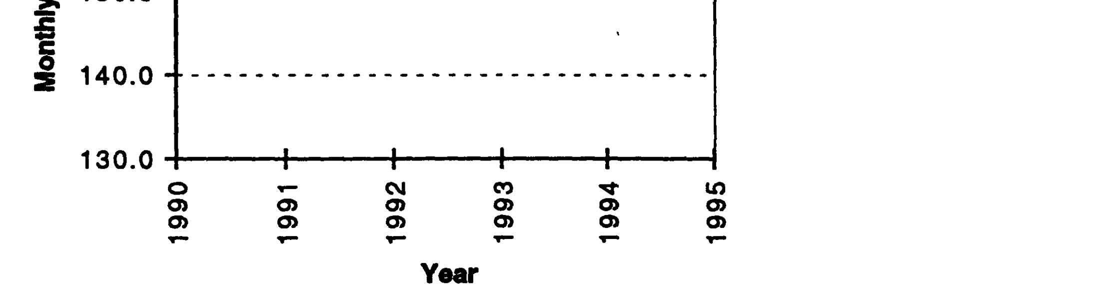
Figures 4.2 and 4.3 illustrates that wages are lower and working hours are longer in the construction industry than in other industries.



Source: The Ministry of Labour, *Maitsuki-Kinrou-Tokei-Chosa (Monthly Survey of Statistics on Labour*, Japan, 1995.

Note: The data are those of male employees of establishments with 5 or more employees.

Figure 4.2 Comparison of Monthly Income by Industry in Japan



Source: The Ministry of Labour, *Maitsuki-Kinrou-Tokei-Chosa (Monthly Survey of Statistics on Labour*, Japan, 1995.

Note: The data are those of male employees of establishments with 5 or more employees.

Figure 4.3 Comparison of Monthly Working Hours by Industry in Japan

In addition to the higher occurrence of occupational accidents, these unattractive wages and working hours are the main barriers preventing the recruitment of young workers to the construction industry. Oyama points out that the main reason Japanese high school students avoid working in the construction industry is the bad image of the industry they have, such as fewer holidays, dirty and tough work, long working days, and dangerous conditions (Oyama 1991). Therefore, great efforts have been made to improve these working conditions in the industry. Salaries have been raised, working hours have been shortened, and occupational accidents have been reduced significantly. These efforts, however, have not been sufficient to remove this negative image of the construction industry completely. The 3Ks or 3Ds (in English): kitanai = dirty, kiken = dangerous, and kitui = debilitating, are the words most frequently cited in Japan to depict the characteristics of such working conditions of the industry.

The decreasing recruitment of young workers to the industry increases the dependence on middle-aged and aged construction workers, and thus leaving the industry with an ever increasing average age of workers. Currently, the aging of construction workers is one of the most serious concerns in the industry. As discussed in Chapter 3, about half of the victims of occupational accidents are workers older than 50 years old (see Figure 3.12). Moreover, they account for more than 60 % of fatalities from falls which are the dominant cause of occupational accidents (see Figures 3.14 and 3.15).

Besides low wages, long working hours, and high risks of accidents, the frequent transfer of workers, especially of subcontract workers, from site to site throughout Japan is another negative factor in the construction industry. The need for frequent transfer results mainly from both the lack of nationwide labor pools as provided by U.S. trade unions and heavy dependence on subcontracting based on the long-term paternalistic relationships between subcontractors and their prime contractors. It is common practice in the Japanese construction industry that subcontract workers move to the next site immediately after completing their current contracts, for the purpose of working on projects of paternalistic prime contractors. They live in prefabricated dormitories erected near construction sites for a large part of the year[27], leaving their families at home. Frequent transfer has a great negative influence on their morale, they become frustrated about their journey-jobs, they miss their families, and they become bored and alienated from their jobs; thus spoiling their performance on their jobs. Frustrations and complaints accumulated in their minds are directed toward their prime contract workers and sometimes ruins the long-term relationships. Hinze examined the influence of psychological climate of workers on their safety performance and concludes that safer workers are those who have positive feelings about their jobs and their employers (Heinze 1981). Consequently, it is not a wonder that occupational accidents occur mostly to subcontract workers.

Seasonal workers are exposed to similar working conditions as those of subcontract workers. To meet the increasing demands for construction work, seasonal workers have been an important source of labor and have augmented the decreasing supply of young recruits. Most of them are peasants and go to cities to work as construction workers in the winter season when they are free from farm work. They are employed for a temporary period. However, their contractual status is very unstable and ambiguous, because they usually make oral contracts with agent workers of subordinate contractors. The lack of formal contracts undermines their loyalty to the contractors who employ them. They do not have formal safety education and training. In addition, their informal contractual status hinders the specifying of the liabilities for accidents. Thus seasonal workers are rarely aware of job-site safety. Actually, their fatality frequency rates are more than two times higher than those of the average frequency rate of the industry (Tsunemi *et al.* 1994).

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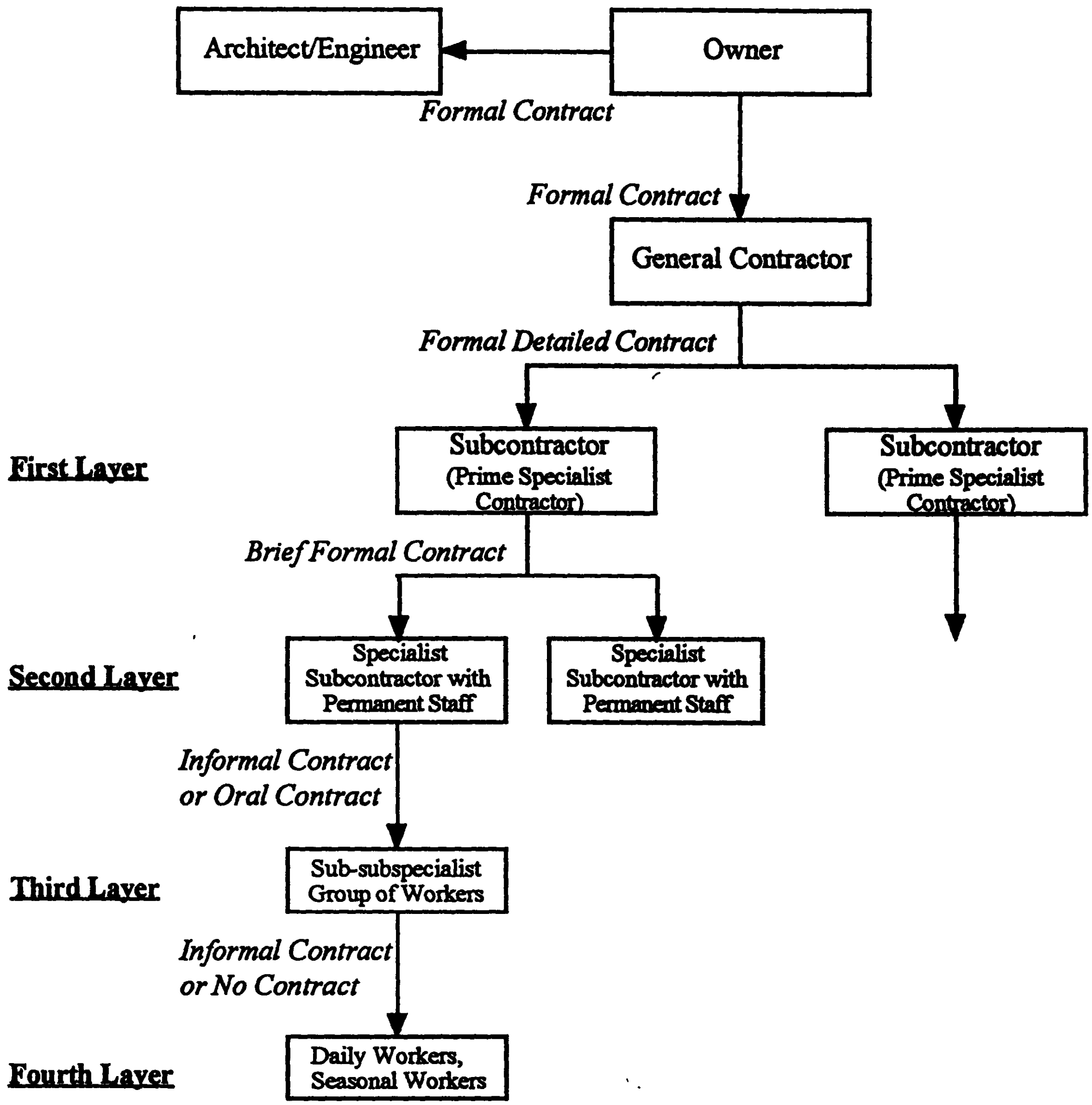
[27] They go back home to meet their families usually twice a year: during the Bon Festival during the summer, usually in the middle of August, and during New Year's Days.

4.2.5 Labor Relations and Labor Management for Safety

Labor relations and labor management of the Japanese construction industry are based on its heavy dependence on subcontracting, the consensus approach to decision-making and to dispute-settlement, and the long-term relationships based on mutual trust.

The heavy dependence on subcontracting results in a hierarchical structure comprising multi-layered contracts. Figure 4.4 illustrates this multi-layered structure of contracting. Under this hierarchical structure, workers of subordinate contractors directly perform virtually all the work of a project. On the other hand, general contractors supervise the overall project control and management, such as cost control, schedule control, and the supervision of the safe performance of the subordinate contractors.

For both general contractors and their subordinate contractors, occupational safety at the construction-site is crucial to survival in the industry. Since the heavy dependence on subcontracting is fostered by the long-term paternalistic relationships based on their mutual trust between contractors, occupational accidents undermine both this mutual trust and the long-term relationships. Occupational accidents lead subordinate contractors to lose face before their paternalistic contractors, and thus the contractors have great difficulty in obtaining new contracts with them. The same can be said of general contractors. General contractors also lose face before the owners such as government and municipal agencies. General contractors are subject to governmental sanctions such as the suspension of bid-designation and the down-grading of their ranks, and thus their business can be undermined.



Source: Bennett, J., *International Construction Project Management*, Butterworth and Co., Ltd., 1991.

Figure 4.4 Multi-Layered Structure of Contracting in the Japanese Construction Industry

Chapter 3 of the Industrial Safety and Health Law prescribes a safety and health management system with two different aspects: one, the management system implemented by each contractor which participates in a project; the other, the overall system in which the prime contractors and their subordinate contractors are incorporated, focusing on the contractual relationship between prime contractors and subcontractors. These systems are illustrated in Figure 4.5.

Under the former management system, the contractor shall appoint those people who take charge of activities and measures to prevent occupational hazards and to secure job-site safety and health; these people, the general safety and health director, the safety supervisor, the health supervisor, and the industrial physician, are appointed for each workplace. Together, they organize a safety and health committee to investigate and to discuss countermeasures for occupational hazards, for that workplace.

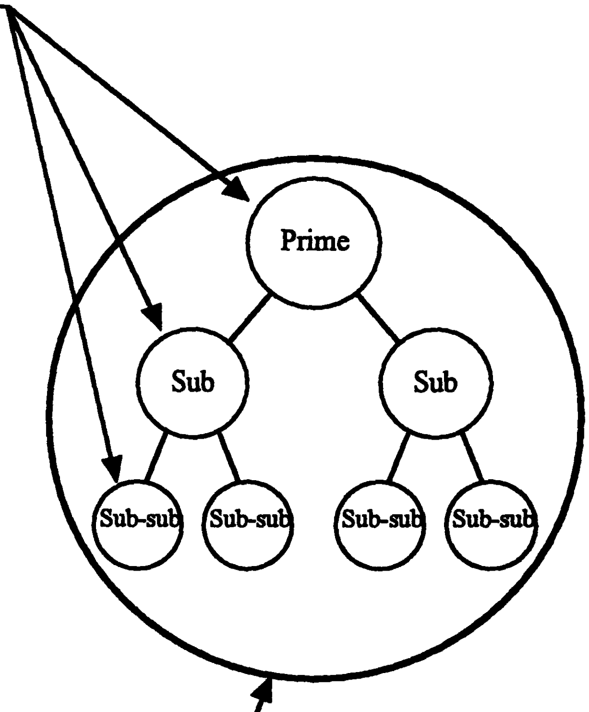
On the other hand, under the overall management system, the prime contractor shall appoint an overall safety and health controller and a prime safety and health supervisor, whereas the subordinate contractor shall appoint a safety and health controller. The prime contractor shall establish and administer a consultative organization in which all their subordinate contractors participate, to prevent occupational accidents and illnesses. This safety and health management system is appropriate for the Japanese construction industry which heavily depends on the multi-layered structure of contracting.

The members of the safety and health committee and consultative organization implement several countermeasures which they deem necessary for the safe performance of the workers: regular safety patrol, weekly and monthly safety meetings, safety education and training for workers, especially for newcomers. In addition, under their supervision, ordinal workers strive to promote occupational safety (and health) at the site. Their efforts take the form of a meeting before the commencement of the day's work, known as a tool box meeting (TBM), such activities to promote their awareness of hidden danger and hazards as the Kiken-Yochi-Katudou (KYK; kiken = danger, yochi = to foresee, and katsudou = activities), reports notifying co-workers of their frightening events through which they nearly experienced injuries or deaths, and daily and weekly routines for cleaning and tidying the job-site after the day's work. In a KYK meeting, workers brain-storm about particular jobs; they look at the illustration of the jobs to find unforeseen dangers and discuss ideas to protect them from accidents. These activities are grass-root safety activities initiated by workers who are directly exposed to occupational hazards at the site. TBM, KYK, and the daily cleaning and tidying are the most common, and most thoroughly enforced activities to prevent occupational accidents in the Japanese construction industry.

Consequently, the Japanese safety management involves the participation of all parties and members engaged in a construction project in activities to monitor job-site safety and it emphasizes teamwork-oriented safety activities such as TBM and KYK. The important factors for this Japanese safety management are mutual trust, cooperation, and friendly relationships between these parties and members, for which the Japanese consensus approach to decision-making and dispute-settlement and the long-term relationships based on mutual trust work very positively. The consensus approach promotes mutual communication between employers and employees, between prime contractors and subcontractors, and between members of each construction firm: job-site managers, foremen, and workers. Although it takes a long time to reach consensus, it assures cooperation and an object-oriented team effort in implementing these safety activities (Paulson 1980b). The long-term relationships based on mutual trust foster friendly relationships between these parties. In the Japanese construction industry, it is crucial to retain trust and thus save face, because the ruin of trust results in the loss of business.

Safety and Health Management System for Each Contractor

Workplace Size (Number of Workers)	Members for Safety and Health Management
Works requiring control	Operations chief
from 10 to 49	Safety and health promoter
50 and more	Health supervisor Safety supervisor Industrial physician Safety and health committee
100 and over	General safety and health director



Overall Safety and Health Management System for All Participating Contractors

Type of Construction	Workplace Size (Number of Workers) 20 / 30 / 50
Tunnel	Overall safety and health controller (Prime contractor) Prime safety and health supervisor (Prime contractor) Safety and health controller (Sub and Sub-subcontractors) Consultative organization to prevent industrial accidents (Prime, Sub, and Sub-subcontractors)
Works involving Pneumatic method	
Some of bridge construction in densely populated areas	
SC or SRC building	Establishment safety and health controller (for every establishment where subcontracts are concluded)
Others	

Source: Nishimoto, N., Safety Legislation, *Construction Worker Safety*, Special Issue, JSCE, Vol. 80-5, April, 1995, (in Japanese), pp. 11-14.

Ministry of Labour, *Jitsumu-ni-Yakudatsu: Rodo-Anzen-Eisei-Ho (Industrial Safety and Health Law: Useful for Business Practices)*, 3rd. ed., Japan Industrial Safety and Health Association (JISHA), Tokyo, Japan, 1995.

Figure 4.5 Safety and Health Management System in Japan

However, the heavy dependence on subcontracting has an adverse influence on labor relations and labor management for safety in the industry. Because of the captive contractual relationships with paternalistic prime contractors, subcontractors are prone to make a unilateral contract with a low profit margin for which they cannot appropriate budget for safety measures. Moreover, as revealed by Bennett, the contractual relationships and the degree of support provided from above become less formal and less certain at the lower levels than they are at the top level in a hierarchical organization (Bennett 1991). The heavy dependence on subcontracting results in the informal employment of workers in the third, and fourth layers through agent workers (see Figure 4.4). Like the seasonal workers discussed in the previous paragraph, the workers employed for a temporary period by informal contracts rarely feel loyalty to the companies for which they work, and get rarely little formal safety education and training. Therefore, they are more prone to occupational accidents than the workers who are formally employed by contractors.

4.2.6 Education and Training for Safety

Education and training for workers rely on on-the-job training (OJT), rather than apprenticeship common to the U.S. However, since no comprehensive training program has been established in Japan, most of tiny firms, who only supply labor, offer no training to their employees (Oyama 1991). The lack of training for workers in tiny firms results in the failure in promoting their skills, thus results in their exposure to more occupational hazards.

Therefore, contractors endeavor to implement safety education and training for workers, which include the following activities: safety activities provided at the job-site such as TBM and KYK, outside lectures and skill training courses administered by designated institutes by the Ministry of Labour or affiliated organizations such as JISHA, and spontaneous communication between workers after working hours in their dormitories. TBM and KYK are, as previously mentioned, the prevailing activities for protecting workers from occupational accidents. The Industrial Safety and Health Law and the affiliated ordinances prescribe that workers engaged in certain duties complete skill training courses concerning their duties. Carrying out this requirement is the responsibility of, for instance, an operations chief. The last of these methods for giving safety education and training to workers, spontaneous communication between workers, is quite unique to the Japanese construction industry, which heavily depends on paternalistic relationships between prime contractors and subcontractors, and as well as a reliance on subcontracting. Since subcontract workers are transferred from site to site throughout Japan, they live in dormitories near the sites and have a communal life with other subcontract workers and with contract workers. This community life provides them with the environment in which they can freely talk about their jobs and duties, including discussion about protecting themselves from accidents.

4.2.7 Discussion

The Japanese construction industry, in cooperation with governmental agencies and affiliated institutes and associations, has made a great effort to protect workers from occupational accidents. The Industrial Safety and Health Law enacted in 1972 and complementary ordinances have played a leading role in this effort. Within this legal framework, the industry has endeavored to implement better management systems to provide a safe and comfortable environment for workers.

The current safety management system has been greatly influenced by the characteristics of the industry: long-term paternalistic relationships based on mutual trust, heavy dependence on subcontracting, a consensus approach to decision-making and dispute-settlement, and the sovereign power of governmental agencies, such as the Ministry of Labour and the Ministry of Construction. The characteristics of this safety management system are summarized as follows:

1) The strongest incentive for contractors to assure occupational safety is the avoidance of governmental sanctions and sanctions which prime contractors take against subcontractors.

2) The administration of licenses by the Ministry of Labour gives workers who are engaged in specified duties an incentive to strive for their safe performance.

3) The Ministry of Labour and its subordinate organizations are heavily involved in activities to secure occupational safety at both the central and local levels.

4) Contractors have a strong incentive to reduce occupational accidents, because they harm the long-term relationships based on mutual trust on which the Japanese construction industry heavily depends.

5) The safety management system at the construction site incorporates every prime contractor and every subcontractor into cooperative safety activities, such as safety patrol, safety committees, and safety education and training.

6) This safety management system involves the participation of workers through cooperative or grass-root safety activities, such as TBM and KYK.

7) Workers are commonly provided with safety education and training through job-site safety activities like TBM and KYK and through outside safety lectures and training. In addition, the community life in dormitories near the site provides them with an opportunity for spontaneous communication to improve safe performance.

These characteristics have a positive influence in the effort to reduce occupational accidents in the industry.

In addition to these characteristics, the design-build approach and the active involvement of management in research and development have a positive influence in securing the safe performance of workers. The direct engagement of design engineers in construction provides better coordination in carrying out their design intentions; it also give them an awareness of workers' needs and an opportunity to receive practical feedback. The better coordination promotes communications between employers and employees, and thus helps assure comfortable and safe working environments. The practical feedback enables designers to incorporate their job-site experience into the design phase, which helps avoid occupational hazards in construction. On the other hand, the active involvement of managers in research and development can result in the invention of new construction materials or new construction methods to improve safety of workers.

However, the Japanese construction industry embodies the following adverse factors for securing occupational safety:

1) Young people avoid working in the construction industry because of less attractive working conditions, as compared with other industries: lower wages, longer working hours, and more dangerous work. Therefore, the percentage of older workers has been increasing. As discussed in Chapter 3, older workers are the major victims of accidents. Workers older than 50 years old account for roughly 50 % of the total fatalities, and they account for more than 60 % of the total fatalities resulting from falls. To decrease accidents incurred by such older workers, it is crucial for the industry to increase young recruits. For this purpose, the industry has to become more attractive to young people by implementing measures to improve its working conditions. A major way to reach this objective would be to continue the efforts to reduce occupational accidents further.

2) Subcontract workers and seasonal workers who are informally employed are often subjected to undesirable contractual conditions; this circumstance explains their high vulnerability to occupational accidents. This argument is verified by the results shown in Chapter 4 that workers of the Labour

Insurance Affairs Union or workers of small construction establishments incur high fatality and injury frequency rates, because these workers are those who are informally employed as subcontract workers or seasonal workers. To reduce accidents incurred by such informally employed workers, it is crucial to abolish such informal employment and to give appropriate safety education and training to all workers, including seasonal workers.

Figure 4.6 represents the above discussions.

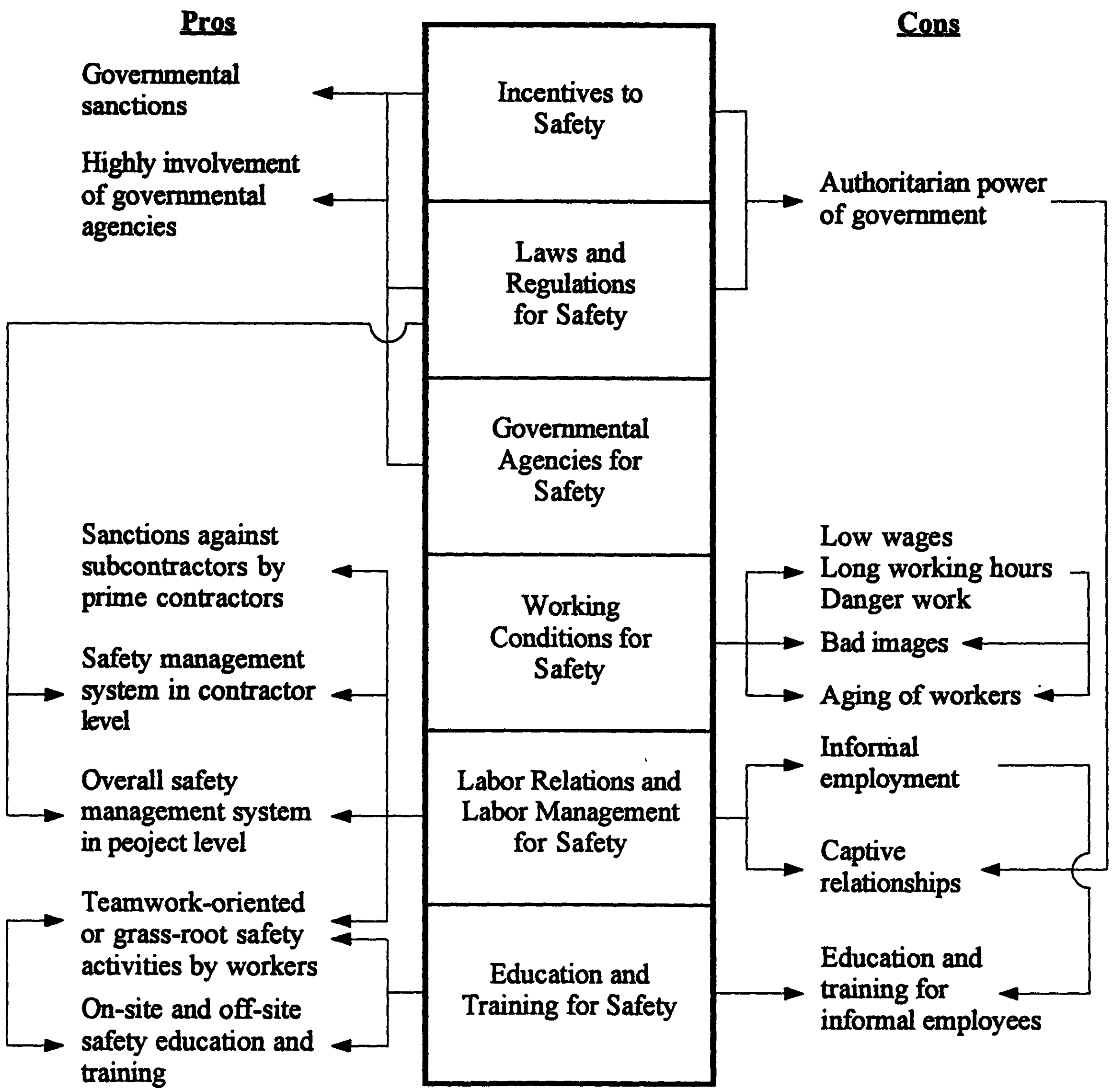


Figure 4.6 Pros and Cons of the Japanese Construction Industry in Preventing Occupational Accidents

4.3 Management of Safety in the U.S. Construction Industry

4.3.1 Incentives for Safety

In contrast to incentives for safety in the Japanese construction industry, the strongest incentive for safety in the U.S. construction industry is the cost of workers' compensation insurance. Under the workers' compensation laws, employers are required to provide their workers with compensation insurance for medical treatment and rehabilitation, and for compensation of themselves and of their families for pay losses (Levitt and Samelson 1993). In the competitive U.S. construction market, contractors endeavor to reduce their insurance costs because these costs in high risk trades can typically account for as much as 20 % of their direct labor costs (Suazo *et al.* 1993).

Workers' compensation insurance is composed of two components: the manual rating and the experience modification rating known as X-Mod. The X-Mod gives contractors an incentive to reduce the number of occupational accidents. Thus the formula to calculate the insurance cost is:

$$\textit{Workers' compensation insurance cost} = \textit{Payroll} \times \textit{Manual rate} \times \textit{X-Mod}$$

The manual rate is calculated by the rating bureaus annually for about 450 types of work. With this rate, one can project the manual insurance costs for the coming year. These costs reflect the medical costs and benefits, administrative costs and profits of the insurance companies, the costs of the rating bureau, and federal and state taxes (Levitt and Samelson 1993). The manual rate is calculated for each work classification per $100 of straight-time payroll, not of total payroll which may include overtime and other premiums. The rate is an indicator of the risk associated with a particular work classification thus varying greatly among work classifications. Moreover, this rate also varies greatly from state to state for each work classification. However, the manual rate does not consider the safety record of each employer in its calculation; thus, the rate designated for a particular type of work is standard among all contractors under the same calculation formula. The manual insurance cost for a particular work classification is obtained by multiplying the total payroll for this work classification by the manual rate. The manual rates usually range from about $3 to more than $160 per $100 of straight-time payroll (Everett and Thompson 1995).

On the other hand, the X-Mod is calculated for each contractor for the coming year based on the contractor's past accident experience in the three years prior to the immediate past year (Levitt and Samelson 1993). Therefore, the X-Mods greatly differ between contractors depending on the contractors' safety records. The X-Mods range so widely[28] that contractors with poor safety records have to pay considerably higher workers' compensation insurance premiums than contractors with excellent safety records. The X-Mods emphasize the frequency of accidents rather than the severity of accidents. The three-year rating period helps prevent the X-Mods from drastically fluctuating from year to year. Through their efforts to improve their safety records, contractors can reduce their insurance premium from 20 % to 12 % of the total direct labor costs (Suazo *et al.* 1993). This 8 % savings in the direct labor costs plays a critical role for contractors in winning bids and in securing their appropriate profit margins.

The workers' compensation insurance provides strong incentives for contractors to improve their safety performance because they can obtain a significant competitive advantage by lowering their X-Mods. However, several studies criticize the current system of the insurance. Everett and Thompson examined how the insurance premium is computed by using the manual rate, the payroll, and the X-Mods. They argue that the complex method of computing the insurance premium prevents contractors from

[28] Note that an X-Mod of 50 means that the workers' compensation insurance cost which a contractor have to pay is reduced to 50 % of the manual compensation insurance cost. The X-Mods range from 50 to 205 for interstate contractors and 35 to 260 for contractors with California X-Mods (Levitt and Samelson 1993).

understanding how their insurance premiums are computed. They propose that this complex method misleads contractors in their efforts to assure safety and undermines their incentives for safety (Everett and Thompson 1995). They also point out that the three-year rating period wearies contractors striving to improve safety. Under the current system, contractors have to wait two years until their efforts to improve their safety records influence their compensation insurance premium. In addition, the impact of their efforts is spread out over the three-year rating period.

As pointed out by Everett and Thompson, it is crucial that contractors understand how their insurance premiums are calculated. Contractors who fully understand the calculation method will be much more motivated to improve safety and would be given a more competitive advantage in this competitive construction market.

4.3.2 Laws and Regulations for Safety

The Occupational Safety and Health Act (OSH Act) is the first comprehensive federal law concerning occupational safety and health. The OSH Act was enacted in 1970 to secure safe and comfortable working environments for workers by implementing federal standards developed under the Act (Roberts 1976). The Act has played a leading role in preventing workers from occupational accidents. It corresponds to the Industrial Safety and Health Law in Japan. Under the Act, practical standards have been developed in great detail for every industry. The Construction Standards (29 CFR Part 1926) are applied to the construction industry. The Act covers the following areas:

- Responsibilities and duties of employers and employees (Section 5);
- Provisions for standards developed under the OSH Act (Section 6);
- Provisions for inspections and investigations by OSHA inspectors, and for mandatory requirements imposed on employers for recordkeeping, reporting, and posting notices (Section 8);

- Provisions for citations and mandatory requirements imposed on employers for posting copies of citations (Section 9);
- Procedure for enforcement of penalties, employers' right of appeal to contest citations and/or proposed penalties (Section 10);
- Judicial review including the prohibition of discrimination (Section 11);
- Procedures to counteract imminent dangers in hazardous situations (Section 13);
- Penalties imposed on violation of standards (Section 17);
- State jurisdiction and state programs for occupational safety and health in compliance with the OSH Act (Section 18);
- Safety training and education for workers (Section 21); and
- Provisions for collecting, compiling, and analyzing statistics on occupational injuries, fatalities, and illnesses (Section 24).

According to OSHA, more than 100,000 workers' lives have been saved since the enactment of the OSH Act in 1970. However, many arguments have been made about the effects about the effectiveness of the Act in reducing occupational accidents in the construction industry. The study by Koehn and Musser (1983) is one of the most noteworthy studies in this respect. They examine the effects of regulations of the OSH Act on contractors and discuss the benefits and costs of compliance with the regulations. Their results are based on the replies to questionnaires sent to contractors. The study reveals that the majority of contractors surveyed have negative feelings about the Act. The following concerns are cited from their study (Koehn and Musser 1983):

- The great majority of contractors apply the regulations of the Act to the type of work they perform.

- The majority of contractors feel that compliance with the regulations of the Act increases the costs of projects.
- The large contractors perceive greater benefits from the Act than the small contractors.
- The large contractors perceive that they spend less money for complying with the Act than small contractors.
- Contractors who feel that good general construction practices usually satisfy the requirements of the Act spend significantly less in complying with the regulations of the Act than do contractors who do not feel that good general construction practices usually satisfy the requirements.
- The majority of contractors feel that the regulations of the Act have not helped reduce the number and severity of occupational accidents on their projects.
- The great majority of contractors support revising regulations of the Act because they feel that the regulations are unrealistic and impractical.

The above results are quite suggestive; the majority of contractors surveyed in the study think that the OSH Act is not effective in preventing occupational accidents. They also feel that compliance with the Act leads to an increase in project costs. On the other hand, contractors who have positive feelings about the Act save money. It is also noteworthy that compliance with the Act seems to give financial disadvantages to small contractors, who account for the great majority of the total number of contractors. Considering these results, the revision of the Act is crucial to eliminate negative feelings which many contractors have about the Act. In addition, contractors should be aware that the expense of compliance with the Act is much less than the total direct and indirect costs resulting from occupational accidents. Since the expense required to comply with the Act is not excessive, it is crucial for every contractor to strive for compliance with the Act with the purpose of improving safety performance.

The OSH Act and the Industrial Safety and Health Law of Japan have many ideas and approaches in common concerning standards and measures for occupational safety and health. However, the following differences are notable because they provide a remarkable contrast in comparing the incentives and management for occupational safety and health between the two countries:

1) The OSH Act prescribes that the employers have duties only with respect to the contractual relationships between an employer and his/her employees (see Section 5 of the Act). The Japanese law, on the other hand, prescribes the employer's duties with respect to the relationships between an employer and his/her employees, and between prime contractors and subcontractors, as well (see Article 15 in Chapter 3 of the law). The Japanese safety and health management system shown in Figure 4.3 is based on this provision. Although subcontracting is a common and typical practice in the U.S. construction industry (though the U.S. industry does not rely so heavily on subcontracting as does the Japanese industry), there is no provision for safety regarding the relationship between contractors in the Act. Therefore, the Japanese law is probably more advantageous than the OSH Act in securing safe working environments.

2) The OSH Act imposes much severer civil penalties on employers than the Japanese law; these penalties range from a minimum of $5,000 to a maximum of $70,000 under the Act, whereas penalties under the Japanese law are less than 3 million yen (≈ $ 30,000) maximum. The U.S. greatly emphasizes monetary sanctions, such as these penalties for violating the Act and workers' compensation insurance premium, to motivate employers to reduce the number

of occupational accidents. The emphasis on monetary sanctions is effective in encouraging employers to comply with the Act, because people put top priority on costs in the U.S.

3) The OSH Act presents no provision for measures to promote employees' incentives for their safe performance, as do Japanese governmental agencies. Under the Japanese law, revoking workers' licenses acts as an incentive for safety. The lack of these sanctions against workers in the U.S. seriously weakens their individual efforts to reduce the number of occupational accidents.

4.3.3 Governmental Agencies for Safety

Governmental agencies that administrate occupational safety and health in the U.S. forms a hierarchical structure which resembles the structure of Japan (see Figure 4.1). The federal government authority that takes charge of occupational safety and health is the Department of Labor. Under the OSH Act enacted in 1970, three major agencies were established to administer the Act: the Occupational Safety and Health Administration (OSHA), the Occupational Safety and Health Review Commission (OSHRC), and the National Institute for Occupational safety and Health (NIOSH). In addition, OSHA's subordinate offices are established at regional and local levels throughout the U.S.

1) At the federal government level, OSHA, OSHRC, and NIOSH are major agencies that administer the OSH Act. OSHA is established in the Department of Labor for the purpose of setting and enforcing standards developed under the Act. OSHRC is set up independent from OSHA as an adjudicatory agency to hear challenges by employers to OSHA citations and proposed fines. NIOSH is a federal research institute established in the Department of Health and Human Services (DHHS) for the purpose of taking charge of conducting

research and making recommendations to prevent workers from occupational injuries and illnesses. In addition, to assist the Secretary of Labour, advisory committees have been established in DOL: the National Advisory Committee on Occupational Safety and Health which advises, consults with, and makes recommendations on the administration of the Act, and advisory committees which assist in the standard-setting functions.

2) The U.S. territories encompassing 50 states are divided into 10 regions. For each region, a regional office has been established.

3) Under each of the regional offices, area offices, consultation offices, and state plan offices have been set up. Ninety three area offices, 53 consultation offices, and 26 state plan offices are dispersed throughout the territories. About 2,100 inspectors are spread among these offices.

In comparison with Japan, the governmental administration has less influence at the local level for this expansive country; In Japan, 390 local governmental offices (47 Prefectural Labour Standards Offices plus 343 Labour Standards Inspection Offices) are located throughout Japan, whereas only 182 local offices of the federal government (10 regional Offices, 93 Area Offices, 53 Consultation Offices, and 26 State Plan Offices) are located in the U.S., which is about 25 times as large as Japan. In addition, the number of governmental inspectors in the U.S. is half the number in Japan: about 4,000 inspectors at work in Japan, whereas only 2,100 inspectors at work in the U.S. The nationwide prevalence of OSHA administration plays an important role in promoting OSHA inspections. The inspections augment the effectiveness of the Act with the enforcement of the standards and regulations. Therefore, the establishment of more local offices seems to deserve sincere consideration for the purpose of assuring safe and comfortable workplaces.

Figure 4.7 illustrates this hierarchical structure composed of governmental agencies for occupational safety and health.

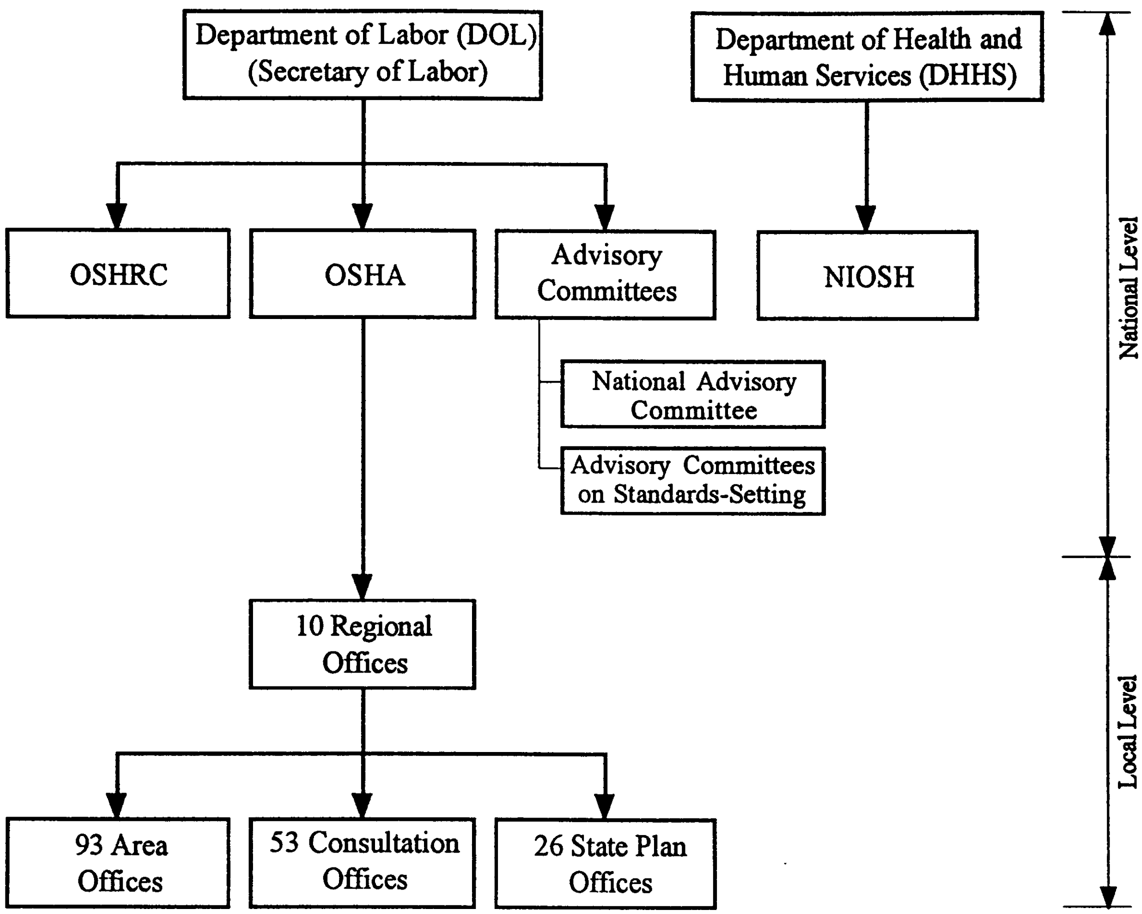
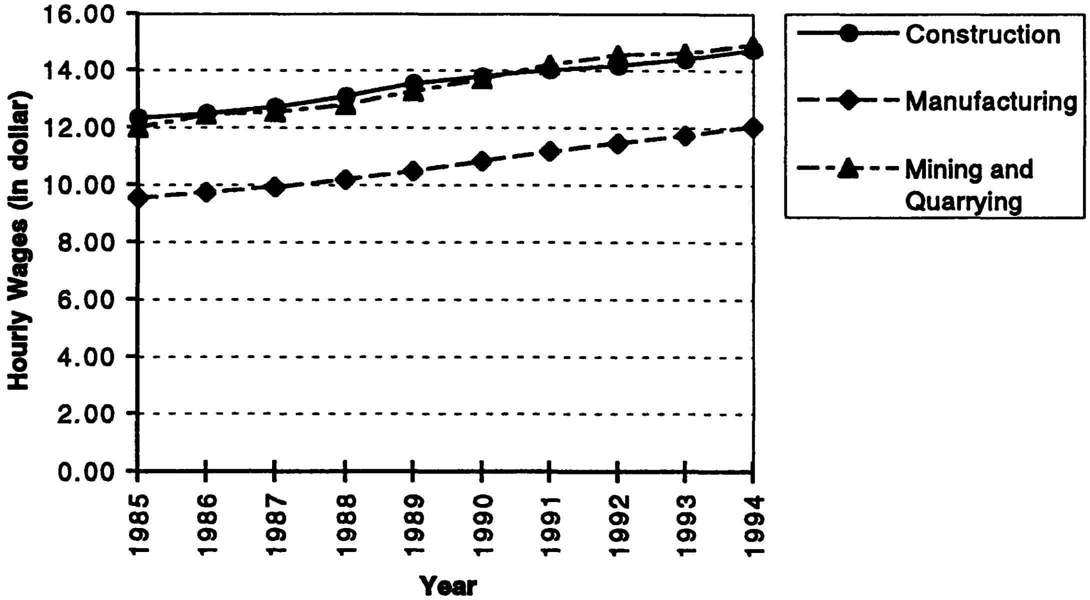


Figure 4.7 Governmental Agencies for Occupational Safety and Health in the U.S.

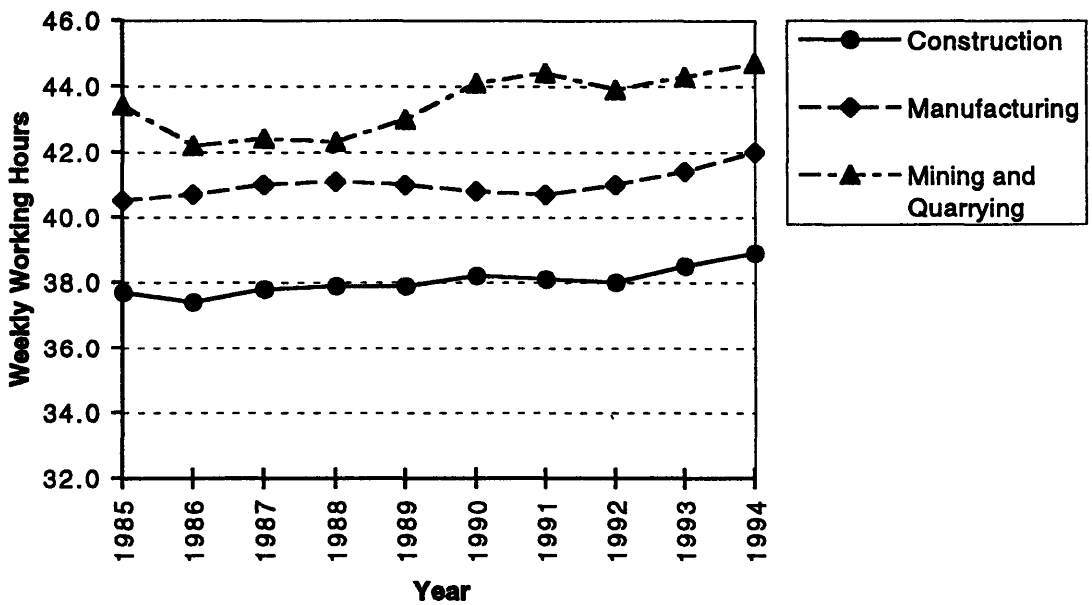
4.3.4 Working Conditions for Safety

One of the major differences between the U.S. and the Japanese construction industries is the existence of strong trade unions. The U.S. construction industry needed a trained labor pool nationwide in this huge country. This helped the development of the trade unions in the industry as organizations with strong collective bargaining power with employers. This strong bargaining power of the trade unions has bestowed upon construction workers better working conditions in wages and working hours than those of other U.S. industries, as shown in Figures 4.8 and 4.9.



Source: International Labour Office, Geneva, *Yearbook of Labour Statistics, 1995.*

Figure 4.8 Comparison of Hourly Wages by Industry in the U.S.



Source: International Labour Office, Geneva, *Yearbook of Labour Statistics, 1995.*

Figure 4.9 Comparison of Weekly Working Hours by Industry in the U.S.

According to the study by Oyama (1991), U.S. youths, like Japanese youths, have negative images of construction work: it seems to them boring, repetitious, tedious, and stressful. They also consider that construction work is not associated with prestige and respectability. However, high wages and short working hours are attractive enough for young people to work for temporary cash earnings. Moreover, such temporary hiring of young workers is beneficial to site managers too. U.S. construction management is principally cost-oriented; thus, the managers emphasize minimizing surplus labor costs by hiring and firing workers. Young workers are hired for a temporary period through hiring halls, newspaper advertisements, or local public-employment services, primarily by open shop firms. Open shop firms have more flexibility and efficiency than union shop firms in hiring workers in accordance with the types and sizes of their construction projects (Levitt 1979 and Barrie and Paulson 1992). They are best suited for helpers for routine or unskilled work in open-shop construction.

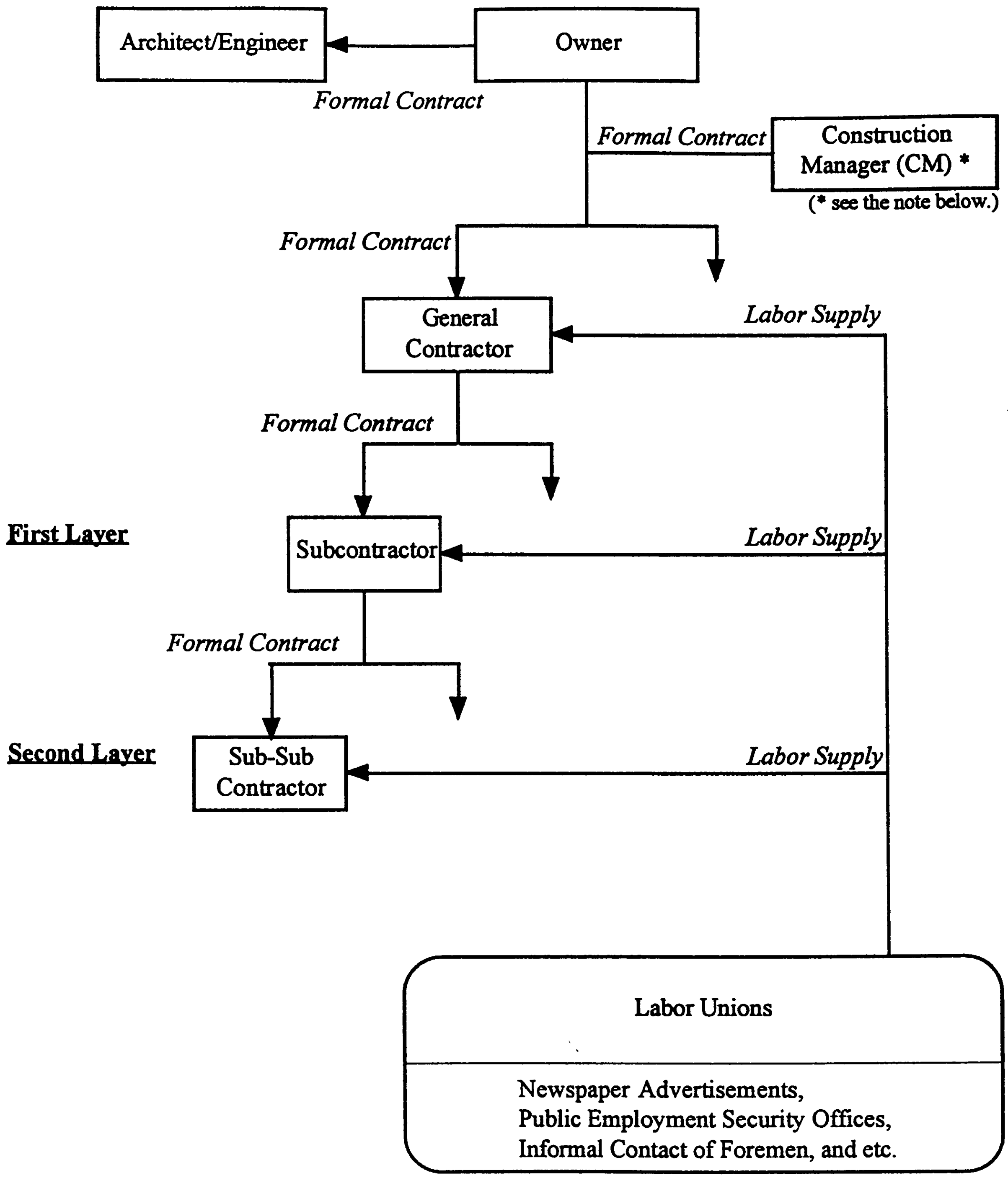
However, there is a pitfall in the temporary hiring of young people. Like seasonal workers in the Japanese construction industry, young temporary workers lack loyalty to their employers and formal training and apprenticeships. They work only for temporary money, not for long-term stable employment. These negative attributes of their jobs decrease their long-term interest in job-site safety and lower their involvement in safety activities, thus ultimately exposing them to occupational accidents. The practice of the temporary hiring of young workers is probably one of the major causes of the high rates of occupational accidents among young workers (see Figure 3.26).

The maintenance and cleanness of the construction site is also an important factor in preventing occupational accidents; they help decrease hidden dangers, promote workers' smooth performance, and assure safe and comfortable workplaces. In Japan, great emphasis is placed on organization and cleaning. Because the country is small, notoriously crowded, and chronically subjected to heavy traffic, workers are constantly reminded to keep the site clean and organized by slogans and posters plastered everywhere in the site. In contrast, the U.S. is such a huge country that it rarely suffers from such annoying problems as seen in Japan. Under this favorable working environment, the U.S. construction industry seems to have less interest in cleaning and maintaining workplaces than the Japanese construction industry. More emphasis on these preventive measures would be beneficial to the U.S. construction industry, for they would decrease the number of occupational accidents, especially minor nonfatal injuries such as surface wounds and bruises, and secure safer working conditions.

4.3.5 Labor Relations and Labor Management for Safety

Labor relations and labor management of the U.S. construction industry are greatly influenced by the following: the dependence on trade unions as labor pools, the growth of open shop construction, the short-term relationships between employers and employees and between prime contractors and subcontractors, the rapid turnover of workers, and the top-down authoritarian approach to decision-making and dispute-settlement.

Under the labor law, construction firms operate a union shop or an open shop. They, whether union or open, hire laborers directly through various ways such as informal contacts by their foremen, hiring halls, public employment security offices, and newspaper advertisements. Contractors perform parts of their work by using these directly hired laborers. The rest of the work is subcontracted. The dependence on subcontracting differs greatly between the U.S. and Japan. According to the study by Oyama (1991), subcontracting costs account for about 30 % of the total cost in the U.S., whereas they account for more than 60 % of the total cost in Japan. Therefore, the labor supply by direct hiring plays a very important role in performing construction in the U.S. The U.S. direct hiring results in a project organization which differs from that of the Japanese construction industry shown in Figure 4.4. Figure 4.10 illustrates a typical project organization in the U.S.



Source: Oyama, K, "A Comparative Study of the US-Japan Construction Industry," thesis submitted to Massachusetts Institute of Technology, at Cambridge, MA, 1991, in partial fulfillment of the requirements for the degree of Master of Science.

Note: This organization is that of CM contracts. Otherwise, CM is excluded from the organization.

Figure 4.10 Typical Project Organization in the U.S. Construction Industry

Because many workers want to get hired for temporary cash earnings and are attracted by high wages and short working hours in the industry, contractors can easily assemble as many crews as they want for the work they perform.[29] Union shop contractors gather workers by requesting that local unions supply laborers by telephone or through hiring halls. On the other hand, open shop contractors can gather workers through newspaper advertisements or open shop hiring halls. It is noteworthy that the ease of direct hiring of workers reflects the rapid turnover of workers in the industry.

Since U.S. construction management puts such strong emphasis on project costs, fast-track construction and cost saving play a crucial role in the management. Under these circumstances, the ease of direct hiring and the rapid turnover of workers bestow great benefit upon contractors. Contractors can hire and fire workers whenever they deem it necessary, thus minimizing the costs of surplus labor. When a fast-track schedule is needed, contractors can increase or decrease their labor force according to the work-load projected under the fast-track schedule.

In contrast, workers are hired usually on a weekly or a short-term basis, and they are prone to be unemployed or in search of another job. The rapid turnover prevents workers from establishing friendly relationships with their employers and lowers their long-term interest in their jobs. These negative feelings about employers and their jobs lower their interest in safe performance and in safety activities. Ultimately these negative feelings prevent the improvement of their safety performance. Moreover, under this system of temporary employment and negative relationships between employers and employees, it is difficult to initiate the bottom-up or grass-root activities for safety such as TBM and KYK, which are the most commonly enforced safety activities in Japan.

[29] Since the demand for skilled laborers and crafts is very high, it is competitive and difficult to recruit such skilled or experienced workers in the U.S. construction industry. The same can be said of the Japanese construction industry.

This is probably one of the reasons why U.S. management cannot help resorting to the top-down approach to safety.

U.S. subcontracting gives another disadvantage in reducing occupational accidents. The relationship between prime contractors and subcontractors is also usually short-term oriented, thus failing to incorporate prime contractors and subcontractors into a long-term cooperative management to assure safety. Every contractor establishes his/her own organization to supervise safety performance. The organization generally associates safety managers, safety supervisors, and safety officers appointed by the contractor with safety consultants of an insurance company who, under contract with the contractor, are responsible for reviewing the contractor's safety plan, implementing safety patrol on the site, and reporting to the contractor (see Figure 4.11). However, little intercommunication usually occurs between contractors. This is because the contractors endeavor to reduce the number of occupational accidents for the purpose of lowering their workers' compensation insurance premium. They do not need to be concerned about other contractors' safety performances.

The provisions of the OSH Act do not remedy these weaknesses associated with subcontracting. The Act provides no regulation or standard focusing on the relationship between contractors and their subordinate contractors. The regulations and standards have been developed under the Act, focused on the relationship between employers and employees in a single establishment. Section 5 of the Act is quoted below to support this argument:

> Sec. 5. (a) Each Employer ————
>
> (1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;

(2) shall comply with occupational safety and health standards promulgated under the Act.

(b) Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.

Therefore, the relationship between prime contractors and subcontractors has a negative influence on reducing occupational accidents. This relationship fails to incorporate these contractors in cooperative activities for safety and discourages prime contractors from supervising safety performance of subcontractors. These arguments can be supported by the large number of occupational accidents incurred by special trade construction, such as plumbing and electrical work, which are usually performed by subcontractors (see Figures 3.27 and 3.30).

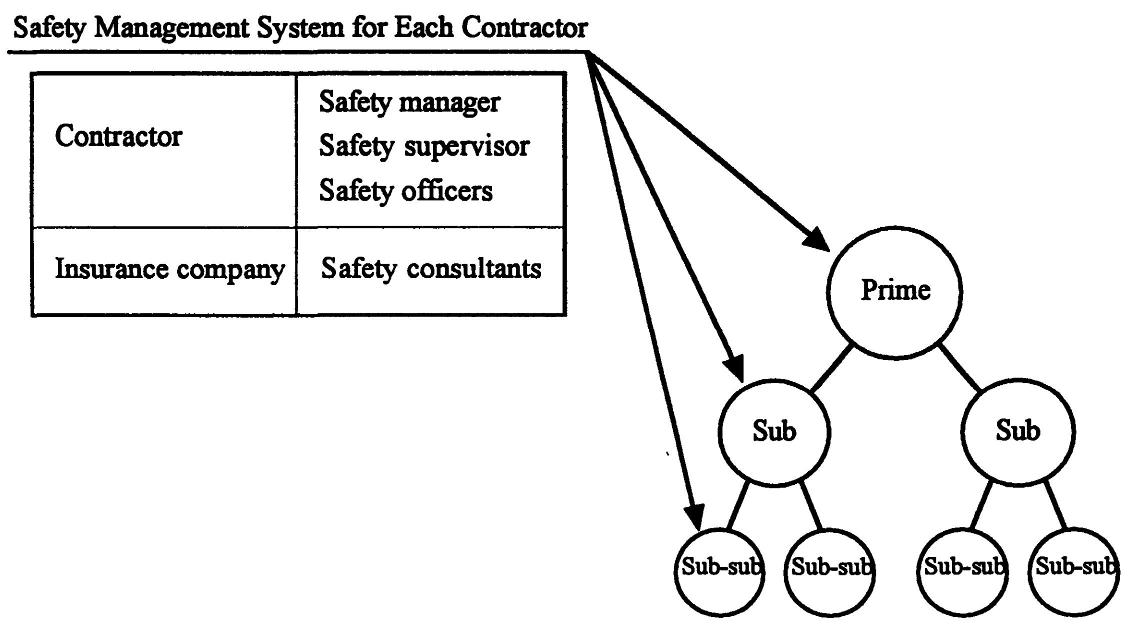


Figure 4.11 Typical Safety and Health Management System in the U.S.

4.3.6 Education and Training for Safety

Labor unions, in collaboration with the Bureau of Apprenticeship and Training (BAT), have developed well-organized apprenticeship programs, which have trained their member workers extensively. When apprenticed workers complete the programs, they are awarded licenses or completion certificates which officially attest to the skills acquired in their trades. Non-union firms have also developed non-union apprenticeship programs along the guidelines of union programs. Although the non-union programs are similar to the union programs to some extent, they give non-union workers great flexibility regarding trade jurisdiction. Few studies have been made to compare skills of union versus non-union workers[30].

After employing union and/or open shop workers, contractors offer safety training and orientation to these workers on a regular basis. The safety training and orientation are strongly emphasized among those who are newly employed or those who are engaged in dangerous work. This differs little from the practices implemented in the Japanese construction industry. However, activities such as TBM and KYK are not so prevalent or common as in Japan.

4.3.7 Discussion

The U.S. construction industry has attempted to reduce the number of occupational accidents in compliance with the standards and regulations developed under the OSH Act enacted in 1970. Violation of the Act provokes severe penalties imposed on offending contractors. The workers' compensation insurance premium gives U.S. contractors strong incentives to reduce the number of occupational accidents because the insurance premium is expensive and is directly based on their safety records. Contractors

[30] Diekman and Peppler (1984) conducts a comparative study between union shop firms and open shop firms in Colorado and argues that there are no significant productivity variations between these firms.

with excellent safety records can lower their premiums to about a quarter of those who have poor safety records. In this competitive construction market, monetary sanctions imposed by the violation of the OSH Act and the insurance premium play a crucial role in motivating contractors to improve their safety performances. Failure to improve safety results in the loss of contractors' competitiveness, thus ruining their business.

The careful examination of working conditions, safety management systems, and safety training and education reveal that the U.S. management for safety is short-term in orientation and puts great emphasis on activities and measures that are individually implemented.

Efforts to reduce occupational accidents; however, have not achieved complete success. Despite the drastic decrease in the number and incidence rates of fatal injuries, nonfatal injuries have not shown significant improvement in number and incidence rates. To explain this situation, some studies present arguments about the nature of the workers' compensation insurance, the OSH Act, governmental agencies affiliated with safety, working conditions, and the safety management and training/education systems. The following is a summary of these arguments:

1) The worker's compensation insurance premium gives contractors the strongest incentives to reduce occupational accidents. Based on safety records during the three year rating period, insurance companies increase or decrease the insurance premium imposed on contractors. The premium variations is so large that the lowering the premium is crucial for their competitive advantage and survival in the construction market.

2) However, the incentives of the insurance premium are prone to be lost in its complex calculation method and its three year rating period. Without complete understanding of this method, contractors' efforts to reduce the number of

occupational accidents may sometimes adversely increase their insurance premium.

3) The insurance premium gives the incentive for safety to each contractor, not to the overall project team comprised of prime contractors and subcontractors. Therefore, the insurance premium hardly encourages contractors to cooperate for thé purpose of improving their overall safety performances.

4) The OSH Act imposes severe penalties for the violation of its standards and regulations. Under the Act, there are no sanctions such as the suspension and revocation of workers' licenses. Therefore, the Act gives individual workers little incentive for their safe performance.

5) Many contractors have negative feelings about the Act, stating that the Act does not reduce the number of occupational accidents and the Act increases project costs. It is noteworthy that many contractors support revising the Act so that it be more realistic and more practical. Moreover, many contractors are not aware that they pay less for complying with the Act than costs associated with occupational accidents.

6) Under the OSH Act, governmental agencies such as OSHA, OSHRC, NIOSH, and subordinate federal agencies nationwide are acting for occupational safety. In a comparison with Japan, the scope of governmental administration is less expansive nationwide in the U.S., and there are very few incentives for individual workers. The governmental involvement in occupational safety seems to run short of the level necessary to cover this huge country.

7) High wages and short working hours are attractive enough for young people to work for temporary cash earnings. These temporary workers are beneficial to contractors who stress minimizing surplus labor costs. However, these young

workers are generally less skilled and less experienced, and thus they are prone to occupational accidents.

8) The short-term oriented relationship between contractors and workers and between contractors adversely influences the efforts to reduce the number of occupational accidents. Contractors can hire and fire workers relatively easily according to work load. This promotes the rapid turnover of workers, fails to establish positive or friendly relationships between contractors and workers, and undermines long-term interest in job-site safety. The above argument can be applied to the relationship among contractors as well. Contractors endeavor to improve their own safety records, but are generally indifferent to activities and measures for safety implemented by others.

9) Consequently, subcontractors are at a disadvantage in improving their safety performances because they can hardly expect supervision or support for safety from prime contractors. This adverse situation in which U.S. subcontractors are placed resembles the situation of Japanese subcontractors. Both in the U.S. and Japanese construction industries, subcontractors have suffered from a preponderance of occupational accidents.

10) The short-term relationship fails to promote the bottom-up or grass-root safety activities such as TBM.

Figure 4.12 illustrates the above arguments.

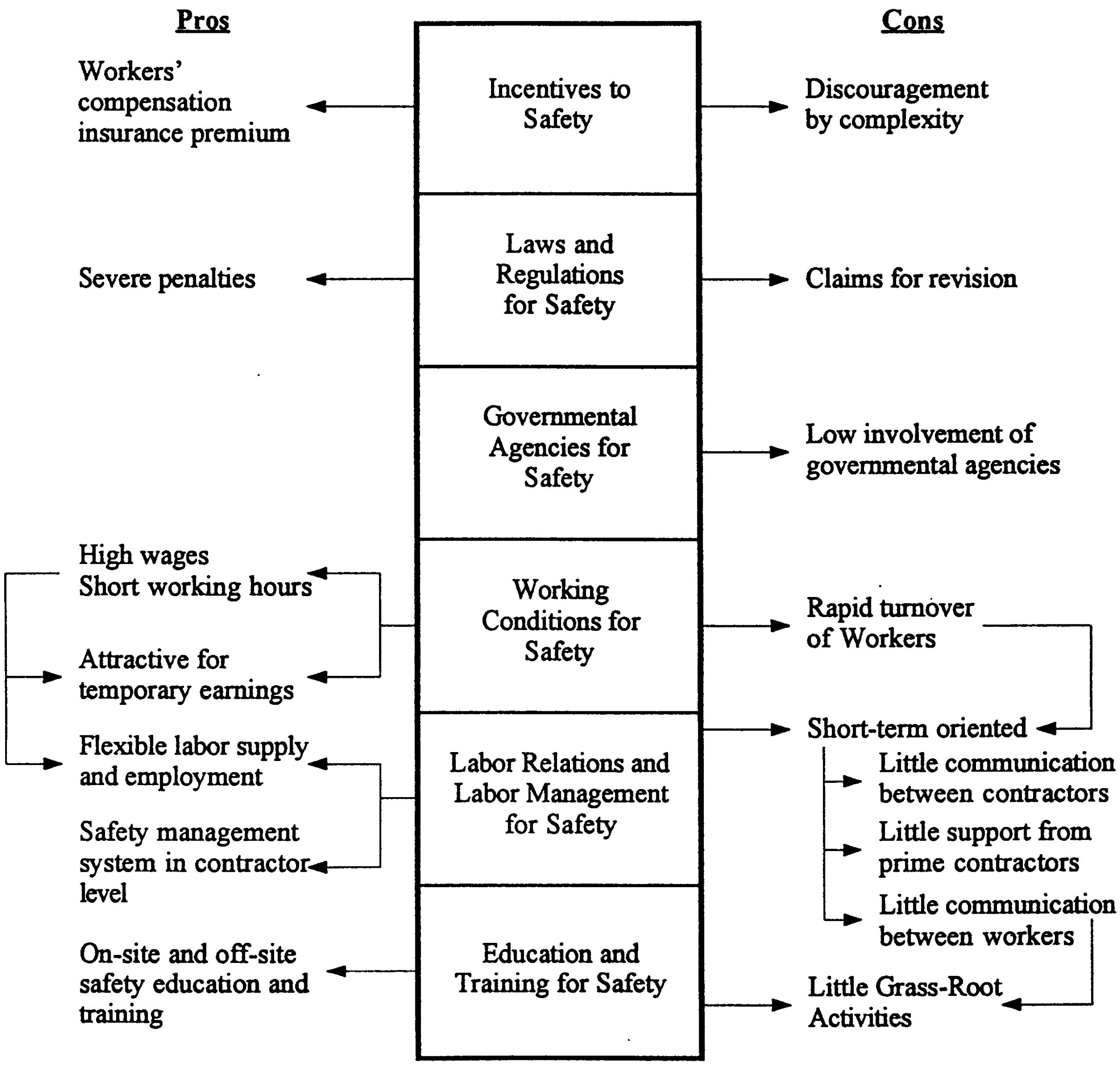


Figure 4.12 Pros and Cons of the U.S. Construction Industry in Preventing Occupational Accidents

Chapter 5

Conclusions and Recommendations

5.1 Conclusions

For the purpose of assuring comfortable workplaces and reducing the number of occupational accidents, Japan and the U.S. enacted laws regarding occupational safety almost at the same time: the Industrial Safety and Health Law in Japan (1972) and the Occupational Safety and Health Act (OSH Act) in the U.S. (1970).

The Japanese and the U.S. construction industries have sought to reduce occupational accidents, in complying with the Industrial Safety and Health Law and the OSH Act, respectively. The Japanese construction industry has successfully improved occupational safety over the past two decades; fatal and nonfatal injuries have decreased both in number and incidence rates. However, the industry has accounted for the largest portion of occupational accidents in Japan: about 30 % of the total nonfatal and fatal injuries and about 40 % of the total fatal injuries annually. On the other hand, the U.S. construction industry has accounted for about 10 % of the total nonfatal injuries and about 20 % of the total fatal injuries annually. These percentages are much lower than those of the Japanese industry. However, the U.S. industry has not succeeded in reducing the number of occupational accidents; the number of nonfatal injuries has experienced insignificant change over the past two decades. In addition, the number of fatal injuries has increased in the last three years from 1992 to 1994.

To clarify the characteristics of occupational accidents in the Japanese and the U.S. construction industries, Chapter 3 examines the statistics on occupational accidents in Japan and the U.S. The examination of the statistics reveals characteristics which are common to both construction industries and characteristics which are different between the two countries. The following findings summarize these characteristics:

Common characteristics

- Fatal occupational injury incidence rates have drastically decreased in both construction industries. In 1994, there is little difference in the incidence rates between two countries: 0.070 in Japan and 0.071 in the U.S. (per 1,000,000 man-hours worked).
- The distribution of fatal occupational injuries by cause illustrates that falls have accounted for the largest portion of occupational accidents in both construction industries.
- Fatal occupational injury incident rates in civil engineering construction are higher than in building construction in both construction industries.

Different characteristics

- The construction industry has accounted for the largest portion of occupational accidents in Japan. However, in the U.S., the manufacturing industry accounts for the largest portion of occupational accidents.
- Both the number and the incidence rate of nonfatal occupational injuries have successfully decreased in the Japanese construction industry. However, there is no significant improvement regarding nonfatal occupational injuries in the U.S. construction industry
- The great majority of occupational accidents are incurred by older workers in the Japanese construction industry; workers older than 50 years old account for about 50 % of the accidents in 1994. In contrast, in the U.S., the great majority of occupational accidents are incurred by younger workers; workers

younger than 35 years old accounted for about 60 % of the accidents in the U.S. in 1994.

- Smaller establishments incur higher occupational accident incidence rates than larger establishments in the Japanese construction industry. On the other hand, in the U.S. construction industry, middle size establishments with 100 to 249 employees incur the highest incidence rates, and small establishments with 1 to 19 employees incur the lowest incidence rates.
- Special trade construction such as plumbing, heating and air-conditioning, and electrical work, has accounted for the great majority, about 60 %, of occupational accidents in the U.S. construction industry. In contrast, such construction to install equipment has accounted for a small portion, about 10 %, of occupational accidents in the Japanese construction industry.

Chapter 4 discusses management and measures implemented for occupational safety in each construction industry and compares them. The discussion helps explain some of the characteristics of occupational accidents in each industry clarified in Chapter 3. The comparison helps examine the pros and cons of their management and measures. Consequently, this chapter reveals that management systems for occupational safety differ significantly in many aspects between the two construction industries. It presents the following findings:

<u>Japanese construction industry</u>

- The multi-layered subcontracting and the paternalistic contractual relationship common in the industry force small contractors, who generally operate as subcontractors, to incur heavier casualties and higher injury incidence rates than large contractors. They diminish incentives for subcontract workers to promote their safety, thus increasing the workers' risk of occupational accidents.

- The bad image of the industry, resulting from low wages, long working hours, and dangerous working conditions, undermines the recruitment of young workers, and thus increases the dependence on older workers. This results in the increase of occupational accidents incurred by older workers. Since older workers account for the great majority of fatalities caused by falls, the most common cause of fatal injuries, the increase of young workers helps decrease fatalities in the industry.
- The decrease in the number of young workers promotes the recruitment of workers who are informally hired by subcontractors such as seasonal workers. These informally hired workers generally lack long-term interest in their safety.
- Governmental sanctions give contractors and workers the strongest incentives to improve their safety performance. These sanctions take the form of the down-grading of contractors' rankings, the suspension of bid-designation to contractors, and the suspension or revocation of workers' licenses. Governmental agencies such as the Ministry of Construction and the Ministry of Labour have the authority to impose these sanctions on contractors and workers for their poor safety performances.
- Considering flaws resulting from the system of multi-layered subcontracting, the industry provides two levels of safety management systems: the safety management system organized by each contractor, and the overall safety management system organized by the entity composed of prime contractors and their subordinate contractors. These systems encourage contractors to implement cooperative measures and activities to improve their overall safety performance.

- The long-term relationship based on mutual trust promotes communication among workers and among contractors. This helps establish the bottom-up approach to safety. Based on this relationship, workers are strongly motivated to participate in grass-root safety activities such as TBM and KYK.

<u>U.S. construction industry</u>

- The workers' compensation insurance premium gives contractors strong incentives to improve their safety performance. Poor safety performance increases the insurance premium, undermines contractors' competitiveness, and thus leads to the loss of their business in this competitive market.
- However, this insurance premium has flaws in its complex calculation and three year rating period, which diminishes contractors' incentives seriously. Many contractors do not understand how their insurance premium is calculated or how their safety performance influences costs of their future projects. Besides, the insurance premium imposed on a contractor is calculated based on his/her safety record, not on the safety record of a group of contractors engaged in the same project. Therefore, the insurance premium gives no incentive to encourage each contractor to cooperate with other contractors to improve overall occupational safety.
- The OSH Act provides severe penalties for the violation of the Act. However, its regulations and standards seems unrealistic and impractical to contractors, giving contractors negative impressions of the Act such as: compliance with the Act increases costs of projects, the Act does not help decrease occupational accidents, and the Act should be revised. Because of these flaws, many contractors are not aware that compliance with the Act costs less than the direct or indirect costs associated with occupational accidents.

- These hidden flaws of the insurance premium system and the OSH Act seem to be major causes which undermine contractors' incentives for safety; thus, preventing the reduction of the number of nonfatal occupational injuries in the industry.

- The scope of governmental administration for occupational safety is less expansive nationwide in the U.S than in Japan. The numbers of local offices and inspectors are insufficient to enforce the standards and regulations of the OSH Act thoroughly in this expansive country.

- High wages and short working hours are attractive to young people looking for temporary cash earnings. These temporarily hired young worker are, however, generally unskilled and inexperienced, and have little interest in their long-term safety. Consequently, these young workers are prone to incur occupational accidents. This seems to explain the reason why young workers account for the great majority of nonfatal occupational injuries.

- The rapid turnover and the short-term relationship with employers promote negative feelings about employers and their jobs, and deteriorate workers' long-term interest in their safe performance. Moreover, they discourage workers from initiating spontaneous activities and measures to improve their safety performance.

- The short-term oriented relationship between contractors adversely influences the reduction of the number of occupational accidents. Under the short-term relationship between contractors, each contractors puts great emphasis on improving his/her safety record, and has very little interest in his/her co-contractors and subordinate contractors. Therefore, it is very difficult to incorporate contractors into cooperative management to improve their overall safety performance.

- The short-term relationship between contractors discourages prime contractors from supervising their subordinate contractors' safety performance. Therefore, subordinate contractors can hardly expect support and supervision for safety from their prime contractors. In this environment, subcontractors are prone to diminish their incentives to assure safe performance.

5.2 Recommendations

Based on the above arguments, the following recommendations are presented to the Japanese construction industry and the U.S. construction industry:

Japanese construction industry

The Japanese approach to occupational safety in the construction industry seems to be on the way to improvement; occupational accidents have decreased both in number and in incidence rates. However, the industry has several areas of serious concerns regarding safety: unattractive working conditions, the bad image of the industry, the decreasing number of young recruits, the aging of workers, and informally hired workers. These problems are interconnected, and have their roots in the unattractive working conditions of the industry. Therefore, it is crucial for the industry to strive to improve working conditions so as to attract young recruits to the industry. In addition, the industry needs to improve the multi-layered subcontracting system. Owners and prime contractors need to be more aware that subcontractors are disadvantaged financially and contractually in assuring safety performance. Prime contractors should avoid making informal contracts with subcontractors and should allocate reasonable expenses for safety measures in their contracts. Owners and architects/engineers also need to be prudent in estimating project costs; they need to consider carefully what sort of dangers are foreseen, when and where such dangers result in occupational accidents, how such accidents can be eliminated or reduced, and how much they should allocate for this purpose in their budget.

U.S. construction industry

The construction industry has successfully lowered fatal occupational injury incidence rates, but it has not decreased nonfatal occupational injuries or lowered nonfatal occupational injury incidence rates significantly. The industry needs to strategize about how they can reduce nonfatal injuries, particularly minor injuries such as surface wounds and bruises. For this purpose, contractors and workers need to put more emphasis on cleaning and maintenance of their workplaces. They also need to promote mutual communication so that everyone involved can foresee hidden dangers in the site. These arguments stress the importance of their cooperation to assure not only individual safety, but also to assure overall safety. In addition, the OSH Act seems to need revision. In addressing many claims from contractors, the affiliated governmental agencies such as OSHA need to consider how the Act and its regulations and standards can be used and followed more easily by industries which must comply with the Act. Additionally, the flaws inherent to the workers' compensation insurance, stemming from its complex calculation, insurance companies need to offer contractors and workers regular lectures about the insurance to promote understanding. Support and involvement of insurance companies play a very important role in increasing the incentives for contractors and workers in promoting occupational safety.

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