SAFETY INFORMATION PROFILE

Heavy Construction, Concrete and Masonry, Non-Highway

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PREFACE

The information in this profile was prepared in accordance with the provisions of NIOSH Contract #210-78-0130-0000 and is only one of twenty-seven Industry Profiles prepared under the contract. The reader should understand that this study is not intended to be an in-depth analysis, but rather, a limited overview of the industry. Each individual profile was prepared by a Profile Manager utilizing approximately 45 hours of professional time. Each profile is a reflection of the available literature, and other information obtained from industry, government, and labor contacts. Information Profiles are primarily intended for use in determining future study needs, priorities and directions. From this preliminary study may come various in-depth studies such as criteria documents, technology assessments, epidemiological studies, etc.

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EXECUTIVE SUMMARY

Information and data are lacking in almost every area dealing with heavy concrete and masonry construction. The last major statistical study of illness and injury within the heavy construction industry was performed in 1967 and was based on 1961 data. Additional work should be accomplished in this area to update the present literature.

The 1975 heavy construction industry fatality rate was the highest of all construction categories and was eight times the rate for the rest of the private sector.

The injury and illness frequency rate for heavy non-highway construction has dropped consistently from 1972 to 1975. The total injury incidence rate is still nearly twice that of the private sector.

Major causes of disabling injury within the non-highway heavy construction industry are, by decreasing prominence, "struck by or against", "strain or overexertion", and "falls".

Strains and sprains have been listed as the largest single injury type for all accidents. In one study, approximately one-third of all disabling injuries were found to be in the categories of strains, sprains, dislocations, and hernias.

The findings in the studies of heavy non-highway construction may or may not reflect injury/illness patterns in the heavy concrete and masonry (other than highway) construction industry.

A. Standard Industrial Classification

This profile deals with the area of heavy concrete and masonry construction, excluding highway construction. It would fall under the standard industrial classification (SIC) of major group 16 - "Construction other than building construction", and would further be defined under SIC 162- "Heavy construction, except highway and street construction".(1) There are three major subdivisions or four-digit SIC's that fall under SIC 162, and each deals with a certain area of heavy construction, except for the last one which is a catchall. The first subdivision is SIC 1622 which pertains to bridge and tunnel construction and the second, SIC 1623, deals with construction of water, sewer, pipelines and communication and power lines. There is no single subdivision that relates specifically to concrete and masonry construction; however, most of the heavy concrete and masonry types of construction are included in the third category SIC 1629 - "Heavy construction not elsewhere classified". These include dam construction, furnace construction for industrial plants, hydroelectric plant construction, kiln construction, light and power plant construction, waterway locks, missile facilities construction, sewage treatment plant construction, and water treatment plant construction.

Where possible, information and data regarding SIC 1629 will be referenced. Much of the available information is either limited to the three digit SIC 162 - "Heavy construction, except highway" or pertains to concrete construction as a whole, including buildings.

There were some 17,966 establishments and 539,590 employees listed under SIC 162 - "Heavy construction, except highways" in 1976 by the U.S. Bureau of Census.(2) There were no figures found in any source regarding the numbers of employees strictly involved in heavy concrete and masonry non-highway construction. The distribution of numbers of employees and numbers of establishments by employment-size class for heavy concrete and masonry construction should be similar to that for heavy construction, except highways, shown in Table 1.

UNITED STATES - ESTABLISHMENTS, EMPLOYEES, AND PAYROLL BY INDUSTRY BY EMPLOYMENT - SIZE CLASS: 1976

TABLE 1

(Excludes government employees, railroad employees, self-employed persons, etc. - see "General Explanation" for definitions and statement on reliability of data. Size class 1 to 4 includes establishments having payroll but no employees during mid-March pay period. "D" denotes figures withheld to avoid disclosure of operations of individual establishments, the other alphabetics indicate employment-size class - see footnote.)

SIC code	Industry, establishments, employees, and payroll	Total	Employment-size class								
			1 to 4	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 to 999	1000 or more
162	Heavy Construction, Except Highway										
	No. of Establishments	17,966	9,635	2,867	2,164	1,833	755	452	134	62	64
	No. of Employees	539,590	16,797	21,019	31,802	58,251	53,894	69,422	47,138	42,991	198,276

A: 0-19; B: 20-99; C: 100-249; E: 250-499; F: 500-999; G: 1,000-2,499; H: 2,500-4,999; I: 5,000-9,999; J: 10,000-24,999; K: 25,000-49,999: L: 50,000-99,999; M: 100,000 or more.

U.S. Bureau of the Census, County Business Patterns, 1976, Table 1B.

B. Process Description

There are two basic methods for poured-in-place operations: fixed form construction and slip form construction. Fixed form pouring operations are commonly used in structures of a limited vertical height where ample formwork is not a problem. Slip form construction may be used when the vertical height of the structure is extreme and a continuous slab or member is necessary. Fixed form construction is accomplished by pouring the concrete in the formwork and leaving the formwork in place until the whole pour can stand on its own; whereas, in the slip form process, the formwork is continuously and uniformly raised while a more or less continuous pour takes place.

Poured in place concrete construction consists of erecting the formwork, shoring the formwork, setting the reinforcing iron, pouring the concrete, and then removing the shoring and formwork. The shoring and formwork required to support the weight of the poured concrete, wind load, and force of the falling concrete into the formwork is precalculated and includes a wide safety margin. Reinforcing iron is tied into place and the concrete is poured over this iron inside the formwork. The pouring may take place at certain locations where a ready-mix truck can use a chute and unload directly into the formwork. In other cases, the concrete may be pumped, hoisted in a bucket by a crane, or moved in a buggy by hand or machine; or a combination of the aforementioned. After the concrete has had an adequate amount of time to set where it can support itself, the shoring and formwork are removed. The major difference between fixed form construction

and slip form construction is that the slip forms are controlled by a lifting device which moves the forms to a higher position as the concrete in the lower portion of the formwork sets enough to stand on its own and support the load of another pour above it. Also, reinforcing steel is continuously being placed above the poured concrete to prepare for the next pour.

Pre-cast and prestressed concrete slabs or beams are formed by the same basic procedures as that described for poured in place concrete, except they are cast in sections or lengths which can be handled by cranes or hoists. Prestressed concrete members differ from normally reinforced members in that they have high carbon steel strands running through them, which when placed under tension provide the member with a higher loading capability than those with simple reinforcing. Prestressing is accomplished by either pre-tensioning the strands before the concrete is poured or by post-tensioning the strands after the pour. Post-tensioning is brought about by tensioning the strands encased in a sheath inside the concrete member after the concrete has reached sufficient compression strength. Preformed wall panels may be erected by "tilt-up" construction, wherein a crane lifts the panels into place, and they are then fastened down. Preformed floor slabs may be lifted into place and fastened onto collars on already erected columns or "lift-slab" constructed. Prestressed beams are set into place similarly to the slab construction described above.

Poured in place concrete construction is probably by far the most common type of construction that would be encountered in SIC-1629. Lift-slab and tilt-up construction would be more common in the construction of buildings.

It is hard to think of an example where masonry block, brick, or stone is used in heavy construction today; therefore, little emphasis will be placed on the topic. The process would basically consist of transporting the brick, block, stone, and mortar supplies to the site; erecting a scaffold to work from; mixing the mortar; transporting the masonry materials to the mason; placing the mortar and setting the block.

C. Potential Hazards

On-site hazards to personnel involved in heavy concrete and masonry construction (dams, waste treatment plants, electrical generation facilities, water treatment plants, and etc.) are generally the same as those common to any extensive construction project. Some areas may present a more severe hazard on the heavy construction site compared to that of residential, commercial, and industrial building construction, but the types of hazard are still basically the same. The various categories of hazards are listed and described in the following paragraphs.

(1) Safety Hazards

(a) Falls

Falls include falls from a height to a lower surface (such as from a scaffold, ladder, or roof) and falls on the same level. Falls on the same level often result from slipping or tripping on the walking surface or on an object and landing on the same surface. Falls on the same surface may be the result of the hazard being insufficiently marked, poor housekeeping, or a slippery surface. Often oil mist or kerosene is sprayed on forms to prevent concrete sticking and can possibly add to the problems of slippery surfaces. Falls from heights may include the same causes, but also may result from falling through an opening or off the edge of an elevated surface, or from a collapse or shift of a ladder or scaffold. Concrete and masonry workers in heavy construction are especially susceptible to falls from scaffolding and elevated surfacesbecause of the massiveness of many of the structures worked on.

(b) Materials Handling

Injuries from handling materials may include overexertion or strain, cuts, bruises and minor crushes. Erection and handling of scaffolding, forms, and shoring present the hazard of workers being struck or overexerted while manipulating the materials, as well as by pieces falling and hitting the workers before the pieces are rigidly placed. According to the Corps of Engineers, a great deal of their minor injuries are related to handling reinforcing bar.(3) Injury may also occur while transporting and handling concrete, masonry blocks or brick, and mortar. The operators of ready mix trucks are subject to strain from handling the chute during concrete pouring if the chute is not hydraulically controlled. Injury may also occur from overexertion in moving concrete in buggies, by lifting and moving masonry block and brick, and during the placement of the concrete by shoveling and raking. Handling bricks or masonry block also subjects the worker to possible injury from smashing their fingers or feet. Concrete workers are liable to being struck by concrete buckets hauled by cranes and by moving concrete buggies. Often, a crane operator has to rely totally on hand signals from a signal man and cannot see the workers at the unloading site. When concrete buggies are moving, they are extremely difficult to stop, because of the inertia, and may continue on their path and strike a person or object suddenly placed there.

(c) Falling Objects

Falling objects are are a major concern on a construction site, as a result of the nature of the work requiring workers to be at different elevations

and materials being handled overhead. Objects may inadvertantly be dropped or spilled by workers on a higher elevation, causing potential injury to those below. Materials being handled overhead by cranes and hoists present a danger if the machinery, rope or cable, or connections fail. Hauling concrete overhead in a bucket by a crane always poses the threat that the load may have to be dumped in a hurry if the operator loses control of the load and it appears that the crane will be rolled. Also, according to safety personnel at the Tennessee Valley Authority (TVA), built-up concrete on the bucket edges often falls off during hauling, creating a hazard to those working below.(4)

(d) Hand Tools

Hand tool injuries may result from operating both powered and non-powered hand tools. Injuries sustained from non-powered hand tools are commonly minor cuts, bruises, and crushes from using hammers in placing forms and removing forms, shovels slipping and striking the worker or by use of crowbars, hand saws, or sledge hammers. The primary hazards associated with operating power hand tools (skill saws, power drills, power grinders, etc.) are cuts, flying objects striking the eyes and shock due to electrical shorting.

(e) Equipment Operations

Injuries are always likely when working with mobile machinery or stationary machinery with moving parts. Such items of concern are table saws, jointers,

concrete or mortar mixers, and concrete finishing machines. The major hazard associated with these machines is that of being caught in the moving parts. If the moving parts are slow moving or dull edged, the injury resulting may only be a strain, bruise, or minor crush; whereas, a sharp edged, fast moving part may cause severe cuts or amputations. There is also the hazard on a heavy construction site of workers being struck by heavy earthmoving equipment or trucks and other vehicles moving in and around the site. Additionally, concrete workers operating vibrators (placed internally in the poured concrete to ensure settling) are subject to being electrically shocked if the vibrator is not moisture proof. Operation of cranes or booms to lift buckets of concrete, slabs, or beams near overhead powerlines exposes the operator of the equipment and those in the near vicinity to the hazard of being electrocuted.

(f) Tension Wire Failure

There is the potential for workers in a prestressing yard to receive severe injury if a wire strand snaps under tension. The strands are placed under tension as high as 180,000 psi, and the strands, fittings, or the equipment connected to them can whip across working areas with deadly results if their stored energy is suddenly released.(5) The tension released may result from an equipment failure, from hot welding metal falling on the strand, or from the strand materials being slightly defective or pitted.

(g) Structure Failure

One of the most extreme and severe hazards in the heavy construction industry of concrete and masonry structures is the failure and collapse of the structure itself or the forms and shoring. The occurrence of such an event may be catastrophic or it may only be localized, but the possibility of severe injury or death to workers, resulting from being crushed, struck, or suffocated, is high. Major causes for concrete construction failures are insufficient or defective formwork and shoring, premature removal of false work (formwork and shoring), inadequate reinforcement, low concrete strength attributed to inferior cement or use of insufficient cement, and poor curing conditions during hot and cold weather.(6)

Eye injuries are a potential hazard for any worker operating or working near cutting, grinding, or chipping machinery. Also, included in possible sources of eye injury are the use of high pressure air lines or water lines to clean surfaces or equipment, such as the use of high pressure water lines to clean concrete and masonry equipment.

(h) Combustible Liquids

The storage and use of various flammable and combustible substances on a construction site presents a constant fire hazard. Such sources are gasoline, liquid propane, solvents and thinners, paints, glues, fillers, gas cylinders, etc. The storage of these flammable and combustible liquids, the use of

portable heaters (salamanders), and the cutting and welding of materials throughout the construction site make up the major sources for fires on the site.(7)

(2) Health Hazards

(a) Chemical Hazards

Chemical hazards stem from inhalation, ingestion, absorption through the skin, or reaction with the skin or eyes. The hazards specific to concrete and masonry work are respiratory illnesses and skin diseases. The mixing of concrete or mortar may present two types of respiratory hazards. The first is the development of pneumoconiosis (retention of dust in the lungs) resulting from exposure to portland cement. The second is the development of silicosis, which is much more serious and is brought about by exposure to silica dust (from sand) causing fibrotic formation in the lungs. Another respiratory hazard which may cause decreased pulmonary function may be the inhalation of oil mist from spraying formwork. None of these problems would appear to be likely in the open environment and with intermittent exposure and, in fact, no evidence was found indicating that these are realistic concerns.

Exposure of the skin and eyes to cement and the consequent irritation is a different story. There are reports that irritation does occur to the eyes, probably resulting from the alkalinity of the cement. The various forms of occupational skin disorders observed in cement users, such as masons and concrete workers, may result from the presence of hexavalent chromium in the cement, as well as the abrasive quality of the concrete, and the alkalinity of the cement.(8, 9)

Other chemical hazards can be found in and around the heavy construction site, but those will not be discussed because of their generality to the construction industry and non-specificity to concrete or masonry work.

(b) Physical Hazards

Physical hazards other than noise should not be directly related to concrete and masonry workers. There may be welding or torch cutting, which may cause minor exposure to UV radiation and there may be localized heaters emitting infrared radiation and there may even be industrial x-ray units and lasers occasionally used on-site that may create hazards. Once again, none of these should be directly related to the concrete and masonry work.

Sources of noise for concrete and masonry workers include masonry saws, concrete finishing machines, vibrators and mixers. A review of the existing literature gave no indications as to whether or not these sources exceed the defining limits for hazardous noise sources. Hazardous noise exposure is based on the level of the noise and the duration of the exposure.

Another potential hazard is the development of localized vibration induced injury or Raynaud's syndrome. Raynaud's syndrome is typified by whitening of the fingers due to poor circulation. Numbness and poor control are prime characteristics experienced.(10) The potential source of the hazard is the use of vibrators to settle concrete. There was no indication in the literature as to the extent, if any, that such vibration-related injury exists among these operators, nor if these vibrators are really classified as a potential source of hazard.

D. Existing Hazard Controls

Hazard controls can be in the form of engineered controls, administrative controls, or personal protective equipment. Engineered controls are considered to be the most effective, since they control the source of the potential illness or injury.

Controls available to prevent falls from elevations are the use of safety harnesses and safety nets and the installation of guardrails and toe boards on elevated working surfaces. Quality control of ladders and scaffolds reduces the potential for injury resulting from a failure of the unit. A requirement for scaffold permits is an excellent way to also assure that the materials used are in good repair and that proper erecting techniques have been used. Falls may also be limited by marking openings in the walking surface and tripping hazards. Stairs and ladder steps should be treated with skid proofing, and the bottom of moveable ladders should have friction pads to control slippage of the ladder.

Falls from the same level can be reduced by assuring that proper illumination is available, by promoting good housekeeping, by marking tripping hazards or smoothing them out, by treating the surface with a skid proof material if it is likely to be wet or slippery, and by salting and sanding icy surfaces.

The prevention of injury from manual materials handling is difficult. Much of the hazard potential depends on the willingness of the workers to take their time and be careful. Strains and overexertion may be limited

by encouraging the use of proper lifting techniques (to include limiting the load one takes on) and by using hoists and lifts where possible. In the erection of formwork and scaffolding, each piece should either be fastened immediately or held in place by another worker or hoist until it can be fastened. Additionally, the other single control that may effectively limit materials handling injuries is the wearing of hard hats, gloves, and safety toed shoes or boots. Workers awaiting a bucket of concrete or a beam or slab being hauled by a crane should position themselves out of the path of the loadshould it continue to swing beyond the unloading point. They should also try to protect themselves by positioning their bodies behind a structural member. Any place where concrete buggies are dumped should have a cleated surface so that the buggies may be stopped more easily and better control can be maintained. Ready-mix truck operators should wear hard hats, safety glasses, and safety shoes. The chutes should be hydraulically controlled and should have a system for locking them in place.

Injury from falling objects can be controlled by wearing hard hats, eliminating workers from working over and under each other where possible, placing nets or containment structures around overhead conveyor systems, and by restricting work from areas where materials such as buckets of concrete are being hauled overhead. Safety nets placed under workers or an elevated surface may also protect those below from falling objects. An extra effort should be made by personnel loading concrete buckets to remove excess concrete from the outside of the bucket. Cranes or booms and cables and connections used in lifting objects such as beams, slabs, and buckets

should be inspected often to assure that no mechanical or material failures take place. Materials to be hauled should only be transported when fastened to the cable with an automatic locking connection. Concrete buckets should never be hauled by a crane where it is possible that the stability of the crane could be overcome by a load out of control, resulting either in an inadvertent dumping of the load or overturning of the crane. (This is a lesser consideration with the heavier duty cranes used today.) Anytime a bucket is hauled overhead the unloading door should be positively locked to prevent accidental dumping of the load.

An effort should be made to properly train all personnel in the safe handling of non-powered and powered hand tools. Guards and deadman controls may be extensively used to limit injuries from hand powered tools (guards are required on all portable skill-saws). Ground fault interrupters are a requirement on all 120 volt temporary construction power lines. This equipment could eliminate serious injury to personnel due to a short in the tool. Only moisture proof and grounded tools should be used where the tool may come in contact with moisture, such as the internal concrete vibrator. The wearing of personal protective equipment is also important to the worker using hand tools. Protective gear to be worn while using non-powered hand tools are gloves and hard hats. One should wear safety glasses or a face shield while using portable power saws and grinders.

Injury from mobile and stationary machinery can also be limited by the use of guards. All points of access to open gears and moving parts on concrete and mortar mixers, concrete finishers, and other machinery

should be guarded to prevent the worker from getting caught in the moving parts. The use of feeder devices should be encouraged on power machines where a stock item is normally fed by hand. All powered concrete finishing machines (trowels) should shut off automatically when the hands are removed from the controls.

Traffic controls or signal men should be used on site if the traffic flow is heavy, as in the case of a large earthmoving operation. All large vehicles, such as ready-mix concrete trucks, should be equipped with backup warning signals. If the vehicle is not equipped with a backup warning signal a spotter should be used. Additionally, ready-mix trucks should be equipped with positive independent emergency braking systems.

Operation of cranes or other larger equipment where contact with overhead electrical lines is possible should be limited. Use of cranes and similar equipment in areas with overhead electrical lines should be allowed only when the power has been shut off to that section.

Workers in a prestressing yard must not be allowed in the casting bed during stressing of the strands. Physical barriers (preferably concrete walls) should be placed across each end of the casting bed to protect workers from broken strands. The jack operator should also be placed behind this barrier. The ends of prestressed strands should only be cut with a portable strand cutter or a fast cutting abrasive wheel on a portable grinder in order to reduce the possibility of the strand snapping.

Prevention of formwork and structural failures can be accomplished by following the proper guidelines by the National Safety Council, the American Concrete Institute, and the Scaffolding and Shoring Institute. It is most important to ensure that adequate shoring and formwork are used, that the formwork is not removed until the concrete is adequately cured, that the concrete is sufficiently strong and not inferior, and that the appropriate amount of reinforcing has been used.

Safety glasses should be worn by all workers using high pressure air lines or water lines to clean off equipment or surfaces.

Fire hazard can be reduced by proper storage of flammable substances in posted areas where smoking is forbidden, by use of safety containers to carry and store highly flammable substances like gasoline, by restricting or controlling the use of portable heaters, and by carefully monitoring and controlling cutting and welding operations. Oil mist or kerosene should not be applied to concrete formwork if welding or torch cutting is being done nearby.

Although it is unlikely that a serious respiratory hazard exists for masonry workers during the mixing of the sand and cement, respirators could be used to reduce dust exposures. Respirators could also reduce oil mist exposure during application of oil to the formwork. Either one of these two problems could possibly be eliminated by changing the mixing or application procedure.

The potentially adverse effects of the cement to the eyes and skin can be reduced or eliminated in several ways. Workmen should wear gloves, safety glasses, boots, and clothing covering most of their bodies. Additionally, protective barrier creams may be useful, and the removal of watches and jewelry may also eliminate some of the irritation.

The preferred control of noise or vibration exposure would be to reduce the source of exposure. This may be done by damping out the noise or vibration through engineering controls. Noise exposure can also be reduced by the use of earplugs or time limitation.

OCCUPATIONAL INJURY AND ILLNESS INCIDENCE RATES, PRIVATE SECTOR, BY INDUSTRY, UNITED STATES, 1975 AND 1976

Industry 1/	SIC code 2/	1976 annual average employment (in thousands) 3/	Incidence rates per 100 full-time workers 4/							
			Total cases 5/		Lost workday cases		Nonfatal cases without lost workdays		Lost workdays	
			1975	1976	1975	1976	1975	1976	1975	1976
Private Sector		64,689.8	9.1	9.2	3.3	3.5	5.8	5.7	56.2	60.5
Heavy Construction - Contractors	16	766.9	17.1	16.3	5.9	5.5	11.2	10.7	113.6	109.2
Heavy Construction - Except Highway	162	526.7	18.2	17.1	6.1	5.6	12.0	11.4	118.1	103.5

1/ Totals for divisions and 2- and 3-digit SIC codes include data for industries not shown separately.

2/ Standard Industrial Classification Manual SIC, 1972 Edition.

3/ Annual average employment for nonagricultural industries is based primarily on employment covered by State unemployment insurance program. For those industries in which the unemployment insurance program does not have complete coverage and there is no change in the content of the industry classification between the 1967 and 1972 SIC manuals, estimates from the U.S. Department of Labor's Employment and Earnings Survey, which are based on the 1967 manual, are used. Annual average employment for the agriculture, forestry and fishing division in a composite of data from the unemployment insurance program, and estimates of hired-farm workers engaged in agricultural production (SIC 01 and 02) provided by the Statistical Reporting Service, U.S. Department of Agriculture. The agricultural production estimates are adjusted to excluse employment on farms with fewer than 11 employees.

4/ The incidence rates represent the number of injuries and illnesses or lost workdays per 100 full-time workers and were calculated as: (N/EH) x 200,000 where

N = number of injuries and illnesses or lost workdays
EH = total hours worked by all employees during calendar year
200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

5/ Includes fatalities. Because of rounding, the difference between the total and the sum of the rates for lost workday cases and nonfatal cases without lost workdays does not reflect the fatality rate.

6/ Excludes farms with fewer than 11 employees.

7/ Data conforming to the OSHA definitions for coal and lignite mining (SIC 11 and 12) and metal and nonmetal mining (SIC 10 and 14), and for railroad transportation (SIC 40) were provided by the Mining Enforcement and Safety Administration, U.S. Department of the Interior, and by the Federal Railroad Administration, U. S. Department of Transportation.

NOTE: Dashes indicate no data reported, or data that do not meet publication guidelines.

n.e.c. = not elsewhere classified.

SOURCE: Bureau of Labor Statistics, U.S. Department of Labor.

Chartbook on Occupational Injuries and Illnesses in 1976. U.S. Department of Labor, Bureau of Labor Statistics, 1978, Report 535, Table 1.

CHART 1. WORK INJURIES IN THE HEAVY CONSTRUCTION INDUSTRY, BY KIND OF CONSTRUCTION, 1961

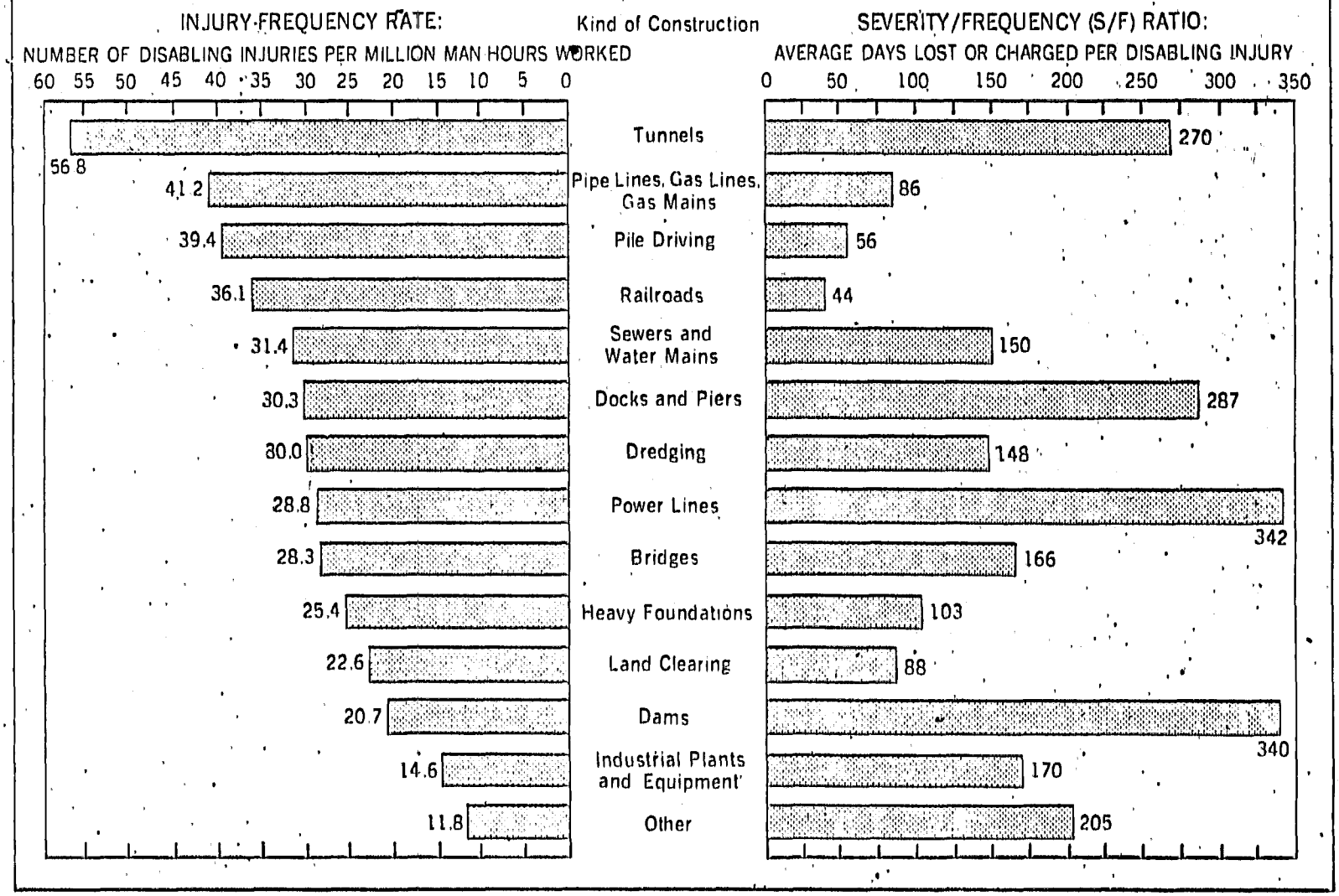
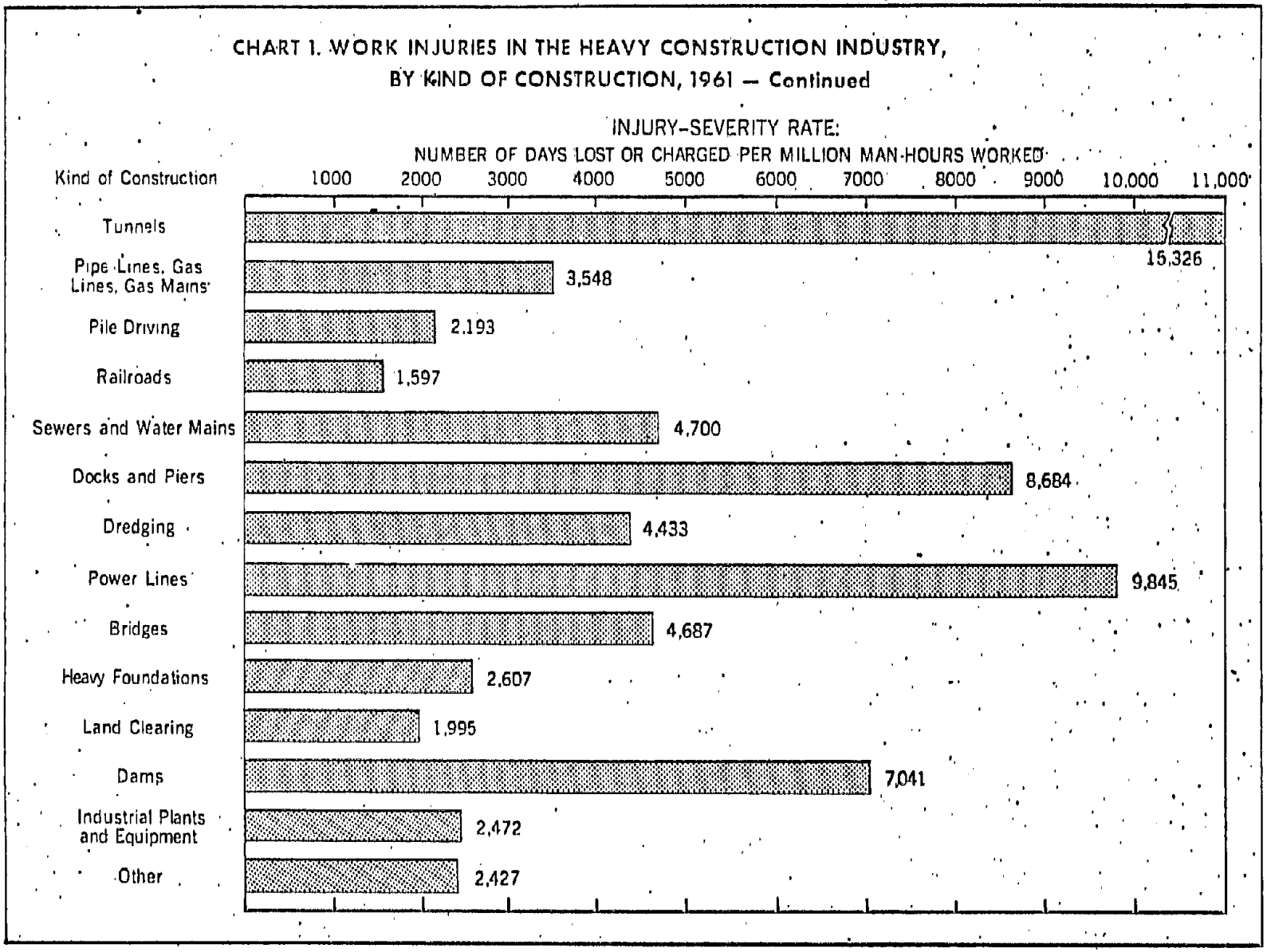


CHART 1. WORK INJURIES IN THE HEAVY CONSTRUCTION INDUSTRY, BY KIND OF CONSTRUCTION, 1961 — Continued



E. Accident and Illness Statistics

Injury and illness statistics specific to heavy concrete and masonry construction, other than highway construction, were essentially non-existent. There are statistics regarding the heavy construction industry in general and also the heavy construction industry other than highway construction. The available statistics are presented in the following paragraphs.

Bureau of Labor Statistics (BLS) data for injuries and illnesses within the heavy construction industry for 1975 and 1976 are shown in Table 2.(11) According to the data presented, the category of heavy construction, except highway (SIC-162), has an incidence rate much greater than that for the average private sector. Also, while the rate increased in all categories of disabling and non-disabling injuries between 1975 and 1976 for the private sector, the incidence rates decreased across the board for SIC-162.

The most recent study of the heavy construction industry that could be found was conducted by the BLS in 1967.(12) The data evaluated was that from a 1961 nationwide compilation of statistical data. Injury frequency and severity data for the various industry subcategories are shown in Chart 1. The two categories which definitely include concrete or masonry construction, heavy foundations and dams, demonstrated injury frequency rates lower than the mean for the entire heavy construction industry. Construction of dams, unlike that of heavy foundations, showed a severity rate higher than the mean or median. In other words, dam construction appeared to have fewer injuries per worker than the other types of heavy construction, but the injuries that did occur were much more severe than those for the average heavy

construction industry. The study also indicated that smaller organizations within the heavy construction industry experienced proportionately more accidents involving disabling injuries than other organizations, but that the accidents were relatively less severe than those experienced in larger organizations. Laborers were found to have the highest injury frequency rate among the heavy construction workers, which was well over the all-industry total rate. The injury frequency rate for craftsmen, foremen and kindred workers was slightly below the all-industry rate. The severity rates for both categories (laborers and craftsmen) were above the all-industry total. Occupations which appeared to be relatively hazardous as determined by the injury frequency, injury severity, or number of lost days were: laborers in dam construction; bulldozer operators; reinforcing ironworkers; craftsmen, foremen and kindred workers in dam and industrial plant construction; and laborers in heavy foundations construction.

California work injury and illness data for 1975 indicated that the category of other heavy construction, which includes the major forms of concrete and masonry construction, had as the highest disabling injury sources: working surfaces and hand tools.(13) Approximately one-third of all disabling injuries were in the category of strains, sprains, dislocations, and hernias. The three major categories of disabling injuries for dam construction and other heavy construction were "struck by or striking against", "strain or over-exertion", and "falls or slips", in order of decreasing prominence.

Oregon injury and illness data for 1977 showed that the major types of accidents occurring in the heavy construction industry, other than highways, were "struck by or against", "overexertion", and "falls", by decreasing frequency rate.(14) Sprains and strains were listed as the most prevalent type of injury in the entire heavy construction industry.

F. Exposure Levels

The only exposure data discovered during the course of the study was noise data for masonry saws, concrete busters, and electric chipping guns. The data gathered in a Hawaiian study is shown below:(15)

Noise Source	Mean Sound Level
Masonry saw	98 dBA
Concrete buster	106 dBA
Electric chipping gun	101 dBA

These levels represent potential noise exposure levels for operators. All levels exceed the allowable 8-hour exposure limit for 90 dBA. The above sources are all below the maximum permissible sound level of 115 dBA. The existence of a hazardous exposure is dependent on the duration of the exposure.

G. Related Studies

No studies - past, present, or future - were identified. Study is lacking except in the area of health related effects. Most of these studies are concerned with workers in cement plants.

H. Industry Trends

In 1978 new construction of all types (excluding home building) was up 10% in dollar value and an 8% growth was forecast for 1979.(16) The contracting volume was within 5% of the all time peak set in 1973. Heavy construction awards for 1979 were predicted to be 3% short of 1978's rise, netting an approximate hike of 6% or about $41 billion in new contracts. Flood control, hydro-electric, and irrigation contracts are expected to slack off while federally funded sewerage and waterworks projects are expected to grow.

I. Existing Standards

(1) OSHA Standards

In the past, no clear definition existed as to which OSHA regulations were applicable to the construction industry. The construction industry is subject to both 29 CFR 1910, "General Industry Standards", and 29 CFR 1926, "Construction Standards and Interpretations". The construction employer has been obligated to comply with general industry standards (from Part 1910) when specific construction standards (from Part 1926) were not available for an area of concern. This meant that construction employers had to constantly keep up with two sets of regulations and many conflicts arose between the industry and OSHA.

A move is currently underway by OSHA to verticalize the 29 CFR 1926 by removing all portions of 29 CFR 1910 which pertain to the construction industry and place them in 29 CFR 1926. As the first phase of the "verticalization" process, a program directive was established, including a list of applicable Part 1910 standards, and was endorsed by the Advisory Committee on Construction Safety and Health.(17) The program directive (OSHA Program Directive #200-88) basically stated that OSHA personnel would continue to enforce those Part 1910 standards that were endorsed as applicable to the industry by the Advisory Committee. It further stated that the only way a citation can be made for a violation of a Part 1910 standard, not contained on the endorsed list, is to seek the approval of the Regional and National Offices. A copy of the newly integrated list of applicable Part 1910 and 1926 standards is presented in Appendix A.

All subparts listed in Appendix A could be applicable to heavy concrete and masonry construction with the possible exception of Subparts R, S, and T. Subpart Q deals specifically with concrete work and forming and shoring and should receive additional attention. In a conversation with members of the OSHA Construction Standards Division it was learned that Subparts M (Floors and Wall Openings) and L (Ladders and Scaffolds) will be reviewed and revised during FY 1979.(18)

Besides the detailed text of standards contained in OSHA regulations, many consensus standards were adopted and incorporated only by reference. These referenced standards are as much a requirement as those written out in 29 CFR 1910 or 1926. Some of these standards that an employer in the construction industry should possess are listed in Table 3.(19)

(2) State Standards

In some instances states have their own occupational safety and health regulations. In all cases they must be a stringent or more stringent than those of OSHA. When work is anticipated in a state with which the contractor is unfamiliar, the contractor should check with either the Regional Office of OSHA or the Department of Labor or Department of Industrial Relations for that particular state. The list of state operated programs is constantly changing.

Table 3

Subject Area	Referenced Standard
Inspect and Maintain Portable Fire Extinguishers	NFPA N 10A-1970
Electrical Installations	NFPA 70 - 1971
	ANSI C 1 - 1971
Traffic Control Signals, Signs and Barricades	ANSI D 6.1 - 1971
Accident Prevention Tags	ANSI Z 35.1 & .2 - 1968
Crane and Hoist Signals	ANSI
Cranes and Derricks	ANSI B 30.2.0 - 1967
	ANSI 30.6 - 1969
Material Hoists	ANSI A 10.5 - 1969
Permanent Elevators	ANSI A 17
Concrete Construction	ANSI A 10.9 - 1970
Machinery Guards	ANSI B 15.1 - 1958
Woodworking Tools	ANSI O 1 - 1961
Ladders	ANSI A 14.2 & .3 - 1956
Gas Welding and Cutting	ANSI Z 49.1 - 1967
Arc Welding and Cutting	National Elect. Code, Art 63
	NFPA 70 - 1971
	ANSI C 1 - 1971
Powder Actuated Tools	ANSI A 10.3 - 1970
Storage of Explosives	I.R.S. regulations
	26- CFR-181 Commerce in Explosives

(3) National Consensus Standards

(a) American National Standards Institute (ANSI)

The American National Standards Institute is the clearinghouse and coordinating body for voluntary standards activity on the national level.(20) Some 250 ANSI standards have been adopted or referenced in the OSHA standards. One of the most comprehensive standards currently available in the U.S. today is the American National Standard Safety Requirements for Concrete Construction and Masonry Work, A 10.9-1970. This comprehensive standard was included in its entirety by reference in OSHA's Construction Safety and Health Regulations, 29 CFR 1926. This standard has been under revision in order to clarify some of the ambiguities that exist.(6)

(b) American Concrete Institute (ACI)

The source document for many of the ANSI A 10.9 provisions is ACI 347-68, which is considered by many to be the most comprehensive standard for concrete construction. ACI publication SP-4, Formwork in Concrete, provides detailed information relative to formwork practice and is, in fact, cited as part of the requirements in the U.S. Army Corps of Engineer's Safety Manual.(6)

(4) Recommended Practices

Two widely distributed practice documents dealing with safety in the construction industry are published by the Scaffolding and Shoring Institute (S & SI) and the Associated General Contractors of America (AGC). The S & SI Recommended Safety Requirements for Shoring Concrete Formwork provides guidelines primarily in shoring and reshoring. The AGC Manual of Accident Prevention in Construction discusses safety in concrete construction in Chapter 27, but covers shoring to some degree less than the S & SI document and omits lateral load requirements for shoring.(6)

J. Names of Industry Associations, Unions, Other Interested Parties

American Society for Concrete Construction
329 Interstate Road
Addison, IL 60101
(312) 543-0870

Portland Cement Association
5420 Orchard Road
Skokie, IL 60076
(312) 966-6200

American Concrete Institute
P.O. Box 19150, Redford Station
Detroit, MI 48219
(313) 532-2600

National Safety Council
444 N. Michigan Avenue
Chicago, IL 60611
(312) 527-4800

United Cement, Lime and Gypsum Workers International Union
7830 W. Lawrence Avenue
Chicago, IL 60656
(312) 774-2217

American Federation of Labor - Congress of Industrial Organizations (AFL-CIO)

815 16th St. N.W.

Washington, D.C. 20006

(202) 637-5000

Associated General Contractors of America

1957 E. St., N.W.

Washington, D.C. 20006

(202) 393-2040

K. Names and Addresses of Companies

The list of heavy construction contractors below was obtained from consulting the different trade associations and the Thomas Register. All of the firms listed were shown to be large with assets of over $1,000,000.

Bechtel Corp.
50 Beale Street
San Francisco, Calif. 94105
415-768-1234

Kaiser Engineers Division
Kaiser Center
300 Lakeside Drive
Oakland, Calif. 94666
415-271-4257

Hardaway Company
300 East 11th Street
Columbus, Ga. 31902
404-322-3274

Morrison-Knudsen Co., Inc.
P.O. Box 7808
Boise, Idaho 83729
208-345-5000

Al Johnson Construction Co.

1700 N.W. Financial Center

Minneapolis, Minnesota 55431

612-831-8151

Steers, J. Rich Inc.

17 Battery Place

New York, N. Y. 10004

212-943-3500

General Energy Resources

U.S. Route 130

Willingsboro, N. J. 08046

609-387-3700

Industrial Contractors, Inc.

1577 Skyline Drive

Idaho Falls, Id. 83401

208-522-6745

Farrell Construction Co., Inc.

101 W. Ash

Brinkley, Ark. 72021

501-734-2300

Dravo Corporation

Eastern Construction Division

1800 One Oliver Plaza

Pittsburgh, Pa. 15222

412-771-1200

Dravo Corporation

Western Construction Division

225 108th Street, N.E.

Bellevue, Washington 98009

206-454-2049

L. Summary Analysis of Data

Limited conclusions can be drawn regarding heavy concrete and masonry construction from reviewing the available data. Most conclusions are general with regard to the heavy construction industry as a whole or to that category other than highway construction.

The injury and illness frequency rate for "heavy construction, except highway" consistently dropped from 1972 through 1975.(21) The incidence rate for disabling and nondisabling injuries is still nearly twice that of the private sector. Laborers in this category have been reported to have the highest injury frequency rate among heavy construction workers. In 1975 the heavy construction industry had 62 fatalities per 100,000 fulltime workers. This rate was the highest of all the construction industry categories and nearly eight times that of the rate for the rest of private industry.(21)

Studies in California and Oregon showed that the major accident categories resulting in disabling injuries within the areas of "heavy construction other than highways" were "struck by or against", "strain or overexertion" and "falls". Sprains and strains have been listed as the largest category of total injuries.

The Tennessee Valley Authority has indicated that falls from elevations were responsible for most fatalities and serious injuries on their electrical generation plant and dam construction sites.(4) Construction of dams has been found to have an injury frequency rate less than the average of the other categories within heavy construction, but the injuries are usually much more severe. This may be due to the falls from extreme elevations.

REFERENCES AND SOURCES

1. Office of Management and Budget (1972), Standard Industrial Classification Manual, U.S. Government Printing Office, Washington, D.C., 1972, pp. 49-51.

2. U.S. Bureau of Census (1976), "County Business Patterns", U.S. Department of Commerce, Washington, D.C., 1978, p. 8.

3. Communication with Mr. Harlan Lewis, Safety Specialist, Omaha Division of U.S. Army Corps of Engineers - January 10, 1979.

4. Communication with Mr. David Graves, Assistant Director of the Division of Construction Safety of Tennessee Valley Authority (TVA) - January 11, 1979.

5. --- (1971), "Prestressed Concrete", Safety Data Sheet #629, National Safety Council, Chicago, Illinois, 1971.

6. Lew, H.S. (1976), Safety During Construction of Concrete Buildings-A Status Report, Center for Building Technology, National Bureau of Standards, U.S. Department of Commerce, Washington, D.C., January 1976, p. 4.

7. --- (1972), "Fire Prevention and Control on Construction Sites", Safety Data Sheet #491, National Safety Council, Chicago, Illinois, 1972, p. 1-7.

8. Prodan, L. (1976), "Cement", Encyclopedia of Occupational Health and Safety, Vol. I, McGraw-Hill Company, New York, Arranged by the International Labor Office (ILO), 1976, pp. 277-279.

9. --- (1978), "Is Cement Hazardous to Your Health?" Construction Contracting, McGraw-Hill Company, New York, March 1978, pp. 78-79.

10. National Institute for Occupational Safety and Health, (1977), Occupational Diseases - A Guide to Their Recognition, U.S. Government Printing Office, Washington, D.C., June 1977, pp. 517-518.

11. --- (1976), Chartbook on Occupational Injuries and Illnesses in 1976, U.S. Department of Labor, BLS, Washington, D.C., Report No. 535, 1978, p. 19.

12. --- (1967), "Work Injuries and Work Injury Rates in the Heavy Construction Industry", U.S. Bureau of Labor, June 1967, pp. 5, 8, 27.

13. --- (1975), "California Work Injuries and Illnesses - 1975", State of California Department of Industrial Relations, Division of Labor Statistics and Research, San Francisco, California, August 1977, pp. 40, 46, 47, 54.

14. --- (1977), "Oregon Work Injuries and Illnesses, 1977", State of Oregon Worker's Compensation Department, Research and Statistics Section, September 15, 1978, pp. 34, 64, 71, 77.

15. Wayshak, G. (1972), "Construction Equipment Noise Is Above Ear Damaging Level", Journal of Environmental Health, Vol. 36, No. 2, October 1973, pp. 147-151.

16. --- (1978), "Construction Forecast '79", Construction Contracting, McGraw-Hill, Hightstown, N.J., Vol. 60, No. 12, December 1978, pp. 15-17.

17. U.S. Department of Labor Program Directive No. 200-88, October 10, 1978.

18. Personal communication with Mr. Allan (Ike) Martin, U.S. Department of Labor, OSHA, Construction Standards Division, Washington, D.C., December 14, 1978.

19. Bush, V.G., (1975), Safety in the Construction Industry: OSHA, Reston Press, Reston, VA, 1975, p. 10.

20. American National Standards Institute (ANSI), American National Standards for Safety and Health, ANSI, New York, New York, October 1978, p. 1.

21. Wang, Chaoling and Hilaski, Harvey J. (1975), "The Safety and Health Record in the Construction Industry", Monthly Labor Review, U.S. Department of Labor, BLS, March 1978, pp. 3-9.

APPENDIX

APPENDIX A ATTACHMENT

29 CFR 1926 SAFETY AND HEALTH REGULATIONS AND 1910 STANDARDS IDENTIFIED AS APPLICABLE TO CONSTRUCTION WORK

SUBPART A - GENERAL

1926.1 Purpose and scope
1926.2 Variances from safety and health standards
1926.3 Inspections-right of entry
1926.4 Rules of practice for administrative adjudications fc enforcement of safety and health standards

SUBPART B - GENERAL INTERPRETATIONS

1926.10 Scope of subpart
1926.11 Coverage under section 103 of the act distinguished
1926.12 Reorganization Plan No. 14 of 1950
1926.13 Interpretations of statutory terms
1926.14 Federal contracts for "mixed" types of performance
1926.15 Relationship to the Service Contract Act; Walsh-Healey Public Contracts Act
1926.16 Rules of construction

*1910.11 Applicability of Federal standards
*1910.12 Construction standards - Part 1926
*1910.16 Longshoring
*1910.19 Application of 1910.1001 (Asbestos)

SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS

1926.20 General safety and health provisions
1926.21 Safety training and education
1926.22 Recording and reporting of injuries (Reserved)
1926.23 First aid and medical attention
1926.24 Fire protection and prevention
1926.25 Housekeeping
1926.26 Illumination
1926.27 Sanitation
1926.28 Personal protective equipment

*The 29 CFR 1910 standards identified in the document will be cited where appropriate.

*1910.132(b)(c) - Employee owned and design of equipment
*1910.136 Foot protection
*1910.136 Footwear for employees

1926.29 Acceptable certifications
1926.30 Shipbuilding and ship repairing
1926.31 Incorporation by reference
1926.32 Definitions

SUBPART D - OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROLS

1926.50 Medical services and first aid
1926.51 Sanitation

*1910.141(a)(2)(v) - Potable water
*1910.141(a)(5) - Vermin control
*1910.141(g)(2) - Eating and drinking areas
*1910.141(h) - Food handling
*1910.151 Medical services and first aid
*1910.151(c) - Quick drenching or flushing of eyes

1926.52 Occupational noise exposure
1926.53 Ionizing radiation
1926.54 Nonionizing radiation
1926.55 Gases, vapors, fumes, dusts, and mists

*1910.161(a), (2) - Safety requirements in using carbon dioxide

1926.56 Illumination
1926.57 Ventilation

SUBPART E - PERSONAL PROTECTIVE AND LIFE SAVING EQUIPMENT

1926.100 Head protection
1926.101 Hearing protection
1926.102 Eye and face protection
1926.103 Respiratory protection

*1910.94(a)(i)(ii), (5)(i)(ii)(b)(c), (8) - A continuous flow air-line respirator
*1910.94(c)(3)(i), (4), (7) - Abrasive blasting
*1910.134 Respiratory protection
*1910.134(a), (b), (c), (d), (e)(f)(g) - Respiratory protection

1926.104 Safety belts, lifelines, and lanyards
1926.105 Safety nets
1926.106 Working over or near water
1926.107 Definitions applicable to this subpart

SUBPART F - FIRE PROTECTION AND PREVENTION

1926.150 Fire protection
1926.151 Fire prevention
1926.152 Flammable and combustible liquids

*1910.106(a)(22) - Definition of marine service station
*1910.106(g)(1)(i)(g) - Storage tanks
*1910.106(g)(4) - Marine service stations

1926.153 Liquified petroleum gas (LP-Gas)

*1910.110(b)(5)(iii) - Marking container
*1910.110(d)(1), (2) - Other than DOT specifications
*1910.110(d)(7)(vii)(a-f) - Installation of storage containers
*1910.110(d)(7)(viii) - Field welding
*1910.110(d)(10) - Damage from vehicles

1926.154 Temporary heating devices
1926.155 Definitions applicable to this subpart

SUBPART G - SIGNS, SIGNALS, AND BARRICADES

1926.200 Accident prevention signs and tags
1926.201 Signaling
1926.202 Barricades
1926.203 Definitions applicable to this subpart

SUBPART H - MATERIALS HANDLING, STORAGE, USE, AND DISPOSAL

1926.250 General requirements for storage

*1910.30(a)(1), (2), (4), (5) - Dockboard requirements

*1910.176(c) - Housekeeping

1926.251 Rigging equipment for material handling

*1910.184(c)(2), (3), (5), (7), (10), (11), (12) - Safe operating practices
*1910.184(e)(3)(i), (ii) - Inspection records
*1910.184(f)(2)(3), (4) - Wire rope slings
*1910.184(h)(2)(3)(iv)(v), (4), (5)(i-iv) - Natural and synthetic fiber rope slings
*1910.184(i)(2), (3), (4), (6), (7), (9) - Synthetic web slings

1926.252 Disposal of waste materials

SUBPART I - TOOLS - HAND AND POWER

1926.300 General requirements

*1910.212(a)(3)(i-iii) - General requirements for machine guards
*1910.212(a)(5) - Enclosure of blades
*1910.212(b) - Anchoring fixed machines

1926.301 Hand tools
1926.302 Power operated hand tools

*1910.244(b) - Abrasive blast cleaning nozzles

1926.303 Abrasive wheels and tools
1926.304 Woodworking tools

1926.305 Jacks - level and rachet, screw and hydraulic
*1910.244(a)(2)(iii-vi) - Operation and maintenance of jacks

SUBPART J - WELDING AND CUTTING

1926.350 Gas welding and cutting
1926.351 Arc welding and cutting
1926.352 Fire prevention
1926.353 Ventilation and protection in welding, cutting, and heating
1926.354 Welding, cutting and heating in way of preservative coatings

SUBPART K - ELECTRICAL

1926.400 General requirements
1926.401 Grounding and bonding
1926.402 Equipment installation and maintenance
1926.403 Battery rooms and battery charging
1926.404 Hazardous locations
1926.405 Definitions applicable to this subpart

SUBPART L - LADDERS AND SCAFFOLDING

1926.450 Ladders
1926.451 Scaffolding

*1910.28(a)(15) - Material hoisted onto a scaffold
*1910.28(a)(18) - Work on scaffolds during storms
*1910.28(a)(20) - Tools, materials and debris accumulation
*1910.29 Manually propelled mobile ladder stands and scaffolds (towers)
*1910.29(a) - General requirements
*1910.29(c)(1)-(7) - Mobile tubular welded section folding scaffolds

1926.452 Definitions applicable to this subpart

*1910.21(g) - Definition of manually propelled mobile ladder stands and scaffold towers

SUBPART M - FLOORS AND WALL OPENINGS, AND STAIRWAYS

1926.500 Guardrails, handrails, and covers

*1910.23(b)(5) - Guarding of wall holes

1926.501 Stairways
1926.502 Definitions applicable to this subpart

*1910.21(a)(10) - Definition of wall hole

SUBPART N - CRANES, DERRICKS, HOISTS, ELEVATORS, AND CONVEYORS

1926.550 Cranes and derricks
1926.551 Helicopters
1926.552 Material hoists, personnel hoists, and elevators
1926.553 Base-mounted drum hoists
1926.554 Overhead hoists
1926.555 Conveyors
1926.556 Aerial lifts

SUBPART O - MOTOR VEHICLES, MECHANIZED EQUIPMENT, AND MARINE OPERATIONS

1926.600 Equipment

*1910.176(f) - Rolling railroad cars

*1910.169(a), (b) - General, installation and equipment requirements

1926.601 Motor vehicles
1926.602 Material handling equipment
1926.603 Pile driving equipment
1926.604 Site clearing
1926.605 Marine operations and equipment
1926.606 Definitions applicable to this subpart

SUBPART P - EXCAVATIONS, TRENCHING, AND SHORING

1926.650 General protection requirements
1926.651 Specific excavation requirements
1926.652 Specific trenching requirements
1926.653 Definitions applicable to this subpart

SUBPART Q - CONCRETE, CONCRETE FORMS, AND SHORING

1926.700 General provisions
1926.701 Forms and shoring
1926.702 Definitions applicable to this subpart

SUBPART R - STEEL ERECTION

1926.750 Flooring requirements
1926.751 Structural steel assembly
1926.752 Bolting, riveting, fitting-up, and plumbing-up

SUBPART S - TUNNELS AND SHAFTS, CAISSONS, COFFERDAMS, AND COMPRESSED AIR

1926.800 Tunnels and shafts
1926.801 Caissons
1926.802 Cofferdams
1926.803 Compressed air
1926.804 Definitions applicable to this subpart

SUBPART T - DEMOLITION

1926.850 Preparatory operations
1926.851 Stairs, passageways, and ladders
1926.852 Chutes
1926.853 Removal of materials through floor holes
1926.854 Removal of walls, masonry sections, and chimneys
1926.855 Manual removal of floors
1926.856 Removal of walls, floors, and material with equipment
1926.857 Storage
1926.858 Removal of steel construction
1926.859 Mechanical demolition
1926.860 Selective demolition by explosives

SUBPART U - BLASTING AND USE OF EXPLOSIVES

1926.900 General provisions

*1910.109(g)(2)(ii)(a-f) - Blasting agents
*1910.109(h)(3)(ii)(a-f) - Slurry mixing fixed location

1926.901 Blaster qualification
1926.902 Surface transportation of explosives
1926.903 Underground transportation of explosives
1926.904 Storage of explosives or blasting agents

*1910.109(e)(3)(iii) - Pneumatic loading

1926.906 Initiation of explosive charged - electric blasting
1926.907 Use of safety fuse
1926.908 Use of detonating cord
1926.909 Firing the blast
1926.910 Inspection after blasting
1926.911 Misfires
1926.912 Underwater blasting
1926.913 Blasting in excavation work under compressed air
1926.914 Definitions applicable to this subpart

*1910.109(a)(12) - Definition

SUBPART V - POWER TRANSMISSION AND DISTRIBUTION

1926.950 General requirements
1926.951 Tools and protective equipment
1926.952 Mechancial equipment
1926.953 Material handling
1926.954 Grounding for protection of employees
1926.955 Overhead lines
1926.956 Underground lines
1926.957 Construction in energized substations
1926.958 External load helicopters
1926.959 Lineman's body belts, safety straps, and lanyards
1926.960 Definitions applicable to this subpart

SUBPART W - ROLLOVER PROTECTIVE STRUCTURES; OVERHEAD PROTECTION

1926.1000 Rollover protective structures (ROPS) for material handling equipment
1926.1001 Minimum performance criteria for rollover protective structures for designated scrapers, loaders, dozers, graders, and crawler tractors
1926.1002 Protective frame (ROPS) test procedures and performance requirements for wheel-type agricultural and industrial tractors used in construction
1926.1003 Overhead protection for operators of agricultural and industrial tractors

SUBPART X - EFFECTIVE DATES

SUBPART INDEX FOR PART 1926

Safety and Health Regulations for Construction

1926.901 Blaster qualification
1926.902 Surface transportation of explosives
1926.903 Underground transportation of explosives
1926.904 Storage of explosives or blasting agents

*1910.109(e)(3)(iii) - Pneumatic loading

1926.906 Initiation of explosive charged - electric blasting
1926.907 Use of safety fuse
1926.908 Use of detonating cord
1926.909 Firing the blast
1926.910 Inspection after blasting
1926.911 Misfires
1926.912 Underwater blasting
1926.913 Blasting in excavation work under compressed air
1926.914 Definitions applicable to this subpart

*1910.109(a)(12) - Definition

SUBPART V - POWER TRANSMISSION AND DISTRIBUTION

1926.950 General requirements
1926.951 Tools and protective equipment
1926.952 Mechancial equipment
1926.953 Material handling
1926.954 Grounding for protection of employees
1926.955 Overhead lines
1926.956 Underground lines
1926.957 Construction in energized substations
1926.958 External load helicopters
1926.959 Lineman's body belts, safety straps, and lanyards
1926.960 Definitions applicable to this subpart

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1926.1003 Overhead protection for operators of agricultural and industrial tractors

SUBPART X - EFFECTIVE DATES

1926.1050 Effective dates (general)
1926.1051 Effective dates (specific)

SUBPART INDEX FOR PART 1926

Safety and Health Regulations for Construction

* - 1910.401-441 Commercial Diving Operations
* - 1910.1001-1046 Toxic and Hazardous Substances

*1910.1001 Asbestos
*1910.1002 Coal tar pitch volatiles; interpretation of term
*1910.1003 4-Nitrobiphenyl
*1910.1004 alpha-Naphthylamine
*1910.1006 Methyl chloromethyl ether
*1910.1007 3,3' -Dichlorobenzidine (and its salts)
*1910.1008 bis-Chloromethyl ether
*1910.1009 beta-Naphthylamine
*1910.1010 Benzidine
*1910.1011 4-Aminodiphenyl
*1910.1012 Ethyleneimine
*1910.1013 beta-Propiolactone
*1910.1014 2-Acetylaminofluorene
*1910.1015 4-Dimethylaminoazobenzene
*1910.1016 N-Nitrosodimethylamine
*1910.1017 Vinyl Chloride
*1910.1018 Inorganic arsenic
*1910.1028 Benzene
*1910.1029 Coke Oven Emissions
*1910.1043 Cotton dust
*1910.1044 1,2-dibromo-3-chloropropane
*1910.1045 Acrylonitrile
*1910.1046(a) Exposure to cotton dust in cotton gins