

The Evaluation of Occupational Health Program at a Granite Company in U.S.A.

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Introduction

The term quarrying refers to the open pit removal of a wide range of mineral products. The representative operations in quarrying work places are rock drilling, bulk mineral quarrying and dimensional stone quarrying. The well-known health hazards of quarrying workplaces are dust, noise and vibration(Burgess, 1995, p411-21).

There are several approaches to control dust in quarrying work places by the type of operations. The most common dust control techniques for track drills are water mist drilling and local exhaust ventilation. In bulk mineral quarrying, initial attempts at dust control at rock crushes were based on the use of enclosing hoods with a face velocity at all open areas in the 150 to 200 fpm. Since the early 1900s, flame cutting using channel burners has been used in the dimensional stone quarrying. In evaluating dust exposure in quarries, it is extremely important that personal monitoring be conducted. Noise is normally associated with the operation of rock drills in rock drilling and flame cutting in

dimensional stone quarrying. Muff-type ear protection can reduce the noise with an impressive 20-dBA, but the worker will still have an exposure above 100dB. Now many dimensional quarries are using automated burners that permit the operator to stand some distance from the noise source. Vibration is usually introduced to workers with noise. To protect vibration exposure, the intensities of works are recommended to wear protective gloves(Burgess, 1995, p411-21).

Study Method

The subject of this study was one granite company in Massachusetts, U.S.A.. The data for occupational health program of the subject company were collected by field tour and communication with safety manager. The field tour was conducted on March 1st 2000 and the purpose of the tour was to identify the general characteristics of the plant, the types of health hazards and control programs. The collected data were evaluated by types of hazards. The hazard of granite operation was searched by OSHA statistics(<http://www.osha.gov>). With

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time limitation, some program could not be evaluated properly.

Result

1. Plant overview

The study granite company has been a recognized leader in the dimensional quarrying and fabrication of fine granite products since 1881. The study granite factory was the first industry to use quarry wire saws and circle guillotines to produce good qualities of granite. The operations of the granite factory belong to SIC(standard industry classification) 1411 (Granite, dimension-quarrying) and SIC 3281 (Granite, cut and shaped) (<http://www.osha.gov>). The most commonly cited OSHA standards for SIC 3281 from October 2000 to September 2001 were Hazard Communication (1910.1200), Respiratory Protection (1910.0134), Control of Hazardous Energy : Lockout/Tagout (1910.0147), Powered Industrial Trucks(1910.0178) and Occupational Noise Exposure (1910.0095) (www.osha.gov, 2002)<Table 1>.

The operations of the granite factory can be classified 3 major categories: the mountain quarrying<Figure 1> various indoor operations <Figure 2> and transportation with storage. The total number of employees was 142 persons.

Between 22 and 27 employees were working in mountain quarrying and between 50 to 55 employees participated the indoor operations and transportation with storage. With the computerized operations, there had been decreased the number of employees (The safety engineer explanation).

2. Hazards and Controls

Mountain Dimensional Quarrying

The dimensional quarry operations were observed from a distance of 1-2 km on the open railroad car<Figure 1>. Dust exposures, noise and vibration, possibilities of accidents and the poor conditions of personal hygiene were the potential health hazards related to mountain dimensional quarrying.



<Figure 1> Mountain quarrying

<Table 1> General characteristics of the subject granite company

SIC	operation	No. of employees	Frequent OSHA cited : federal level (2000, October-2001, September)
Granite, dimension-quarrying(1411)	mountain quarrying	22-27	No cited
Granite, cutting and shaped(3281)	* various indoor operation * transportation with storage	50-55	* Hazard Communication (1910.1200) * Respiratory Protection (1910.0134) * Control of Hazardous Energy : Lockout/Tagout (1910.0147) * Powered Industrial Trucks (1910.0178) * Occupational Noise exposure (1910.0095)

Dust exposures were related to the operations of pneumatic drilling, wire saws and flame cutter operation. Because the workplace was observed from a long distance, the exact source of dust could not be detected. But with the cloud of dust seen near the flame cutter operation, the dust exposure of employees in this workplace was suspected. To prevent the dust exposure, the granite factory employed the water injection system. According to the presentation of the safety engineer of the granite factory, they applied the local exhaust ventilation systems and the high quality personal protection masks also.

Noise exposure could be detected with the operation of pneumatic drilling, wire saw and flame cutter operation. The safety engineer explained that the personal protection equipment included ears plugs and hearing protectors were supplied.

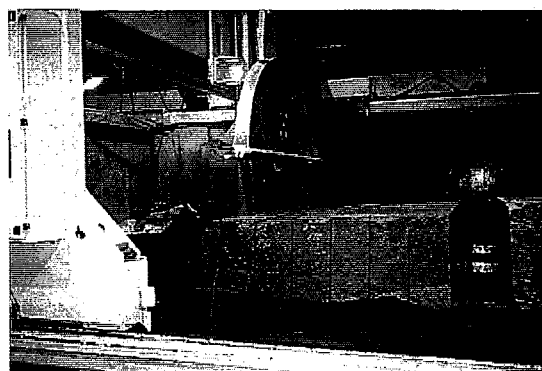
There were some possibilities of accidents and problems of personal hygiene. For example, there were steel bars at the edges of cliff near underground dimensional quarrying area. A worker was to be seen leaning the bar without harness. There might be some safety problems with crane operations. The workplace was in the mountain and it might be difficult to get running water for personal hygiene.

Indoor Operations

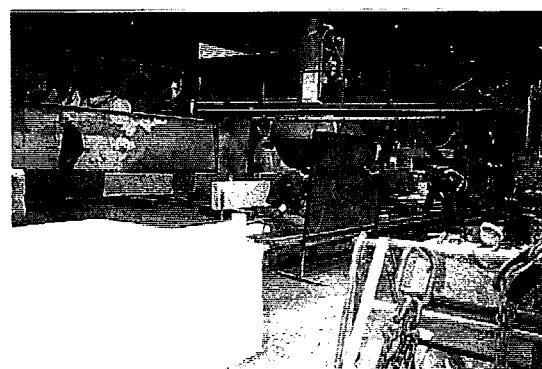
Indoor operation was composed with various operations(Figure 2). Those were the granite dimensional operations with diamond saws (Figure 3), wet jackhammer operations, welding (Figure 4), guillotine dimensioning, pneumatic tools, steam cleaning, grinding and hand finishing. The major health hazards with those operations were noise, dust, radiation exposures



〈Figure 2〉 Indoor operations



〈Figure 3〉 Diamond saw dimensioning



〈Figure 4〉 Welding

and safety problems.

Noise exposures were detected with diamond

saw operations, wet jackhammer operations, welding, guillotine operations and steam cleaning. As there were no walls among operations, all the workers in the workplace were exposed same sources of noises. All the workers were found to use ears plugs but still it was hard for the observers to do normal conversations. Dust exposure was detected with the operations of granite dimensioning, and jackhammer. General ventilation and local exhaust ventilation were used to prevent dust exposure.

Radiation exposure could be happened with the welding(Figure 4). The welding worker used helmet and eye protector during operation, but the attendant did not use any protector for the prevention of radiation exposure.

Safety problems might be related with the operations of diamond saw dimensioning(Figure 3), jackhammer, welding, guillotine, steam cleaning, grinding, wet jackhammer, hand finishing, and indoor transportation. To prevent accidents, all workers wore hard hats, safe

〈Table 2〉 Types of hazards and controls in the subject company

Operation	Hazards	Situation exposed	Controls adopted
mountain dimensional quarrying	dust exposure	* flame cutting operation	* water injection system * local exhaust ventilation * high quality personal protection
	noise exposure	* pneumatic drilling operation * wire saw * flame cutting operation	* ear plug * hearing protection
	possibilities of accident	* operation near the edges of cliff * crane operation	* hard hat * safe shoes * goggles
	problems of personal hygiene	* no running water for personal hygiene	
Indoor operation	noise exposure	* diamond saw operation * wet jackhammer operation * welding * guillotine operation * steam cleaning	* ear plug
	dust exposure	* granite dimensioning * jackhammer	* general ventilation * local exhaust ventilation
	radiation exposure	* welding	* helmet * eye protector * only welding worker not attendant
	safety problems	* diamond saw dimensioning * jackhammer * welding * guillotine * steam cleaning * grinding * wet jackhammer * hand finishing * indoor transportation	* hard hat * safe shoes * goggles * individual controlling system
storage and transportation	noise exposure	* train transportation	* ear plug
	safety problems	* train transportation	* big impact sound * stop signal
general aspects	hard to keep personal hygiene health education		

shoes and goggles. And there were many remote control operations. It was interesting that workers who control the operators never left the controllers during their operations while they handled the granites with one free hand. It is an important operation to prevent accidents.

Storage and transportation

The operations of storage and transportation were the intermediate operation between mountain quarrying and indoor operations. The possible health hazards of those operations were noise exposure and safety problems. To prevent the traffic accident, the train which transported quarried granite made a very big impact sound before crossing the road. Even with the earplug, it was too big sound. For transportation the train had to cross the road and there was no stop signal. It can induce traffic accidents.

In general aspects

In general aspects, some problems were detected. First, it seemed difficult for all workers to keep personal hygiene conditions properly. In mountain quarrying, it was difficult to keep personal hygiene and even in indoor operations it seemed difficult. Eating and drinking was prohibited in the indoor workplace, but the drinking cans and cigarette-butt were found in workplace.

3. Program evaluation

The control programs for health hazards in workplace are consisted with evaluation and control. For evaluation the workplace, hazards investigation, exposure evaluation and health evaluation are necessary. With the trip in the granite factory, some important health hazards were detected. With the findings, program

evaluations were done as follow. The main health hazards were dust exposures (especially silica), noise exposures, safety problems and personal hygiene problems.

Dust exposure control

The programs for dust exposure control consist of exposure evaluations and exposure prevention programs. There are two types of evaluation: personal sampling and environmental sampling. In mountain quarrying, it is difficult to evaluate the environmental sampling but it is necessary for the environmental protection for the residences near the company. No information concerning dust exposure evaluation was provided from the safety engineer. The exposure prevention programs were water jet operations for dimensional operations and local exhaust ventilation and the exposure control program could be seen during the field trip.

Noise control programs

For noise control, personal exposure shall be checked for 8 hours weight average exposure (TWA) and impact sound. And hearing level with audiometer had to be evaluated. In mountain dimensional quarrying, it is sufficient to check personal exposure. For the indoor operation workplace, it is necessary to evaluate the environmental exposure as there are many chances of rebound sound. To prevent noise exposure, personal earplugs shall be recommended and for high level exposure, ear protectors shall be provided. For the indoor operations, sound absorbent materials shall be applied on the inner walls.

Safety Problems

Some safety problems were also detected in the

granite factory. In mountain quarrying, the possibilities of falling accidents were detected. General safety measures included safe vest, harness, warning posting, easy detectable color

painting guards shall be adopted. In indoor workplaces, there could be found many safety measures included one-handed operations with controller operation workers near pneumatic tool

<Table 3> OSHA Standards Cited for SIC 3281 at all sizes company in federal level

Standard	#Cited	#Insp	\$Penalty	Description
19101200	60	21	9485.00	Hazard Communication
19100134	57	18	12437.50	Respiratory Protection
19100147	23	6	8635.00	The Control of Hazardous Energy, Lockout/Tagout
19100178	21	14	4480.00	Powered Industrial Trucks
19100095	19	8	4125.00	Occupational Noise Exposure
19100305	16	11	6670.00	Electrical, Wiring Methods, Components & Equipment
19100132	11	10	3350.00	Personal Protective Equipment, General Requirements
19101000	11	4	2600.00	Air Contaminants
19100107	9	2	3875.00	Spray Finishing w/ Flammable/Combustible Materials
19100212	9	8	10950.00	Machines, General Requirements
19100242	8	8	3145.00	Hand & Portable Powered Tools & Equipment, General
19100303	8	4	2640.00	Electrical Systems Design, General Requirements
19101052	8	1	11550.00	Methylene Chloride
19100176	6	5	7070.00	Materials Handling, General
19100253	6	3	975.00	Oxygen-Fuel Gas Welding & Cutting
19260451	6	1	4000.00	General Requirements for all types of Scaffolding
19100106	5	4	1350.00	Flammable & Combustible Liquids
19100133	5	5	1750.00	Eye & Face Protection
19040005	4	2	0.00	Annual Summary, Occupational Injuries & Illnesses
19100023	4	4	3170.00	Guarding Floor & Wall Openings & Holes
19100037	4	2	1000.00	Means of Egress, General
19100136	4	4	2075.00	Occupational Foot Protection
19100141	4	3	2025.00	Sanitation
19100213	4	2	1200.00	Woodworking Machinery Requirements
19040002	3	3	0.00	Log & Summary of Occupational Injuries & Illnesses
19100022	3	2	900.00	Walking-Working Surfaces, General Requirements
19100036	3	2	725.00	Means of Egress, General Requirements
19100120	3	1	1300.00	Hazardous Waste Operations & Emergency Response
19100138	3	3	50.00	Hand Protection
19100151	3	3	2850.00	Medical Services & First Aid
19100157	3	3	0.00	Portable Fire Extinguishers
19100215	3	2	825.00	Abrasive Wheel Machinery
19100219	3	2	300.00	Mechanical Power-Transmission Apparatus
19100334	3	3	2495.00	Electrical, Use of Equipment
19040017	2	2	350.00	Employee Emergency Plans & Fire Prevention Plans
19100038	2	1	0.00	Overhead & Gantry Cranes
19100179	2	2	0.00	Slings
19100184	2	1	700.00	Bloodborne Pathogens
19101030	2	2	0.00	General Duty Clause (Section of OSHA Act)
5A0001	1	1	730.00	Fatality/Multiple Hospitalization Accident Reportg
19040008	1	1	2500.00	Fixed Industrial Stairs
19100024	1	1	225.00	Safety Requirements For Scaffolding
19100028	1	1	4410.00	Compressed Gases, General Requirements
19100101	1	1	250.00	Storage & Handling of Liquefied Petroleum Gases
19100110	1	1	0.00	Permit-Required Confined Spaces
19100146	1	1	600.00	Automatic Sprinkler Systems
19100159	1	1	0.00	Guarding of Portable Powered Tools
19100243	1	1	1250.00	Electrical, Wiring Design & Protection
19100304	1	1	300.00	Electrical, Selection & Use of Work Practices
19100333	1	1	0.00	Training Requirements for all types of Scaffolding
19260454	1	1	0.00	
Total	364	41	129317.50	

3281 Cut Stone And Stone Products

Listed below are the standards which were cited by Federal OSHA for the specified SIC during the period October 2000 through September 2001. Penalties shown reflect current rather than initial amounts. For more information, see definitions.

Source : [www.osha.gov\(2002\)](http://www.osha.gov(2002))

dressings and diamond saw operations. And slightly tilted postures of hand finishing chisel operation workers could prevent direct exposure to flipping stone fragments in architectural dimensional operation areas. Also the good arrangement of multiple lines was good measure to prevent accidents. But some problems were found. There were no postings for safety measures. Some workers were found walking on the conveyor near dimensioning operation in curbstone production area and it is recommended to write red warning signs on the conveyor (e.g. NO WALKING). Some cigarette-butts were found near welding operation in the indoor workplace. But NO-SMOKING postings were too small to recognize in workplace.

Personal hygiene

It seems that it is difficult to control personal hygiene in the granite factory as there are many operations in mountain and many operations with dust. But it is strongly recommended to apply some facilities to keep personal hygiene to protect employees from diseases. For personal hygiene, running water have to provided in toilet, break room, near entrances. Postings are also necessary such as 'Washing hands before leaving workplaces'.

Discussion

The operations of granite factory can be classified 3 major categories: the mountain quarrying, various indoor operations and transportation with storage. The typical health hazards in the granite factory were dust and noise exposures, possibility of accidents and problems with personal hygiene. Many good programs for safety and health hazards control were found in the granite factory, such as water

jet quarrying, wearing personal protectors included earplugs, hard hats, eye protectors, helmets, harness, thick gloves, safe vests and so on. With time limitation, some program could not be evaluated properly. Some recommendation can be proposed for the additional program evaluations such as the exposure monitoring for dust and noise. And posting for safety and personal hygiene are recommended.

The most commonly cited OSHA standards for SIC 3281 from October 2000 to September 2001 were Hazard Communication (1910.1200), Respiratory Protection (1910.0134), Control of Hazardous Energy ; Lockout/Tagout (1910.0147), Powered Industrial Trucks(1910.0178) and Occupational Noise Exposure (1910.0095) (www.osha.gov, 2002)〈Table 3〉.

There are differences in the standard industry classification between U.S.A. and R.O.Korea. The Korean Standard Industry Classification (KSIC) was renewed in January 2000. The operations of granite company belong to 1411 (Granite, dimension-quarrying) and SIC 3281 (Granite, cut and shaped) (<http://www.osha.gov>) in U.S.A., and KSIC 1212 and 2691 in R.O. Korea. 〈Table 4〉 shows the details of the difference between two countries.

There are three occupation health delivery system in R.O.Korea. The first program is for large scale companies. By law, the employers should employ more than one occupation health nurse(or hygienist, physician). The second program is for middle scale companies. The employers should develop occupational health programs and could delegate the program to occupational health agencies approved by the Ministry of Labor. The last program named "Clean 3D project" is for small scale company.

According to the labor statistics of Ministry of Labor in Korea, there are 546 industries and 9,211 employees for 'Mining of Nonmetallic Minerals, Except Fuels' (KSIC 12). The average number of employee of those companies is 16.9. Among 9,211 employees, 1,277 employees are appeared to work in 'Quarrying and Dimension' industry (KSIC 1212) and the average number of employees per industry was 14.3. The scale of industry for KSIC 2691 is appeared similar to KSIC 1212. Those data show that the most of the quarrying company in Korea belongs to small scale company (<http://laborstat.molab.go.kr>). Therefore, the occupational program for granite company must be included in the 'Clean 3D Project' (Table 5).

The occupational health hazards and programs for granite company in Korea are currently hard to identify. However, the result of this study tells the possible health hazard of employees, the occupational health program and the limitation of the program in the granite

company. The occupational health nursing program for granite company in Korea should be focused on the prevention of dust and noise exposure, and the safety programs including the control of hazardous energy and the accidents from the powered industrial trucks.

Conclusions

The author had conducted an one day field trip at a granite factory on Wednesday March 1st 2000. It was an opportunity to find out the health hazards and to evaluate the occupational safety and health programs of granite dimensional quarrying.

The important health hazards in the workplace, SIC 1411 and 3281, are dust and noise exposure, possibility of accidents and problems with personal hygiene. Many good control programs were found in a granite factory, such as water jet quarrying, wearing personal protectors included earplugs, hard hats, eye protectors, helmets, harness, thick gloves, safe

<Table 4> Comparisons of industry classification index for granite company between U.S.A. and R. O. Korea

Type of business	Classification	U.S.A(SIC)	R.O.Korea(KSIC)
Quarrying	Division	B : Mining	B : Mining
	Major group	14 : Mining and Quarrying of Nonmetallic Minerals, Except Fuels	12 : Mining of Nonmetallic Minerals, Except Fuels
	Industry group	1411 : Dimension stone	1212 : Quarrying and Dimension 12121 : Quarrying stone for construction 12122 : Dimension stone for construction
Manufacturing	Division	D : Manufacturing	D : Manufacturing
	Major group	32 : Stone, Clay, and Concrete Products	26 : Manufacturing Nonmetallic Minerals
	Industry group	3281 : Cut Stone and Stone Products	2691 : Manufacturing stone

<Table 5> The characteristics of granite industry in R.O.Korea

KSIC	description for KSIC	No. of companies	No. of industries	No. of employees	mean no. of employees per industry
1212	Quarrying and Dimension : Mining of Nonmetallic Minerals, Except Fuels	89	89	1,277	14.3
2691	Manufacturing stone : Mining of Nonmetallic Minerals, Except Fuels	876	907	13,136	14.5

vests. And some problems could be found with safety prevention and personal hygiene.

Recommendations

With time limitation, some program could not be evaluated properly. Additional program evaluations are necessary as followed items. Those are the lists of recommendations.

1. The exposure monitoring for dust is recommended. For mountain quarrying workers, personal exposure evaluations are recommended. And for indoor employees, personal and environmental monitoring is required. For the health of residents, remote area environmental monitoring is recommended.

2. To control noise exposure, personal exposure and hearing evaluations are recommended for all employees. Environmental exposure monitoring is necessary for the indoor workers and impact sound monitoring is necessary for the transportation and storage workers. Also sound absorption material is recommended to control rebound sound for the indoor operations.

3. There are quite good safety control programs. Additionally, postings for safety and personal hygiene are recommended. And some warning color paintings are also recommended on the conveyor in indoor operations and on the steel guards in mountain quarrying.

The author thanks the granite factory company to offer the good opportunity to have a field trip and hope that those recommendations are valuable for the health of granite factory employees.

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- 국문초록 -

일개 채석산업장의 산업보건프로그램 평가

이 성 은*

'채석(quarrying)'산업은 노천광산에서 광물을 캐내는 작업을 모두 포함하는 광범위한 산업을 의미한다. 1900년대에 들어오면서 채석작업에 흡연소기(channel burner)을 이용한 불꽃절개법(flame cutting)이 이용하여 근로자의 먼지 노출이 많이 감소하였다. 채석작업으로 인한 주된 건강문제는 먼지, 소음, 진동 노출이며, 노천작업장으로 작업환경이 개방되어 있어 환경측정 및 관리가 불가능하므로 개별근로자의 먼지와 소음 노출 측정 및 예방이 중요하다. 본 연구는 미국의 일개 채석회사의 근로자 건강관리사업을 평가하였다. 연구자료는 저자가 현장 방문을 통하여 구한 자료와 연구대상 회사의 안전관리자의 의견 및 미국 산업안전보건국 전산자료를 이용하였다.

채석사업장에서 이루어지는 작업은 크게 채석작업과 실내에서 이루어지는 가공작업 및 운반과 보관이며, 미국 산업안전보건국(OSHA)의 표준산업분류(SIC)에서

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1411(채석업)과 3281(채석가공업)에 해당한다(표 1). 연구 대상 사업장에서 이루어지는 산업보건프로그램은 먼지 노출 예방을 위해 석재 채취시 물분사법(water jet quarrying)과 국소환기법을 사용하고 소음 노출 예방을 위해 귀마개를 사용하며 사고 예방을 위하여 안전모와 철모, 보안경, 안전조끼, 보호장갑, 안전끈(harness)을 착용하였다.

평가 결과로 나온 연구 대상 사업장에서 적용하여야 할 산업보건 프로그램은 첫째, 먼지 노출로 인한 건강문제를 예방하기 위하여 근로자 개별 노출 측정을 하고,

둘째 실내가공작업장의 근로자를 대상으로 한 먼지와 소음 노출 측정 및 환경측정이 필요하며, 셋째 안전관리를 위해 채석장에 안전표지판을 설치하여야 하며, 실내가공작업장의 자동이동시스템을 작업별로 채색하여 식별을 용이하게 하여야 하겠다. 또한 이 연구 결과를 영세사업장의 산업간호프로그램인 'Clean 3D'사업에서 적용하여 우리나라 채석사업장 근로자 건강관리를 발전시켜야 하겠다.

주요용어 : 채석산업장, 산업보건프로그램, 건강사업평가