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To Study Lean As A Waste Generation In Marble Marble Processing Plants Saurabh Tege1, Phd Student, Sri Satya Sai University, Sehore

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ABSTRACT

The word marble comes from Greek word, which means a shining stone. In ancient and modern times also any dimensional stone that can be cut dimensionally and has a property to be polished is defined as marble irrespective of its colour, physical characteristics and chemical composition. Although it is true that the processing used to be very slow, tedious and expensive in olden days where as now a days the mining and processing have become faster with the use of latest machines like derrick cranes, diamond wiresaws and automatic line tiling and polishingplants. Sometimes the waste becomes an industrial hazard for nearby population or plantation which may be harmful for flora and fauna. About 70-75% comes under rejects in marble mining and approximately 20% of blocks are converted in marble slurry as a product of processing amounting to about 5-6 million tonnes in Rajasthan. There primitive techniques are used for disposal of waste and there is no planning both at government and mine operators level for scientificdisposal.The marble deposits at global national and state level has been described and in particular with research area of Rajsamand. Marble distribution in Rajasthan has been tabulated and shown on map to display the deposits at a glance inRajasthan.The study has identified the scope of better utilization, disposal and minimization of waste generation in marble industry. Various impacts of marble waste on socio-environmental aspects and their remedial measures have also been suggested.

Keywords: Wire saw, marble, waste generation, waste management

I. INTRODUCTION

The word marble is originated from the word 'Marmor' in latin, that itself has come from the Greek root ‘marmaros’ meaning both as a shining stone. In ancient and modern times also any dimensional stone that can be cut dimensionally and has a property to be polished is defined as marble irrespective of its colour, physical characteristics and chemical composition.

India is endowed with vast and rich reserves of natural stones of different textures and colours, spread in many states in the north and south. The availability of a variety of stones, coupled with high talents & skills, attracted the attention of the world and now India holds a place of pride among the top stone producing countries. Historically the marble marvel of Taj Mahal, the priceless Mahabalipuram sculptures of the Pallava Dynasty in south, the wonders of Konark in the central India, inscription of Ashoka on stone pillars and thousand unmatched temples, reflects in volumes for rich heritage of Indian stones and Indian skills.

Table 1 : Various Types of Marble in India

Calcitic marble	Contains less than 5% magnesium carbonate (Makrana)
Dolomite marble	Contains 5-20% magnesium carbonate (Rajnagar)
Dolomite marble	Contains more than 20 % magnesium carbonate (Banswara)
Siliceous limestone	Contains high silica (Pink marble Babarmal)
Limestone	Contains Oolitic limestone (Jaisalmer yellow)
Serpentine marble	Contains serpentine in high percentage (Green Keshriaji)
Verde Antique	Contains massive serpentine (Dungurpur)
Travertine marble	Formed by chemical precipitation (Italian marble)
Onyx	Dense crystalline form of lime (Kupwara)

Goals of the proposed paper
The objectives of the study are as follows:

i. To Study the areas in marble mining and processing where waste is generated and identify the pin points of wastegeneration.
ii. To study the available practices and method of wastemanagement.

1. Literature Review:
Agrawal V. & Vaish A.K. in "The Rajasthan Mineral Bulletin", a quarterly publication of Department of Mines and Geology in Oct.-Dec.2004,wrote an article "An Overview of Rising Problems of Marble Slurry in Rajasthan and Need for its Eco-Friendly Management" Management of marble slurry is a major problem in many districts of Rajasthan. Substantial quantity of slurry waste generates every year from the processing units and unsystematic disposal of the waste can be converted into eco-friendly wealth by adopting the suitable technology.

- Status of Marble Mining and Processing Activities: Nature has generously endowed Rajasthan with a variety of mineral deposits. Marble is a recrystallized (Metamorphosed) Limestone. In commercial term it is a crystalline rock, composed of calcite or dolomite or serpentine, having hardness from 3 to 4 and can be excavated as blocks. It can be sawed and take goodpolish.
- Marble Slurry: Marble is excavated in blocks of varying sizes. These blocks are then cut into slabs or tiles of variable sizes. During the process fine marble powder is generated as waste and this in combination with water makes slurry. This shares 20% powder and 80% water. The approximate water requirement in a gang-saw is about 43000 litters perhour.
- Physico-Chemical properties of Marble Slurry: Marble slurry is a snow white mixture of marble powder waste (Approximately 200 mesh size) and water. Marble produced during processing of marble does not have fixed chemical composition as several varieties of marble blocks are processed in a single unit. However ,broadlythe
chemical composition of marble slurry is classified in table 5.2 below (Agrawal, et.al.,199; Garg,2004;Singh and Vijaylakshmi,2004)

WasteUtilization

Masood, I., Mehrotra, S.P., Tehri, S.P., Agrawal, S.K. & Ahmad, J.; from Central Building Research Institute, Roorkee described the utilisation of marble sludge from gangsaws and stone

cuttings for building materials in their research paper "Utilisation of Marble Sludge from Gangsaws and Stone Cutting for Building Material." They experimented and found that:

- The marble powder when mixed with cement can be used as binder material for buildingmaterials.
- Cold bonded pressed bricks can be prepared by fine marble powder when mixed with cement and water with specific properties of water absorption and strengths. The so prepared bricks are at comparablecosts.
- Masonry Cement: Masonry cement can be obtained by intergrading the Portland cement and some siliceous, argillaceous or calcareous powdery materials along with some otheradditives.
- Some other products are; Gypsum plaster based boards and blocks, cellular concrete blocks, distempersetc.

Sharma, B. & Rajotia, S.; innovated mechanization in stone craft initiated steps in positive direction of country's strategy to have viable, resilient and competitive technology. They quoted, "the 3-5 mm thin-shelled dining bowl is manufactured solely with our skill in developing fixtures, tools and manufacturing methods indigenously. They have shown that they developed beautiful value added product from the waste of marble mine. They prepared bowls, balls, and interlocking tiles etc., which are giving very high return and are being exported.

Menaria K.L., N. Menaria & Prerna Mathuria explored on utilization of marble waste of Rajasthan in manufacturing of marketable chemicals and identified that useful consumable and industrial products based on marble quarrying and processing waste.

- As physical use in refractory manufacture, fillers, filter aids and aggregate for civil construction involving RCCworks
- Limestone and Dolomite base chemicals for use in cement, dead burnt lime, flux, glass, whitening, putty, sugar industry, paper, poultry grit orpaints.
- Use of quarried and processing waste powder for effluent treatment in place of lime, for providing calcium nutrient for a number of economic crops and soil stabilization of expensivesoils.
- Coal minedusting.
- Highway construction and anti-dusttreatments.

Agrawal V. emphasized that industrial activities and surrounding environment are closely related and number of industries including mining are degrading the environment knowingly or unknowingly because of carelessness or lack of awareness. Marble mining creates pollution and environmental degradation in multiple directions viz. land degradation, noise pollution, dust pollution and change in land use. He also suggested measures for strengthening environmental management by proper disposal of overburden and waste rocks, use of machines and innovative mining methods so that generation of waste is as low as possible, systematic development of mining pits, introduction of personal protective equipments(PPES') for dust noise etc. and regular maintenance of machines to reduce the pollution.

Rathore S.S. discussed the Gainful Utilization of Marble waste for Environmental Protection and stressed on following points:

- The marble mining and processing contribute a very important economic activity in the state and a very large number of employment opportunities both in direct and indirect ways have been generated in this sector. Rajasthan produces more than 95% of the country's marbleproduction.
- He tabulated marble industry in Rajasthan, Marble production in Rajasthan, marble production and slurry generation in Rajasthan in data tableforms.

3. Lean as Material Wastage

Initially, an expansive investigation of the International Stone Sector was performed, to measure quarry creation patterns and to assess the sums and the various typologies of waste. By and large, the prepared quarrying creation represents a minor piece of all out stone extricated, while squander (quarrying waste and handling waste) adds up to most of absolute stone removed. Moreover, world's principle makers and the pattern of quarrying and measurement stone fares were examined. A while later, an outline of the enactment on characteristic stone waste, an examination about the diverse waste typologies, and an examination on current re-employments of stone waste were directed. The finishes of this primer examination are the accompanying: not exclusively could adapting to squander be naturally harming, yet it is additionally monetarily costly for the stone business, which furthermore needs to manage the monetary misfortune brought about by the lower effectiveness of quarrying. Some re-employments of common stone waste, for example, the creation of totals, have just been examined, however they are not beneficial for most quarrying organizations. Subsequent to having done the fundamental examinations, the creation of mortars (combinations of concrete, fine totals and water) has been recognized among the potential uses as the most reasonable one, since stone waste can be re-used somewhat as a substitute of the concrete division and for the creation of the total part, in this way acquiring a higher re-use rate. After this primer stage, a more specialized work was started. At first, the stone waste object of this investigation was provided by a quarrying proprietors which are the individual from Udaipur Marble Association (RAJASTHAN). Physical, compound and mineralogical portrayal of the normal stone waste was performed. All groupings of unsafe components are underneath enactment limits 2. Consequently, the nonattendance of poisons featured that the re-utilization of these materials is appropriate for business purposes. In this way the "environmental mortars" were made, by delivering various test blend plans and utilizing the various parts of stone waste recently gathered.

4. Formulation of data generation for processing waste:

For the assessment of the processing waste, only calculations are used in this study. The processing waste is produced during sawing and sizing operation.

In present study following types and wastes are included in processing waste:

- Sawing (slurry)
- Dressing waste
- Handling waste during sawing sizing
- Sizing waste (slurry)
- Transportation at mines and different processing plants

All the wastes other than sawing waste cannot be calculated, since they vary block to block. Here it is proposed to calculate, actual percentage of sawing waste, and then relevant addition of other wastes can be incurred.

Calculation of sawing waste

$$\text{Slurry produced at Gangsaw} = \frac{[\text{No. of blades x Size of groves}]\,X\,\text{length}X\,\text{height of block}}{\text{length x width x heigth of block}}\,x100$$

(if block sawn along length)

or

$$\text{Slurry in percentage of block} = \frac{[\text{No. of blades X Size of groves}]}{\text{width}} \text{x100}$$

a. Data collection:

A. Primary data: For collecting primary data following method has been used

i. Field visit and observations: An exhaustive study of mining areas producing marble has been made and effect has been recorded and compiled the facts and figures of marble waste generation and its prevention.

ii. Questionnaire: A questionnaire has been prepared to get the views of the persons regarding minimization of waste generation, utilization and proper disposal of waste to protect environment and reduce the hazards of the waste in the form of schedules. (Appendix 1). The questionnaire had questions with multiple choice, some of which have single responses and some have multiple answers.

iii. Interviews: Personal interviews were held from mine operators, processing units' owners to collect a rich quantum of primary data.

B. Secondary data: The following secondary data has been utilized in research study.

i. Sources of Information:

a) Text available.

b) Various reports: Government and business organisations.

c) Proceeding of seminars /workshops/symposiums.

d) Sampling: The target population was supervisors/ managers/ mine owners present at mine. The mining activities in the proposed research area are widely disseminated in approximately 15 Km. around area. The only suitable sampling method which may be applied in research is Non- Probability, Convenience Sampling and in that also Judgmental Sampling will bring out correct sampling information. The mining activities are generally classified as Mechanized Mines, Semi-Mechanized Mine and Manual Mines which are distributed in the research area as per the deposit, size of mine, capital investment of the mine operator and most importantly the quality of the deposit which governs all other factors. In the above background the Judgmental sampling has been adopted in the proposed research. 10 mines and 10 processing plants have been taken as samples for the study.

ii. Data representation: Various types of analytical tables, charts, graphs and figures have been used.

5. Data Analysis & Interpretation:

Data analysis have done in two parts as mention previous chapter, which are as follows heading:

1. Analysis of Marble Mining Industries Waste Generation
2. Analysis of Marble Processing Plants Waste Generation

Analysis of Marble Processing Plants Waste Generation

Table 19: Sawing of Fresh / Large (High Return Blocks)

Intervention	N	%
Less than 30%	8	80
30% to 40%	2	20
40% to 50%	0	0.00
More than 50%	0	0.00

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Total	10	100

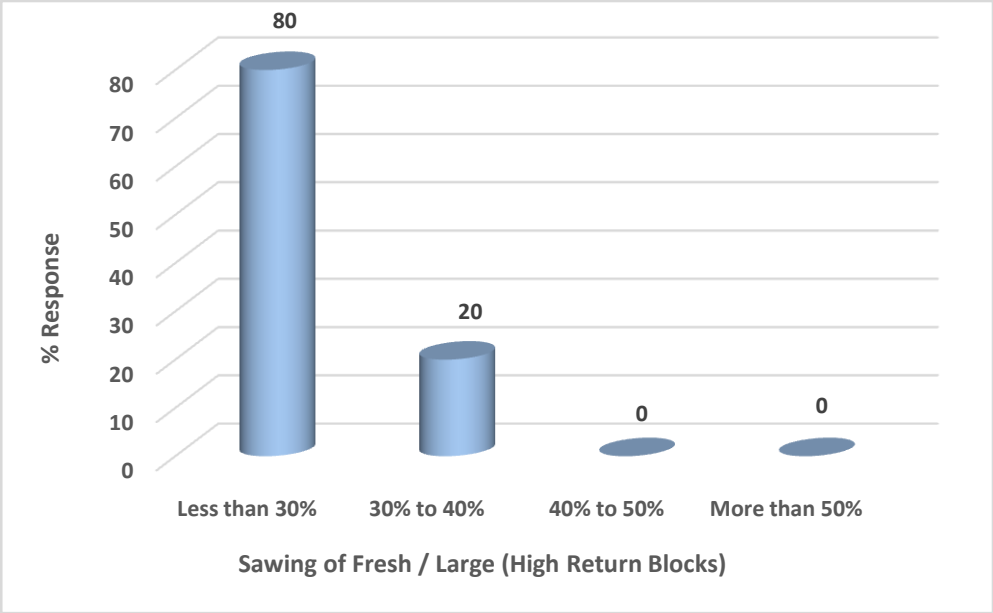

Fig 12: Sawing of Fresh / Large (High Return Blocks)

More than 80% gangsaws cut fresh and high return blocks less than 30 % of overall sawing. This was only 20% for 30-40% fresh blocks. For other option of in the range of 40-50% and more than 50% there was zero response.

Table 12: Sawing of Medium Return Block

Intervention	N	%
Less than 30%	2	20
30% to 40%	5	50
40% to 50%	3	30
More than 50%	0	00
Total	10	100

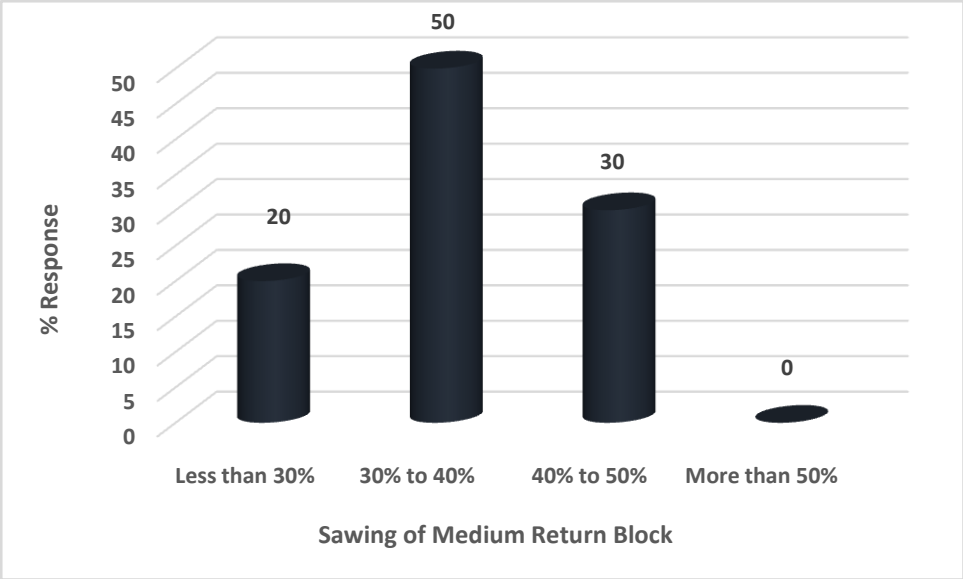

Fig 13: Sawing of Medium Return block

50% sawing was in the range of 30% to 40% of this quality of blocks. About 20% respondents answered as less than 30% and 30% in the range of 40% to 50%.

Table 13: Mode of Waste Disposal and Slurry

Intervention	N	%
At earmarked site for disposal	7	70
At nearest to plant site	1	10
In free area within the plant	2	20
Anywhere barren land around the area	0	00
Total	10	100

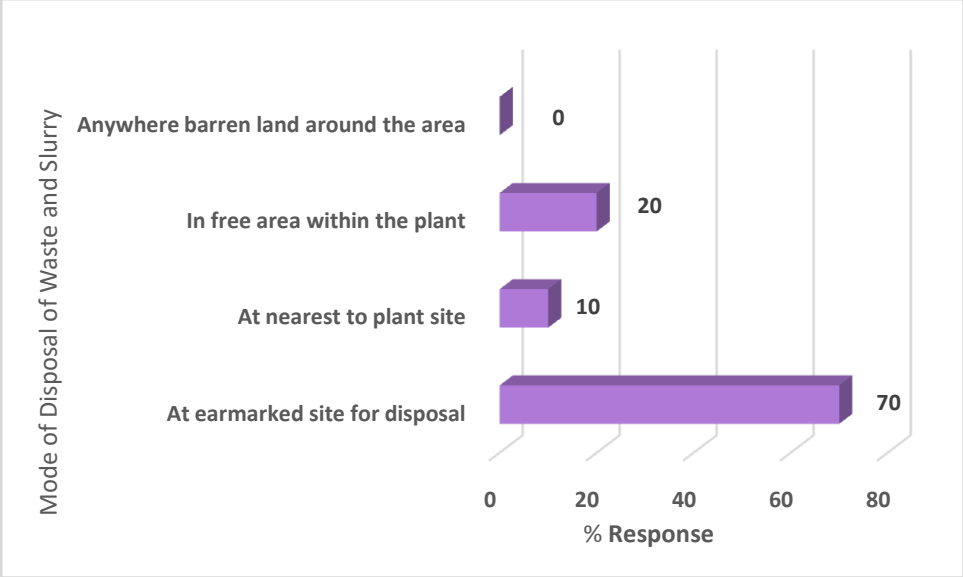

Fig 14: Mode of Waste Disposal and Slurry

70% of the plant owners were disposing the waste at earmarked site for the purpose, however 10% are disposing it at the nearest to their plant site. 20% plant owners are disposing the slurry and waste in the

free area within their plant site to be disposed off afterwards and no one is disposing anywhere in barren land around their plant site.

Table 14: Issues in proper waste management / Slurry

Intervention	N	%
Non- availability of earmarked site	1	10
High cost of transportation to earmarked area	7	70
Easy availability of free land nearby the plant site	1	10
Availability of free area within the plant for disposal	1	10
Total	10	100

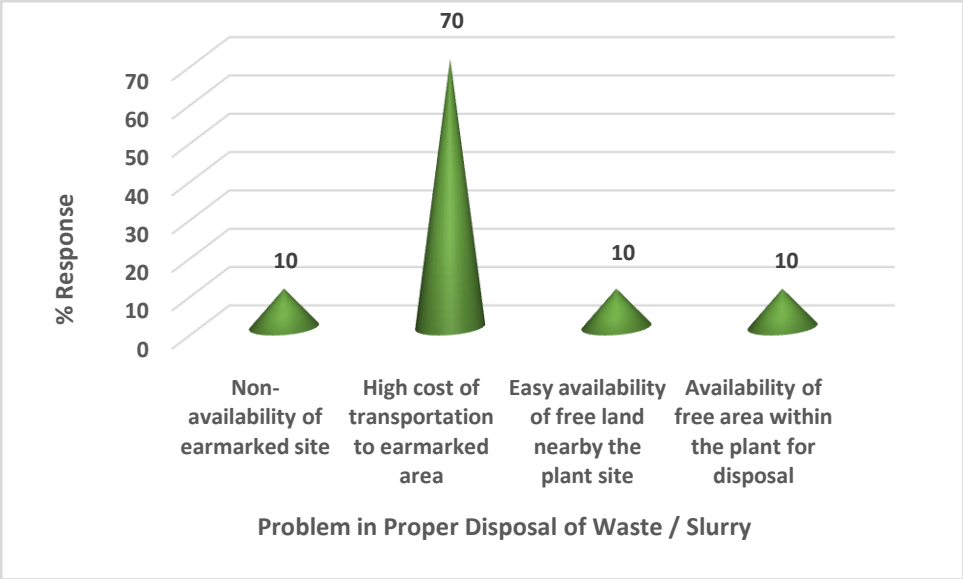

Fig 15:Issues in proper waste management / Slurry

70% respondents felt high transit costs of slurry to earmarked site however they were disposing it at the earmarked site.10% felt non availability of the earmarked site.10% answered equally accessibility of free land near the site of the plant and within plant area.

Table 15: Causes of Generation of Waste

Intervention	N	%
Due to Fractured blocks	7	70
Due to improper block fixing on trolley	1	10
Due to Improper Method of shifting the sawed block	1	10
Due to Lack of proper sawing Machines	1	10
Total	10	100

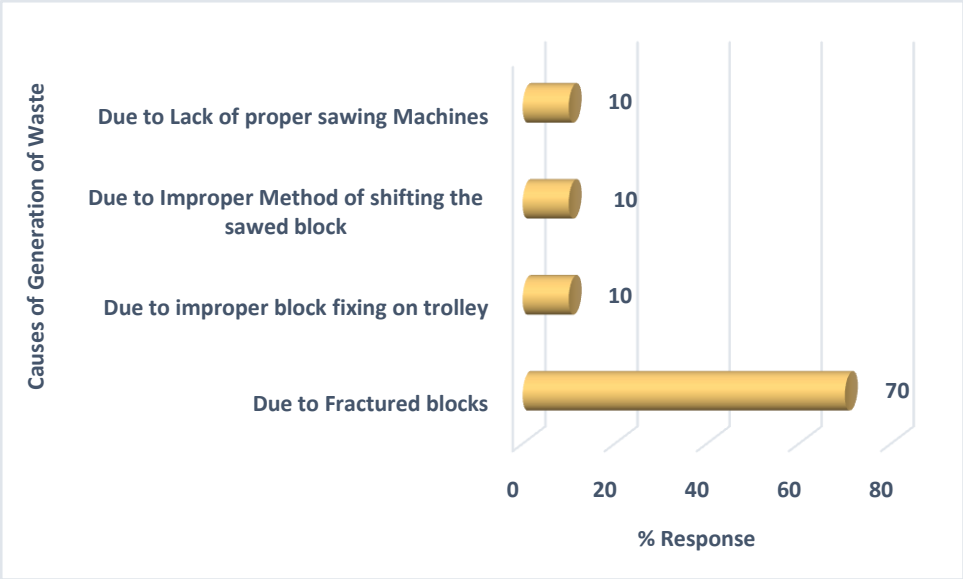

Fig 16: Causes of Generation of Waste

70% of the respondents found fractured blocks responsible for generation of waste however 10% each was felt the cause as improper fixing of blocks on trolley before sawing, shifting of trolley after sawing AND lack OF PROPER sawing machine alignments.

Table 16: Impact on Ecology of Waste Production

Intervention	N	%
Loss of vegetation	8	80
Decrease in cultivation land	5	50
Deepening of groundwater level	4	40
Diversion of water course	6	60

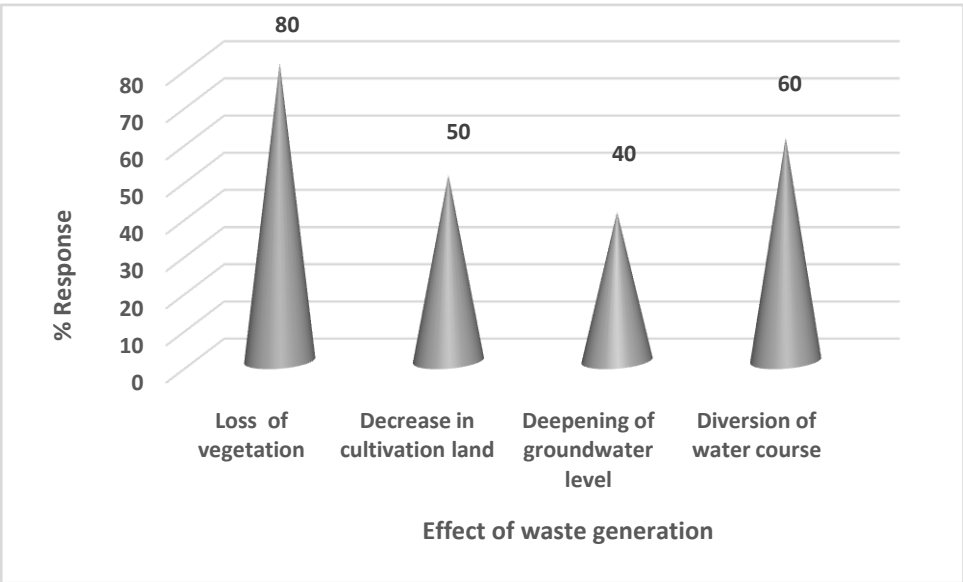

Fig 17: Impact on Ecology of Waste Production

80 percent realized the lack of vegetation due to waste generation, but as a result of the waste, 50 percent have found a decline in land cultivation. In addition, 40 percent is in the view of deepening groundwater as

a final product of the generation and disposal of waste.Diversion of water course was also felt by 60% respondents as one of the evil effect of the waste generation and disposal.

Table 17: Efforts to Minimize Waste Generation

Intervention	N	%
By avoiding sawing cracked blocks	9	90
By Adopting Proper Method of sawing.	9	90
By Deploying proper sawing machines.	8	80
By Handling the sawed blocks properly	7	70

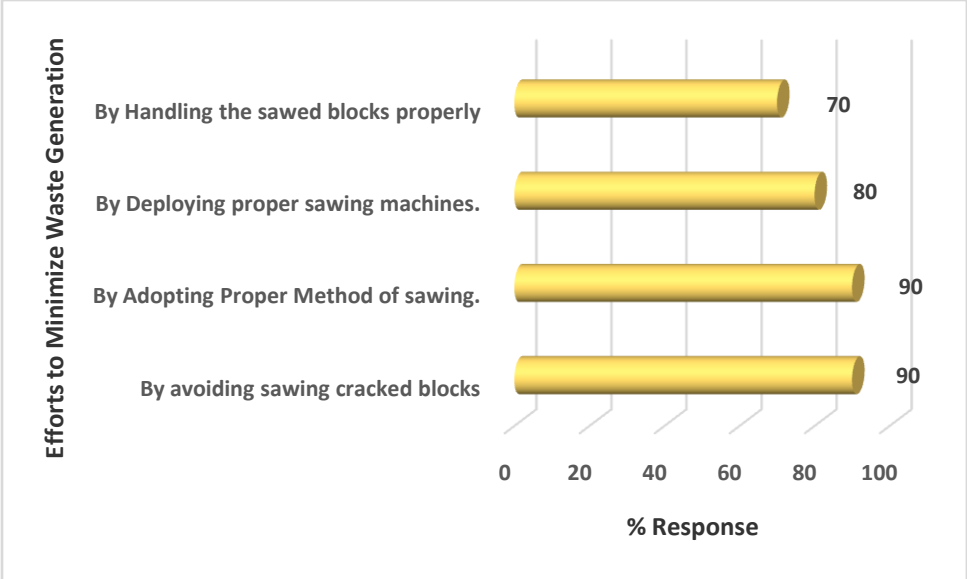

Fig 18: Efforts to Minimize Waste Generation

90% respondents were avoiding sawing of cracked blocks as an effort to minimize generation waste at their plant. 90% plant owners were adopting proper method of sawing as additional option of minimizing waste generation. In the sequence of multiple efforts 80% plant owners were deploying proper sawing machine in alignment and maintenance.70% plant owners were handling sawed blocks properly to reduce waste in transportation of sawed blocks on trolleys.

Table 18: Present Situation of Vegetation in Nearby Plant Area

Intervention	N	%
Low	1	10
Medium	8	80
High	1	10
Total	10	100

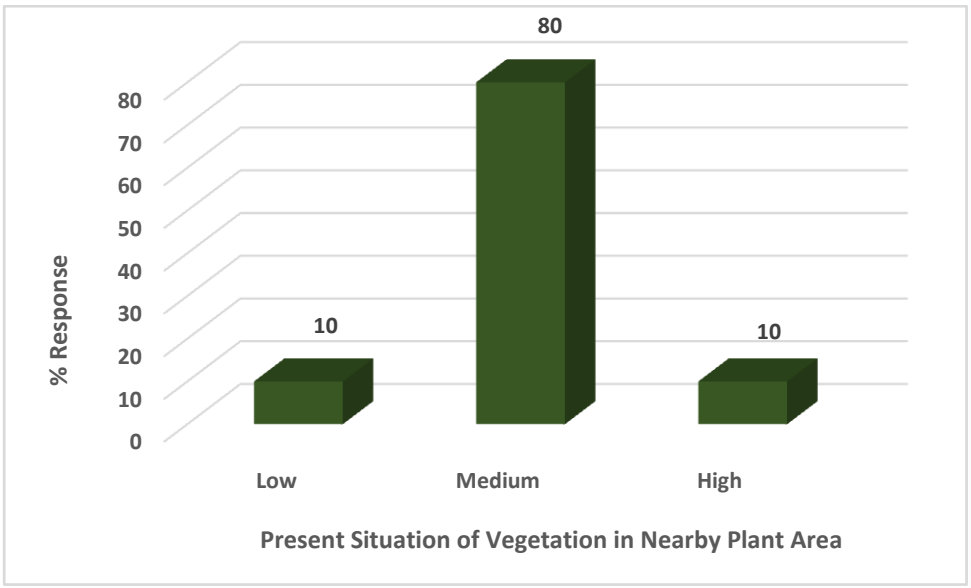

Fig 19: Present Situation of Vegetation in Nearby Plant Area

80% respondents replied situation of vegetation as medium nearby their plant site. Equal percent of 10% replied as low and high situation of vegetation.

Table 19: Elements responsible for degrading the environment

Intervention	N	%
Sawing	1	10
Deforestation	8	80
Urbanization / Industrialization	1	10
Waste disposal	2	20

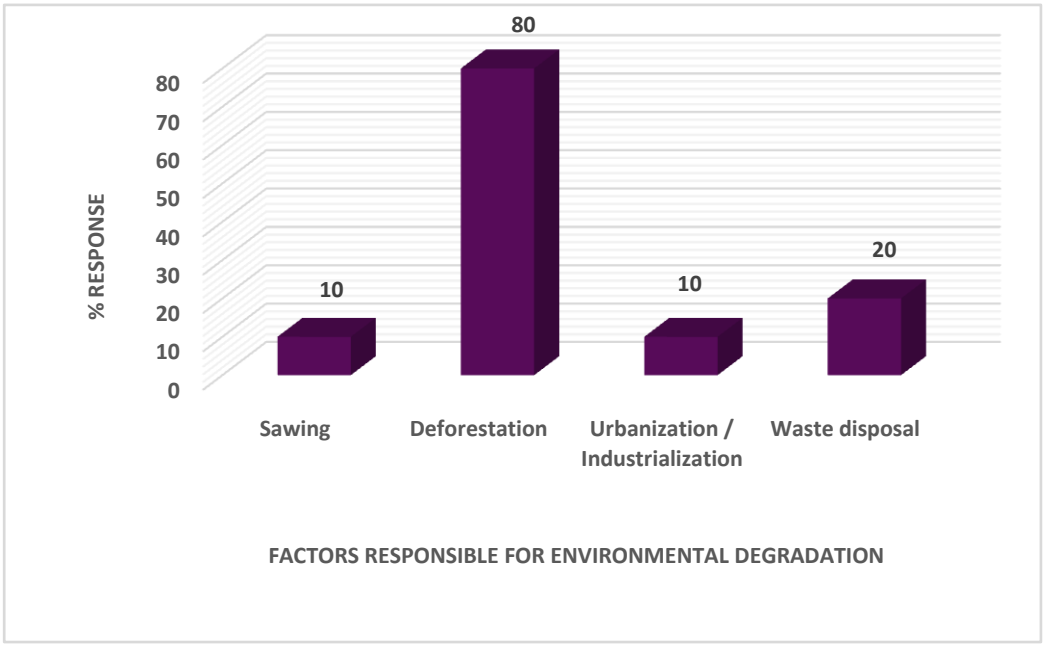

Fig 20:Elements responsible for degrading the environment

Only 10% respondents were in the view of sawing as a factor for environmental degradation. Apart from their activity 80% respondents were in the view that deforestation activity was responsible for degradation of environment. However, 10% and 20% plant operators felt urbanization/industrialization and waste disposal responsible for environmental degradation.

Table 20: Initiatives to reduce Environmental Plant Area Degradation

Intervention	N	%
By disposing the waste on earmarked site	8	80
By Adopting Environment Friendly sawing techniques.	7	70
By Conserving the top soil to be used on waste Dumps to develop plantation after sawing activities	9	90
By Adequate Plantation and protecting existing plants as far as possible while sawing	7	70

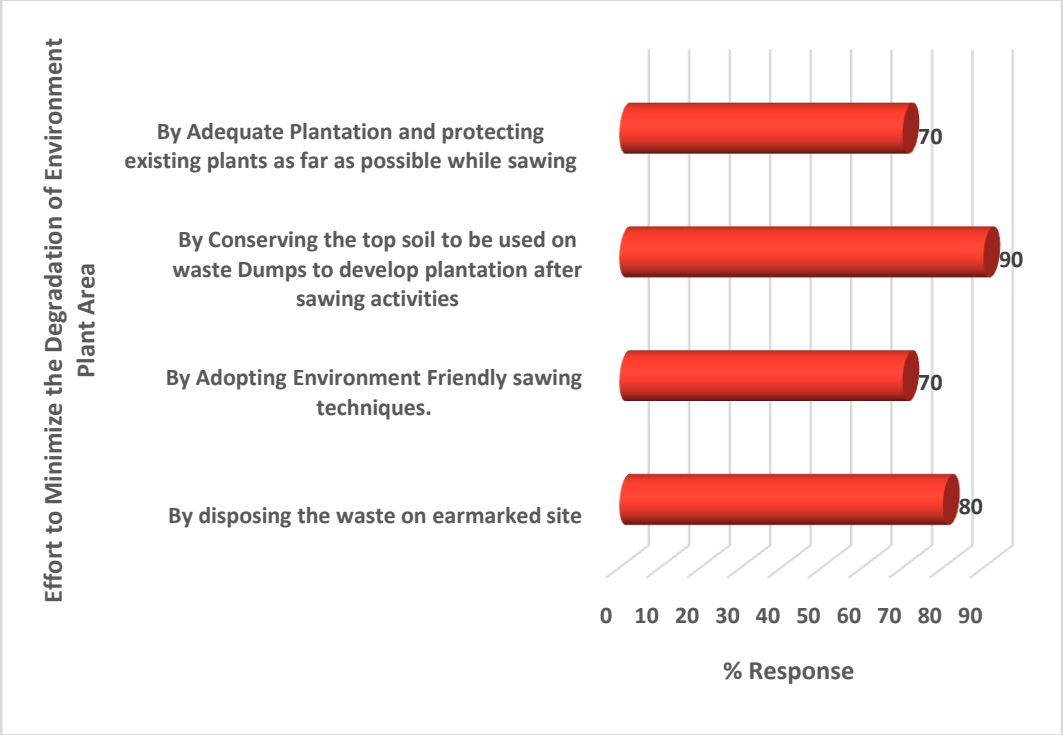

Fig 21:Initiatives to reduce Environmental Plant Area Degradation

80% plant owner disposing the waste on earmarked site for disposal to minimize the environmental degradation. With additional efforts 90% conserved the top soil of disposal site to use the same afterwards for plantation on disposal dumps. 70% to each option was given to adoption of environmental friendly sawing techniques and by adequate plantation and protecting exiting plants while working respectively.

Table 21: Initiatives to protect the ecosystem and the atmosphere by using waste at the site of the plant

Intervention	N	%
Sufficient Trees / Plants have been developed with sawing on slurry disposal area.	6	60
The Top soil of all disposal area has been preserved to be used after disposal activities to recover the vegetation as initial condition.	5	50
The waste generated has been dumped on earmarked area	8	80
Optimum plantation has been done on dumping site	7	70

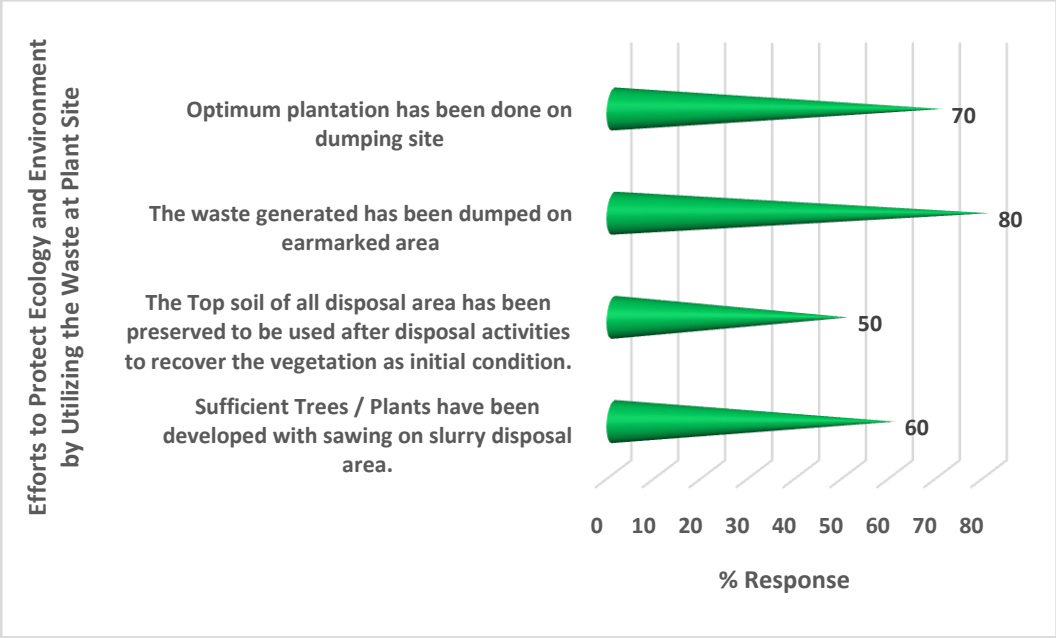

Fig 22: Initiatives to protect the ecosystem and the atmosphere by using waste at the site of the plant

80% plant owners further emphasized on dumping the waste on earmarked site to achieve the desired goal.70% in addition had planted optimum number of plants on dump sites.60% respondents developed sufficient plants with sawing operation in the plant area, however 50% plant owners further preserved topsoil for future.

Table 22: Various waste utilization strategies

Intervention	N	%
Road / Building construction	7	70
Filling of area	1	10
Preparation of marble power for industrial use	1	10
e in marble articles and idols	1	10
Total	10	100

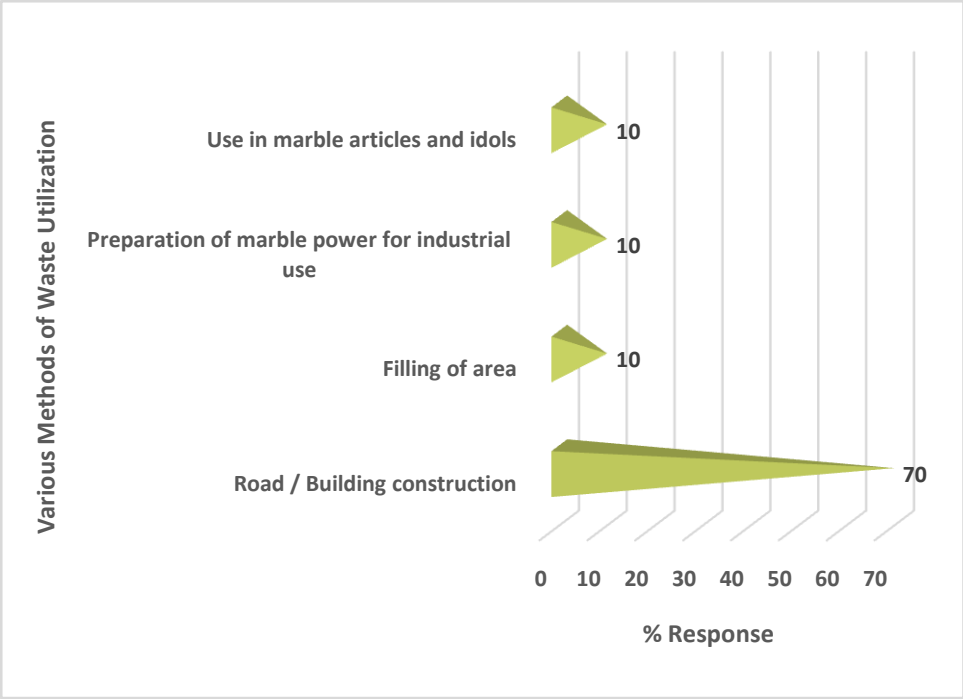

Fig 23: Various waste utilization strategies

80% of the respondents are utilizing the waste in road and building construction. Only 10% each are using the waste for filling and use in industrial purpose respectively.

Inference:

- Looking to the analysis and representation we can conclude that there is no significant amount of waste generation in marble mining as it clear from table no. 4.16 which indicate that main cause of waste generation is fractured block and avoiding that waste can be minimized.
- There is no loss of ecology and environment by waste generated in marble processing as indicated in table no. 4.20 in which it reported that factors responsible for environmental degradation are activities of deforestation and not the processing.
- Moreover 70% plant owner was disposing the waste on earmarked site for disposal to minimize the environmental degradation. With additional efforts 90% conserved the top soil of disposal and mining sites to use the same afterwards for plantation on disposal dumps. 70% to each option was given to adoption of environmental friendly sawing techniques and by adequate plantation and protecting exiting plants while working respectively
- Many plant owners are protecting ecology and environment by dumping the waste on earmarked site, additionally planted optimum number of plants on dump sites. Many plant owners further preserved topsoil for future and protect environment.70% of the respondents are utilizing the waste in road and building construction. Only 10% each are using the waste for filling and use in industrial purpose respectively, thus protecting the ecology and environment.

CONCLUSION

Marble mining is still in not in very developed stage. There is a close relationship between industrial activity (including mining of mineral resources) and surrounding environment. In fact, the industrial revolution has brought with it the seeds of environmental pollution. In his efforts to produce more and more industrial commodities, man has ignored the importance and need for clean and healthy environment, required for his survival. As such, a number of industries including mining are degrading the environment knowingly or unknowingly because of the carelessness or lack ofawareness.

In order to have pollution free and healthy environment, each and every industrial unit is supposed to apply

adequate control measures and remedial processes. Marble occurrences are widely distributed in India. However, deposits of economic importance are limited to a very few states. It is felt now that all mined out areas regardless to their former use, should be completely regarded so that the topography would be rendered suitable for the production of agricultural crops andvegetation.

Once the opening up of mine is decided, the area can be explored and complete in-situ filling of cracks and joints can be carried out simultaneously. The color of the cementing material is so chosen that it gives aesthetic contrast or resemblance with the in-situ material. The day is not far when everybody will adopt this technique at a smaller or larger scale. Such a filling will improve the recovery of blocks and economics of operation considerably. It will decrease the generation of solid pollutants conserving the non-renewable wasting asset to a large extent. It is better to do wet drilling than to carry out dry drilling that will not only give several economic advantages but also fulfill the requirement of statute as well as tell the general condition of cracks and joints while drilling.

The future of this Industry depends upon the positive change in the whole attitude and outlook of the government. Deliberate planning backed by dedicated implementation not only in the area of technology but also in marketing the products and proper tailoring of initiative efforts of the persons involved in the industry will surely accomplish the corporate mission on the one hand and individual and group aspirations for growth and improved quality of product.

REFERENCES

1. Agarwal, R. K.; “Modern marble processing techniques and their suitability for Indian condition”; A company report by Rajasthan Udyog,Jodhpur.
2. Agarwal, V.; “Environmental Management in marble mines”; Skill and Technology up gradation program in Marble mining by UCCI; Udaipur; 13 Sept – 9 Oct1999.
3. Ajay Kumar, L., Shanker, K. V. & Rahaman, M.; “Improving productivity Techniques in Granite quarries”; V National Seminar of Surface Mining, I.I.T. Kharagpur; 4-5 Dec. 1995; pp.206-209.
4. Anon; “Marble Policy-2002”; Government of Rajasthan, Jaipur Notification, Mar. 2002,; Mining Engineering Journal; Vol. 4, No. 2, Sept. 2002; pp25-35.
5. Anon; “Quarrying of Dimensional Stone in India”; National Project No. GMO20IC; National Institute of Rock Mechanics Training Course; June2002.
6. Anon; “Technical Report on Use of Marble Slurry Dust (MSD) in Road and Mass concrete work for UCCI”; Rigid pavement division; CRRI; New Delhi; July2000.
7. Banthia, H. R.; “Need of Technology Management and its input for cost effectiveness in various operations in the process of dimensional stone production”; Report on skill and technology upgradation program in Marble Mining; by UCCI; Udaipur; 13 Sept-Oct. 1999.
8. Bhatnagar, A.; “Experimental investigations for the influence of flushing media on the performance of diamond drilling.” M. Tech. thesis; Department of Mining Engineering;I.
9. T., Kharagpur, 1996.
10. Bhatnagar, A.; “Scientific and modern mining of marble - Development of large block extraction with minimum of waste.” Global seminar for golden jubilee of I. I. T. Kharagpur, TMMPE-2000; Dec. 1-3,2000.
11. Bhatnagar, A. & Bapna, P. C.; “Marketing practices in marble industry - a critical review for minimization of waste.” National workshop on safety & technology in marble mining and processing in new millennium; Udaipur; March 10-11, 2000pp143-149
12. Bhattacharya, B. C.; “Possible utilization of waste marble powder/ slurry - a case study.” Seminar on gainful utilization of marble slurry in various construction activities; UCCI, Udaipur; Sept. 18,2000.
13. Cragg, A. W.; “Sustainable development and mining: Opportunity or threat to the industry”; CIM bulletin; Sept. 1998; pp.45-50.
14. Dak, Harish; “Conservation of water and disposal of marble waste by using filterpress.”
15. ; National workshop on safety & technology in marble mining and processing in new millennium; Udaipur; March 10-11, 2000 pp83-93.
16. Garg, P. K. ; “Problems of marble slurry and its recycling”; Seminar on gainful utilization of marble slurry in various construction activities; UCCI, Udaipur; Sept. 18, 2000.
17. Gupta, R. L., Gautam, D. K., Jain, S. K. & Manglik, R. K.; “Utilization of marble dust in production of bricks and blocks”; Seminar on gainful utilization of marble slurry in various construction activities; UCCI, Udaipur; Sept. 18, 2000.
18. Joshi, S. S.; “Environmental control in marble industry”; Safety and Technology in marble mining & processing in New millennium.; Mar 10-11; 2000; Udaipur; pp. 233- 238.
19. Joshi, S. S.; “Scientific and systematic mining of marble use of modern techniques & suggestions”; Skill & Technology upgradation program for marble mines managers; UCCI; Udaipur; 13 sep-8 Oct;1999.
20. Kataria, N.; “Mechanization of marble mines – A need of the hour”; Report on skill and technology up gradation program in marble mining by UCCI; Udaipur; 13 Sept-9 Oct; 1999.
21. Mukhopadhyay, S. K. & Bhatnagar, A.; “Marble mining in India – A technical aspect”; Institution of Engineer’s Journal (Mining Engineering. Division) 1997; Vol. 78; No. 97; pp.42-46.
22. Parihar, S. K. & Surana, D. M.; “Utilization of quarried land and waste in dimensional stone industry” National seminar on dimensional stones

– quarrying, processing and marketing, Hyderabad, 1992; pp.221-229.

23. Porwal, A. & Wahy, S. N.; "New Technological Trends in Marble Mining"; Rajminerex, Golden Jubilee seminar on Mineral development in Rajasthan, Udaipur; 3-5 July, 1998; pp. 68-73.
24. Saxena, N. C., Singh, G. & Ghosh, R.; "Environmental management in mining areas"; Scientific Publishers (I),Jodhpur.
25. Sharma, G.D.; "Mining, Processing and Trading of Marble, DDSR'90." Organized by Deptt. Of Mines and Geology. Rjasthan, Udaipur. April26-27,1990
26. Sinha, A. K.; "Marble Industry and Environmental issues scenario in Rajasthan"; Indian Stone Mart 2000, Feb. 2-6, 2000, Jaipur Rajasthan; pp.277-294.
27. Tebhanoglous G. Theisen, HEliassen R.; "Solid Waste: Engineering Principles and Management issues". Mc Graw Kongkusha Ltd. 1977.
28. Vijaylaxmi, V., Singh, S. & Bhatnagar D.; "Efforts towards gainful utilization of marble slurry." National workshop on safety & technology in marble mining and processing in new millennium; Udaipur; March 10-11, 2000pp150-157.
29. Vijayvergia, S.; "Selection of equipment for mining of dimensional stones"; safety & technology in Marble mining and processing in new millennium; 10-11 March 2000, Udaipur;pp.59-67.
30. Wahy, S. N. and Jha, U. K.; "Mechanization for Improving Marble Extraction" XIV National convention of Mining Engineers; (Shaping the mining industry for future); Udaipur; Feb. 25, 2002; pp.208-215.
31. Wilson, D.G.; "Hand book of Solid Waste Management"; Van Nostrand Reinhold, New York.1977.