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COVER PHOTO

Narowal road repairs work in progress,January 1997.

(Courtesy of Mr. A. W. Mir)

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EDITORIAL

REGULAR MAINTENANCE OR REBUILDING

Facilities and information built to provide service to the public undergoes the normal wear and tear in addition to accidental damage. This is a normal nature process and one can not stop it altogether, one can through various procedures and techniques prolong or delay the again process of materials.

We desire to highlight the nearly non-existent system of roads and rain water drains maintenance of our major cities and main highways. We have two distinct rainy seasons in our country namely the summer monsoon and the winter rains. Procedure need to be established and followed whereby all rain water drains are cleaned and ready to be operational with the first rain. At present such system is either missing or not followed resulting in overflowing drains and standing water causing damage to roads and adjoining buildings plus a source of major inconvenience to the general public.

Breakage of road pavement invariably starts with a small hole, which can be fixed with only a handful of asphalt. Due to absence of adequate and effective maintenance system small hole gets bigger and bigger and eventually takes the shape of a major rebuilding project costing millions. In the process road users suffer the agony of discomfort and accelerated wear and tear of vehicles.

The present leadership of the country is very keen to develop the land communication infrastructure of the country and spending very huge amount of scarce funds of this purpose. It is our humble request to them that beside building new and rebuilding old road, highways, motor ways etc., we urgently need to establish on permanent basis credible and effective maintenance program otherwise the huge investment being made now will go waste. The investment in maintenance program is only a tiny fraction of the total cost of the project.

Engineering Congress can assist and guide the Government Department and other agencies involved in setting up maintenance procedures and guidelines.

CAREER GLIMPSES
OF
ENGR. CH. MUHAMMAD RASHID KHAN
President, Pakistan Engineering Congress

Engr. Ch. Muhammad Rashid Khan is B.Sc. Electrical Engineer and L.L.B. He is FIE (Pak), MIEE, (Pak), MPCE (Pak), Hon. FCSC (Canada), MIEE (USA), Serving WAPDA since 35 years. Ex. Secretary General WAPDA Engineers/ Electrical Engineers Association. Ex-President IEP, President IEPM Co-op, Housing Society, Lahore, Chairman IEP Foundation, Chairman Engineer's, Club, Chairman IEP Quaid-e-Azam Forum, Ex-Secretary and Vice President Pakistan Engineering Congress, Ex-Member Executive Committee PEC, Ex-Member Executive Committee IEEE (Pakistan), Chief Editor "The Pakistan Engineer" IEP, Ex-Editor "Engineering News" Pakistan Engineering Congress, Ex-Member Executive Committee W.F.E.O Under (UNO), Member International Environment Committee, Ex-Vice President FEISCA (Saarac Countries), Member Executive Committee Common-Wealth Engineers Council, Member Executive Committee FEIIC (OIC Countries). He is a member/fellow of a number of Pakistani and Foreign professional institutions. He has got a vast experience of about 40 years in the field of power generation, transmission & grid stations, power distribution, project preparation, consultancy service energy surveillance, inventory control etc. He got a number of awards for his meritorious services E.G. award of commendation certificate by the Chairman WAPDA, awarded twice gold medal by the Pakistan Institution of Engineers, given 20th century achievement award for carrier achievements and social contributions as one of the five hundred leaders of influence, permanently documented one of five hundred leaders of influence by the American Biographical Institute Int. He has attended a large number of technical courses and has contributed and participated in 46 International Seminars / Symposia Conference Congress etc.

ENGR. CH. MUHAMMAD RASHID KHAN
President, Pakistan Engineering Congress

WELCOME TO NEW MEMBERS

The Executive Council of the Pakistan Engineering Congress approved membership of the following new members in to the Congress fold. The Engineering News congratulates all of them and welcomes to PEC.

Members admitted on 28-4-2001

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1.	Engr. Qazi Mohib-Ul-Allah Khan
2.	Engr. Muhammad Nawaz
3.	Engr. Khalid Saleem
4.	Engr. Humayun F. Raja
5.	Engr. Muhammad Shafiq
6.	Engr. Bilal Ahmed Sh.
7.	Engr. Saleem Khan Tareen
8.	Engr. Muhahid Farooq
9.	Engr. Ayaz Ahmad Durrani
10.	Engr. Muhammad Khurram Javeed
11.	Engr. Ziaullah Iqbal
12.	Engr. Rana Saleem Akhtar
13.	Engr. Uzma Ghulam Rasool
14.	Engr. Nauman Azmat Mir
15.	Engr. Nabeel Akram Chaudhary
16.	Engr. Taqueer-ul-Haq
17.	Engr. Khurram Aftab Warraich
18.	Engr. Asim Ijaz
19.	Engr. Muhammad Khalid
20.	Engr. Uzma Dildar
21.	Engr. Muhammad Dildar Ahmed
22.	Engr. Atif Khalid
23.	Engr. Syed Asif Ali Burney
24.	Engr. M.Iqbal Javed
25.	Engr. Nasrullah Dogar
26.	Engr. Sarfraz Haider Naqvi
27.	Engr. Lt. Col.® Muhammad Aslam
28.	Engr. Nizakat Ali
29.	Engr. Muhammad Zubair
30.	Engr. Muhammad Nashad Khan
31.	Engr. Syed Wijdan Hyder
32.	Engr. Muhammad Zahid
33.	Engr. Zubair Jan Awan
34.	Engr. Tahir Mansoor
35.	Engr. Muhammad Khalid Bhatti
36.	Engr. Jawad Ali
37.	Engr. Muhammad Rashid Sajid
38.	Engr. Shahzad Hussain
39.	Engr. Aamir Ali Qureshi
40.	Engr. Muhammad Atique Azhar
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42.	Engr. Muhammad Amjad
43.	Engr. Ahmad Nadeem Nawaz
44.	Engr. Syed Shafat Husain
45.	Engr. Yasser Masood
46.	Engr. Sadaf Zehra Jafri
47.	Engr. Nasir Saeed
48.	Engr. Naeem K. Haq
49.	Engr. Zafar Iqbal
50.	Engr. Iqbal Rasool
51.	Engr. Wasim Latif
52.	Engr. Maroof Shuja
53.	Engr. Abdul Rashid
54.	Engr. Muhammad Hussain
55.	Engr. Mazhar Hameed
56.	Engr. Fiaz Ahmed
57.	Engr. Javaid Parvaz
58.	Engr. Muhammad Nasir Iqbal
59.	Engr. Rooh-ul-Amin Jan
60.	Engr. Ahsan Amin
61.	Engr. Atif Manzoor
62.	Engr. Mian Abdul Haq
63.	Engr. Moeen-ud-Din Sheikh
64.	Engr. Ishfaq Ahmed
65.	Engr. Mukhtar Ahmed
66.	Engr. Altaf Hussain
67.	Engr. Anbreen Zia Khan

Members admitted On 09-06-2001

1. Engr. Muhammad Yaseen
2. Engr. Shahid Saleem
3. Engr. Imran Ismail
4. Engr. Muhammad Asif Irfan
5. Engr Muhammad Shakeel
6. Engr. Aamer Ali Niazi
7. Engr. Nazar Ahmad Bhutta
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9. Engr. Asif Raza Gurmani
10. Engr. Mahmood Munir Akbar
11. Engr. Muhammad Shabbir Haider
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13. Engr. Sajid Rashid
14. Engr. Amjad Kabeir
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25. Engr. Muhammad Imran
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32. Engr. Rehan Sarwar
33. Engr. Abdul Haq
34. Engr. Hasan Zia
35. Engr. Shahab Ahmad
36. Engr. Anwar Saeed
37. Engr Muhammad Saddique
38. Engr. Javed Ali
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44. Engr. Bahar Khan
45. Engr. Abdul Majeed
46. Engr. Muhammad Rajab
47. Engr. Muhammad Ayub
48. Engr. Abdul Shakoor

Members admitted on 07-07-2001

1. Engr. Waqar Ashraf Sheikh,
2. Engr. Muhammad Aslam Khan Niazi.
3. Engr. Azhar Masood
4. Engr. Rana Muhammad Sarwar Khan
5. Engr. Syed Muhammad Shoaib
6. Engr. Irfan Aftab
7. Engr. Muhammad Haseeb

REPORT

ENGINEERS ASKED TO HELP SOLVE WATER SHORTAGE PROBLEM

41st IEP convention was inaugurated by the Ex-President Islamic Republic of Pakistan Rafiq Tarrar. He said on the occasion that promotion of science and technology is the corner-stone of socioeconomic development of the country. "Without adopting emerging technologies in the fields of engineering information, agriculture and industry we cannot accelerate our economic and social development," he said while inaugurating a three day 41st Annual Convention of the Institution of Engineers of Pakistan (IEP) here at the Expo Centre.

The Government, Ex-President Tarar said, had therefore embarked upon a massive programme for the advancement of science education. He hoped that our engineers will make full use of this enabling environment and equip themselves with the latest techniques in the fields of scientific and technological education. That is the only way by which Pakistan can benefit from the fruits of economic and digital globalization, he said.

He drew the attention to the problem of water scarcity, and said our engineers should take it as a challenge and devise ways and means to augment and manage the existing water resources. The Ex-President urged the IEP to continue to make all-out efforts to maximize the use of local resources, in men and material, to reduce dependence on imported technologies with a view not only to achieving self-reliance, but to build capacity for exports.

"However, to become effective in the quality and cost conscious global market, we must attain competitive edge through environment friendly production processes, quality control and competitive prices," Past President Tarar said adding that was the only way to benefit from the emerging global market, being governed by strict WTO regulations and monitoring. He sought Allah's blessing for our efforts to make Pakistan a prosperous Islamic welfare state. He thanked the delegates to the convention from abroad. He hoped that they would find the exchange of experience and knowledge with their Pakistan counterparts rewarding.

He observed that the IEP is one of the biggest and premier engineering organization, which aims at updating technical knowledge of Pakistani engineers through exchange of experience by holding lectures, seminars, conferences, symposia and workshops. The past president said the Expotech exhibition, being organized on the occasion, would help promote our exports. He praised the IEP for their endeavours to promote science and technology in the country. He said he would be looking forward to receiving the recommendations of this convention.

Earlier, in his presidential address, Engr M. P. Gangwani, Chairman of the IEP, said in the past 53 years engineers, whether in the private or public sector or in the armed forces, we have kept the head of the nation high. The development achieved physically and its effects on nation-building activities were there to be seen by everybody, he said adding that by and large engineers had provided mettle whether in constructing the fifth tunnel of the Tarbela Dam, Kahuta or the successes in the nuclear field.

Mr Gangwani said to continue to provide a similar level of service is no longer going to be the yard stick of success. With the WTO coming into force in a couple of years, the need for "international engineers" will arise. Our engineer will have to be well equipped to serve anywhere in the world and be able to travel and work across the borders. With that scenorio in view, he said the IEP has begun planning for the future. We are in advance stage of negotiations with donor agency for financial support.

We are expecting that our scheme to develop core courses, modules of instruction and evaluation for "Continued Professional Development" will upgrade the technical knowledge of our engineers to international standers for qualifying our engineers as "International engineers" who will be entitled to serve and practice in any country as well-equipped engineers.

This, he said , would not only open new avenues for jobless engineers but would also prove beneficial on the economic front as well. "We have been surviving and progressing without any financial support from any agency or government, unlike other countries in the region," he claimed. He said we have witnessed a gradual erosion in the importance of engineers.

He made the following suggestions:

1. It is the age of Professional team management for optimal and sustainable growth in developing the economy and improving the quality of life. Therefore, all engineering ministries, departments and corporations be headed by engineers.
2. Engineers, as a body and as individual experts, be involved in all nation-building activities, and this should not be left alone to the professionals from the banking, legal, or financial circles only.
3. Specialized knowledge of engineers is required in every development scheme, but it is sad to mention that in the recent PERK programme for Karachi we find not a single engineer on the committee. If the package is to be made successful, participation of the IEP should not be ignored.
4. There is no federal engineering services cadre in the government services structure. The central engineering service cadre was abolished in 1973. This needs governmental attention for improvement in the public sector departments. In this connection establishing engineering staff college and academies would further strengthen the engineering base in the country.
5. The local construction industry is in its death throes as all major projects are awarded to foreign contractors at very high rates. The "natives," though possessing all the technical know how and manpower to work as main contractors, are asked to work as sub contractors at ridiculously low rates.
6. The plight of consulting engineers is no better either. While being fully capable of carrying out work, they are denied their right and normally work is awarded to foreigners. To add insult to injury, foreigners then in turn engage the "natives," to do the same job, at a lower cost.

Earlier, the Secretary-General of IEP, Chaudhry Mohammed Rashid Khan, presented address of welcome. An IEP shield was awarded to Ex-President Rafiq Tarar. On the occasion MIE (Pakistan) Diplomas were awarded to five engineers, including Engr Mohammad Shafiq of the Karachi Building Control Authority.

Honorary fellowship of the IEP were awarded to Prof (DR) Ing Jose Medem, President of the World Federation of Engineering Organizations - UNO, and S.H.Hashmi. Gold Medals were awarded to Engr Nadir Khan, Past Secretary General of the IEP. The lifetime achievement award was presented to Gen Anwar (retd), the 101-year-old Past President of the IEP.

The ceremony was attended, among others, by Sindh Governor Mohammed Mian Soomro, Chancellor of Sir Syed University of Engineering and Technology, Z.A. Nizami, Maj Gen Ghulam Umer (retd) and Dost Mohammad Faizi.

QUALITY PRACTICES IN PAKISTANI INDUSTRIES

Basic Research Findings

by

Kamran Moosa*

BACKGROUND

Competition and rising demand for quality and productivity standards in organizations are forcing organizations to institutionalize quality and productivity management, i.e. **Performance Improvement Management** (PIM). This can only be achieved if management and technical skills. systems and technology are regularly up-graded. The process of improving the performance of organizations is presently called Total Quality Management (TQM). The implementation state of this process is generally known as Quality Culture. A good quality culture, therefore, represents a good implementation state, and a bad quality culture implies a poor implementation of the (TQM) process.

It is difficult to classify the quality culture of companies in terms of their practice levels in quality management. Even poor companies have a few high level characteristics and vice versa. In spite of this difficulty, organizations can be divided into the following quality categories (Ref: 1,2,3):

Zero Level (No Customer Concern/No Inspection).

These companies do not focus customers and incorporate management systems to measure or control the quality characteristics of their products and services. In open competition. such organizations exist for a short while and then disappear. Those that remain usually enjoy monopoly, such as : most government organizations, utility suppliers, revenue collection departments, courts, police departments and universities. In countries like Pakistan, the State has traditionally been the center of power and generally there is no accountability for poor quality. The consumers, including industrialists do not posses any political power. This results in poor quality to the extent of torturing customers. Most government organizations in underdeveloped countries are rated poor. Even in developed countries, ratings for government organizations are also usually lower than those for private companies. No inspection mechanisms exist for the assessment of quality of their services. Irrespective of their poor quality, their survival is guaranteed by the State People with this culture are insensitive to the requirements, and needs of their customers. They consider customers as those who matter in their survival, i.e. their commanders and superiors, not the consumers. Similarly, the service contents of many manufacturing firms also fall under this level. Many manufacturers are usually ignorant on the service part of their quality.

Level I: (Inspection Oriented).

These organizations consider laboratory and testing of products as the main activity of quality management. They invest in and develop their products/services measurement systems, e. g. Quality Control Labs and Departments. Testing and measurement make them react to non-conformities only. Most manufacturing companies in Pakistan, and in other developing countries, usually fall under this category. Defects in products are considered inevitable, and a defect is considered to be a defect only if it is detected; otherwise everything is OK. Such companies consider quality as the role of QC Dept, i.e. inspection department. Production and other people only react to the reported defective quality.

Level II: (Quality Assurance/Process Control Based).

These companies understand that a product is the result of many processes; and unless these are controlled effectively, quality can not be delivered. Therefore they try to control all those

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processes that effect product quality. ISO 9000 Standards are basically Quality Assurance Standards. These companies, therefore, try to standardize their core processes, and use Internal Audits to check this. The present popularity of ISO 9000 in Pakistan, is essentially and era of up-gradation of companies from Quality Control (Level I) to Quality Assurance (Level II). Most of the companies who implement these standards now realize the importance of Quality Assurance and usually accept it as an essential element of their quality management activity. However, the degree of implementation varies considerably.

Level III: (Continual Quality Improvement with Integrated Quality Management Programs).

These companies further realize that process improvements are directly proportional to the competence, commitment and teamwork of employees at all levels. For them, mere conformance to the defined specifications is not enough to compete with the competitors. Each passing day requires Continual Performance Improvement at all levels, functions, and systems of organizations. Quality concept changes from quality of product to performance improvement of organization. ISO 9000 becomes insufficient for this level. Such organizations mobilize company-wide campaigns for developing skills of quality management at all levels, up to workers. Various TQM tools are taught and then practiced; a shadow organization of quality teams emerges; teams structures are developed and quality assignments are given and taken on daily and weekly basis. Each supervisor, section incharge and departmental head address every process in detail and improve them with his/her own departmental teams. A special culture evolves through people equipped with TQM tools, skills, and commitment. These companies focus on involvement and mobilization of all employees rather than any one person or department. Few companies fall under this category in Pakistan.

Level IV: (Perfection Champions).

These companies are the global champions and dominate markets with their products and services. They have mature quality culture. They show long term survival and are also technologically advance in introducing new products before their competitors. Other companies imitate them. In addition to Level III, they also set trends in R&D. Some examples are: Toyota, IBM, Toshiba, National, Boeing, Motorola, Oxford University, Massachusetts Institute of Technology (MIT) and Caterpillar. These organizations show their superiority in the management as well as technological skills and resources. They provide benchmarks to others. Perfection here does not refer to absolute perfection in products. It is the complete satisfaction and trust of markets in their products and organizations. Their management practices are highly effective and efficient. No organization in Pakistan is presumably under this category.

Introduction

This research paper is based on the rationale that an in-depth assessment of companies from the point of view of quality management will be a good contribution. It will help the management of organizations and academicians to understand the quality culture in Pakistani organizations to improve and promote better and improved programs in quality management.

The research was carried out in 1999 (Ref: 4) and was based on identifying the common attributes (both positive and negative) of the quality culture in Pakistani organizations. In order to capture the quality culture of organizations, the following seven aspects were selected:

1. Technological Status
2. Quality of Management Functions
3. Effectiveness of Quality Assurance/ISO 9000
4. Levels of Continual Quality Improvement
5. Quality of Human Resource Development
6. Degree of Awareness and Implementation of TQM Tools
7. The status of organized TQM program or process

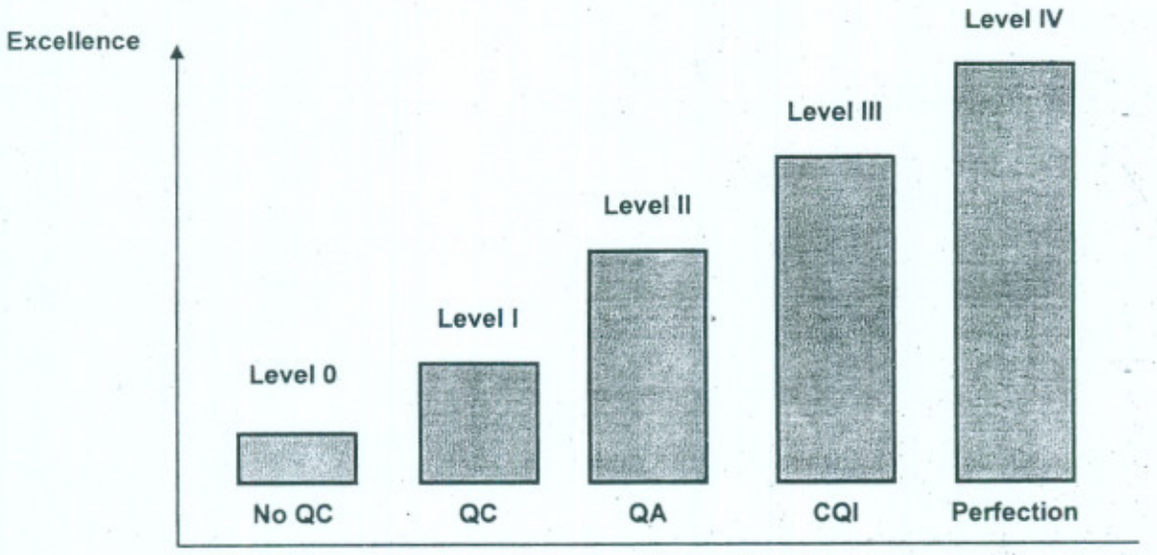


Figure 1: The Four Levels of Quality Management

The above seven factors were arrived at after considering the research limitations and the expected usefulness of the findings to industries in Pakistan. An assessment of the above seven factors can provide an insight into the quality culture, and a base for designing and developing TQM functions in organizations.

The aim of quality management is to continually maximize organizational performance. This can be achieved only by improving the quality of the whole organization. In recent years ISO 9000 has become popular for the same reason. Its certification is being considered by many to be the magic solution to worldwide competition and excellence in management. There is no evidence to prove that it improves overall quality. However, it does provide a sound quality assurance infrastructure. Good management is dependent upon good practices and a good quality culture.

Learning from successes is difficult because it is usually difficult to identify all the factors and their combinations that lead to success, and how they prevented mistakes from being made. In case of failures the most important factor(s) can usually be identified easily. Therefore, a critical evaluation of companies is essential to provide an insight into how quality management is being misapplied. This is different from knowing what should be practiced. In other words, case studies of good practices from other countries do not necessarily provide a real worthwhile learning experience to those who want to implement them effectively. What is required is to find out how and why other companies fail or mal-practice, preferably those working in the same country and environment as one's own. This is the best and quickest way to improve quality.

RESEARCH DESIGN

1. Objective:

The objectives of this research project were to:

1 Identify mal-practices in quality management in Pakistani organizations.
2 Understanding the contradictions in quality management perceptions and practices.
3 Add useful knowledge in quality management for the benefit of professionals. academician and future researchers.
4 Find out whether ISO 9000 certification is being implemented and practiced effectively.

2. **Usefulness:**
After a thorough investigation, it was found that little has been published (or done) in Pakistan in this. Therefore, this research is of particular importance to:

1 CEOs to identify the strength and weaknesses in their own organizations and in their leadership styles.
2 Middle management to identify the opportunities for improvements, and to address the most common weak areas.
3 Universities and colleges to provide an objective overview and analysis of Pakistani organizations to students so that they are better prepared when they enter their professions.
4 Provide useful foundations for further research in quality issues.

3. **Key Issues/Questions addressed in the research.**
The research was to discover new aspects in the field. The core questions explored were:

1. Which are the strong and weak management functions in Pakistani organizations?
2. How effective is the quality assurance function in ISO 9000 certified firms? Does the third party certification result in an effective quality assurance program? Which are the strong and weak areas of implementation?
3. Most organizations are aware of the importance of human resource development, which is a key contributor to a quality culture. How well is this function organized in companies?
4. In relation of continual quality improvement, what are the strengths and deficiencies of competence, quality management skills, and commitment in the top management, middle management, and supervisors/workers?
5. What is the degree of awareness and implementation of TQM tools in companies?
6. Many companies claim to practice TQM. Do they have a serious TQM program being implemented in their organizations?
7. How much is the disparity between knowledge and its practice in the field of quality management?

4. **Research Plan.**
20 companies from different sectors and cities were selected. The process took approximately six months to complete.

5. **Research Focus.**
The main focus was on:

1. Identification of those factors, which are important in practice; not just for philosophical/ intellectual exercises.
2. Identification of the actual reality, rather than what was perceived or said by the management of the companies surveyed.
3. Not to confuse company personnel in the use of quality terminology (like benchmarking, re-engineering, etc.) but to find out the implementation of those activities even if being done with some other name titles.

FINDINGS, ANALYSES AND INFERENCES

1. Types and location of companies

1. A total 20 of companies were audited and analyzed. Out of these 8 (40%) were from the textile sector (spinning, fabric, and garments); 5 (25 %) from mechanical

(automotive, medical instruments, steel bars and fasteners); 3 (15 %) from chemical (cooking oils, lubricating oils and cement); 3 (15%) from electrical (telecom and capacitors); and one from construction.

2. The size of the companies varied from a minimum of 50 to a maximum of 3000 persons. The number of companies with less than 250 employees were 8 (40%); between 250 and 500 were 6 (35%); between 500 and 1000 were 4 (20%) and only one (5%) with more than 1000.
3. Ten companies (50%) were located in or around Karachi, 4(20%) in or around Lahore; 2 (10%) in Sialkot; 3 (15%) in the northern region (Islamabad, Wah, and Haripur); and one (5%) in Hyderabad.
4. Seven (35%) companies were found using old technologies; 5 (25%) were using medium technology; 6 (30%) were using new and the latest; and 2 (10%) were using a blend of old and new technologies.

2. Quality of Management

This refers to good management practices in the basic systems and processes; and their effectiveness. It included checking of management functions and analyzing their effectiveness, i.e. systems, processes, competence, and skills of management, planning daily control, and their overall impact on the organization. It also included the application of TQM processes and tools, Quality Assurance and Control and the change that have occurred in their history. The degree of practice was critically analyzed. This analysis does not reflect how the management of companies assess themselves; it reflects authors viewpoint as a third party.

1. Marketing:

This must focus on customers. It includes effectively capturing their requirements and expectations, transforming these expectations into clearly identified attributes, providing feedback to the operations management, establishing effective relationships with customers; identifying the changes in market trends; identifying potential customers; maintaining their effective data base; and effective advertising. 70% of the companies surveyed had a separate marketing department/function and 30% had no clearly defined function department. Only 30 % had established this department on a professional basis, led by professional persons. 70% of these heavily focused on establishing relationship at the CEO's level. Their main marketing strategy was relationship marketing. Little use was made of professional advertising.

2. Design:

The strength in product quality is generally achieved through effective R&D. However, it is an expensive investment and reflects a long-term survival strategy. Those who do not use R&D are usually dependent on others for product improvements and innovations.

The survey result showed that 80% of the companies did not have any organized design or development department/function; 15 % had a satisfactory design department/function; and 5% had a poor function. The basis of design function was judged from the technological know-how (product know-how), competence of the designers, resources (including information), and design control systems.

3. Production:

Production management reflects effective planning and control to produce defect-free products services consistently (by minimizing variation). This is only possible with strong systems in production planning and control, led by competent and experienced staff.

It is often misunderstood as maintaining a status quo, i.e. maintaining a pre-defined rate of rejection, defectives, and variation levels. A good production management must reduce these levels continually.

Production planning was judged by the use of appropriate tool(s) for resources planning (e.g. MRP, JIT and project planners); while production control was checked by conformance to validated and established procedures, preventive measures, and effective supervision. The result showed that 60% have satisfactory planning procedures and 40% have poor planning. 90% showed good control and 10% poor. One of the reasons for this function being better was ISO 9000 implementation.

4. Quality Assurance.

ISO 9000 was considered as the basic quality assurance model. Effective implementation of the requirements of the standard was checked critically. The 85% of companies were following ISO 9002, while 15% were following ISO 9001. No Company was implementing ISO 9003. After evaluation, it was found that 60% had poor implementation; and 40 % were either satisfactory or good.

5. Finance.

This was checked from book keeping, accounting, budgeting and effective reporting. 50% had a professional department led by professionals; 25% were weak, and 25% were poor.

Overall Analysis.

The average assessed effectiveness of key departments/functions was 51%. Individual departmental effectiveness as follows:

There was plenty of devices to show that the ISO 9000 program had improved production management function. However quality assurance itself was not satisfactory. Most commonly weak areas were: (1) Design, (2) Marketing, (3) QA, and (4) Finance.

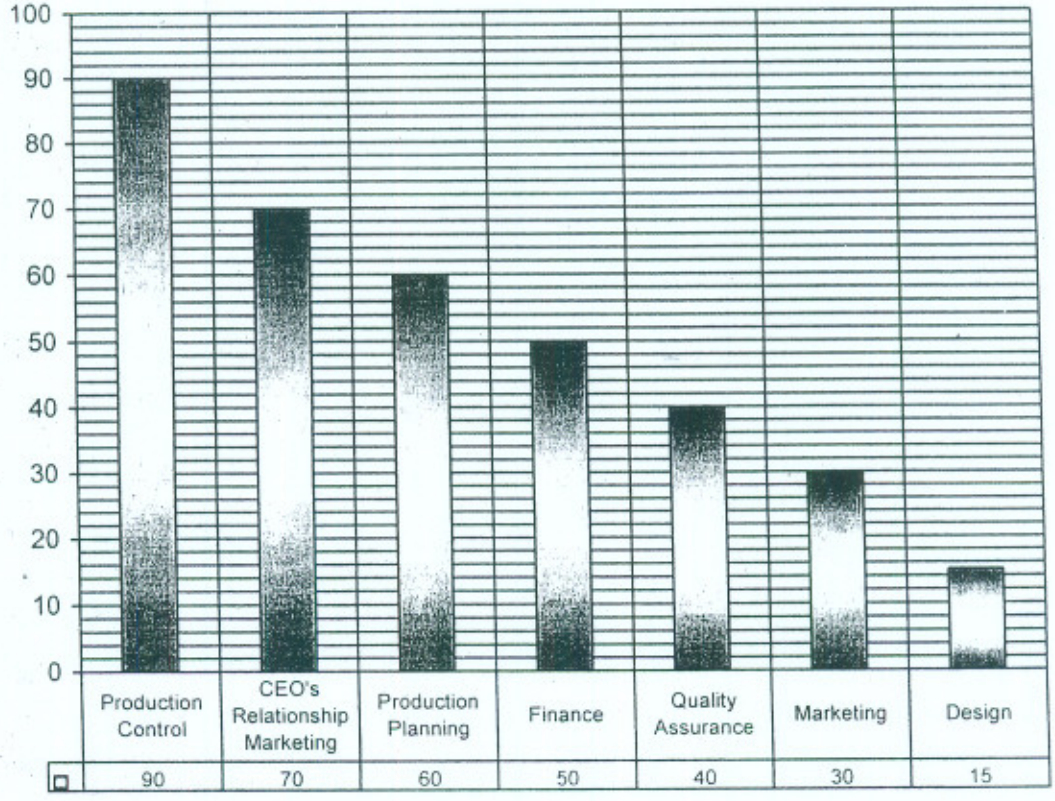


Figure 2: Overall rating of functions in organizations

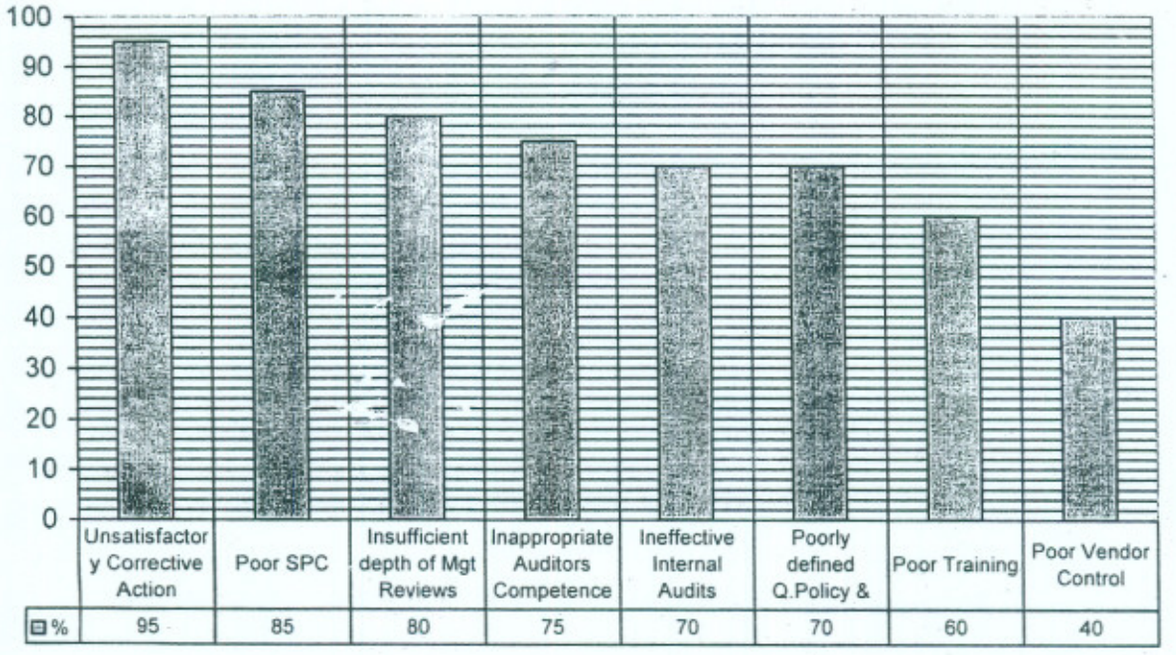
`In terms of rating into A, B, C, D, and F, it is as follwos:

1.	Production Control	(90%)	A
2.	CEO's Personal Marketing	(70%)	B
3.	Production Planning	(60%)	C
4.	Finance	(50%)	D
5.	Quality Assurance	(40%)	D*
6.	Marketing	(30%)	E
7.	Design	(15%)	F

3. The Effectiveness of ISO 9000 QMS

The weaknesses in the ISO 9000 implementation, in order of their priority, were as follows:

Figure 3: Overall weaknesses in ISO 9000 implementation



This is an important discovery. With almost all the studied companies being certified (some close to certification), the indication is that certification is possible with the existence of the above weaknesses. Therefore, excellence in Quality Assurance can not be guaranteed with the proof of ISO 9000 certification. It is dependent on good implementation and day to day running of the contents of ISO 9000, i.e. an intrinsic effort to follow the system in true spirit with competent people.

Whereas ISO 9000 certification is a good Quality Assurance standard by itself, its ineffective implementation is often confused with the quality of the standard itself. The role of consultants and auditors is an extrinsic phenomenon. No one can bring quality in the company if the company does not want it. They can only influence if the company and its management choose to.

* Over all average (51%) D

4. Human Resource Development

In 20% cases, the function was organized but in 80% it was unorganized. The effectiveness was poor in 70 % of the companies.

HRD was found to be one of the weakest areas. The management is generally familiar with the subject but no intentions were found to develop this function seriously. Although a number of HRD manager posts were found, but they were usually not effective due to insufficient competence, commitment and resources.

The strengths in competence, quality management skills, and commitment in the top management, middle management, and supervisors/workers were as follows:

1.	Trade skills of supervisors/workers (good +satisfactory)	=100%
2.	Technical competence of top management (good + satisfactory)	= 95%
3.	Technical competence of middle management (good + satisfactory)	= 80%

This signifies that supervisors and top management make most of the efforts in developing themselves technically and are usually selected on their technical abilities. Middle managers are a little bit behind.

The weak areas were:

1.	Quality management skills of the top and middle management	= 90%.
2.	Involvement of workers in quality initiatives	= 85%
3.	General education of workers	= 80%
4.	Commitment of Quality of top management	= 50%
5.	Commitment to Quality of middle management	= 45%

The weakest area identified was Quality Management skills of the top and middle management. This is one of the key factors resulting in ineffective practices. Systems are designed developed, and run by the management who lack basic professional management skills. Therefore, their skill in equality management is essential for developing quality culture.

Lack of workers involvement was due to a lack of effective quality management systems. Although the general education was weak, there was no evidence that this was the main reason for not taking quality initiatives and getting involved in quality problem solving. It could be only a contributing factor.

In almost half of the companies, both the top and middle management were not fully committed to quality. This could be because of their lack of awareness of, and skills in, quality management. The commitment without skills has been proven ineffective.

5. TQM Tools

Eleven TQM tools were selected to check their awareness and implementation status. Each tool was checked in departments from two angles, i.e. (1) Awareness, and (2) Implementation Status. It was then rated as Good, Satisfactory, or Poor/None. The result was as follows:

a. Overall Awareness of Quality Tools

This is shown as follows (representing both the good and satisfactory levels):

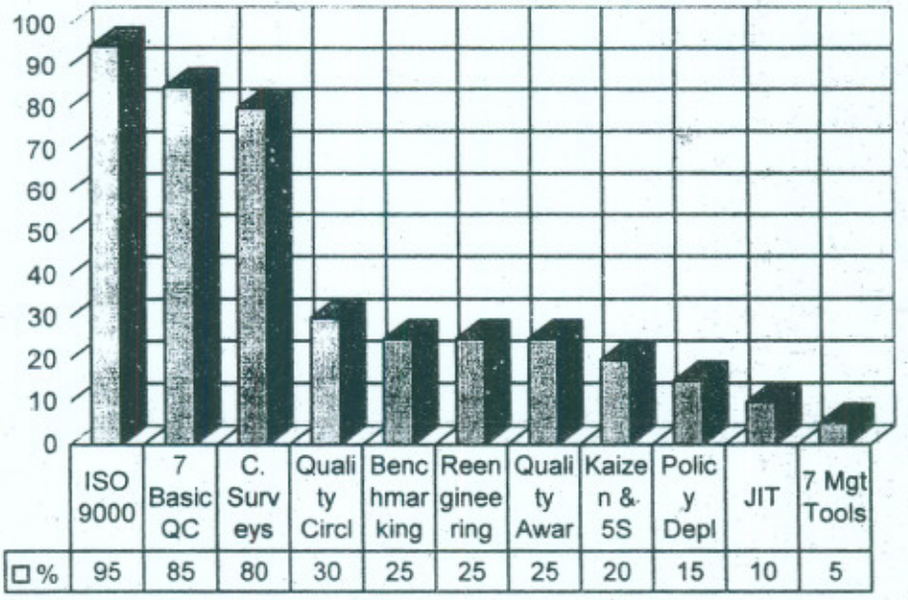


Figure 4: Awareness levels of TQM Tools

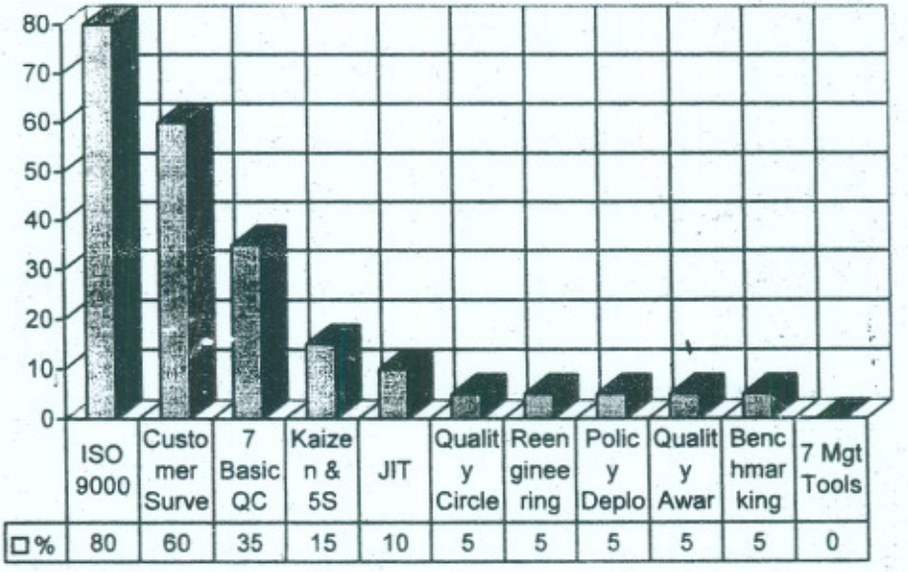


Figure 5: Implementation rating of TQM Tools

6. TQM Implementation

TQM implementation requires effective competence, commitment, resources and organization. These factors were checked in all the companies surveyed. The results were as follows:

Even with a general know-how on the importance of TQM,

1. Most (60%) of the organizations had no intention to implement any TQM program/process. They consider it sufficient to achieve ISO 9000 certification.
2. Approximately 35% companies had serious intentions and preparations were being made but had not yet started (mainly due to lack of many appropriate support.)
3. TQM was properly practiced in only 5% of the organizations surveyed.

This signifies that TQM as a function has not yet being accepted and adopted. It is still used more as a slogan than as an implementation program.

7. Awareness and Practice Disparity

After subtracting the percentage rating of implementation level for the awareness level, the following is the difference/disparity (in order of priority):

1. Statistical Process Control (85%) awareness - 35% implemented) = 50%
2. Quality Circles (30% awareness - 5% implemented) = 25%
3. Customer Surveys, Re-engineering, Quality Awards, Benchmarking = 20%

In other tools there was no appreciable disparity. The weakest area was SPC. Managers are general aware of this tool but are not competent to practice it, and have make no attempts to do so.

Recommendations

1. Design, Marketing and Quality Assurance are generally poor. Lack of awareness and skills are the root causes that result in our poor systems/processes, and thus reduction in overall performance. There is an immediate need to mobilize HRD programs aiming at all the management skills.

2. ISO 9000 is a good framework for Quality Assurance, only if it is implemented effectively and efficiently. The survey proves that this is not being done, in general. Therefore, revitalization of the implementation of the standard itself is immediately required, otherwise this remains just another overhead. Management must come out of the illusion that the certificate is enough as an indicator of good quality. Every person who has a driving license is not a good driver as well. Not every person who has a degree is a good engineer!

3. HRD must be organized and improved for long-term survival. Management is not there just to improve the intellectual know-how in the theory of management. Only those who practice it master the skill. The organizational performance is usually the reflection of the skill its management. A paradigm shift is required for the development and growth of managers, by changing their learning strategies from concentrating on just attending courses and training programs, to acquiring practical skills. Our present training programs and approaches mainly develop intellectualism rather than skills. There is a demand for their re-designing.

4. A Quality Culture is dependent on the skills of its managers: Any TQM program/process must include training and skill development in quality management tools, techniques and strategies. The biggest hurdle found was not the commitment, as generally believed, but the incompetence of the top and middle management in the quality management field.

5. Just walk talk and discuss do not bring changes. The PDCA cycle must be established to continually improve performance and the marketing position. TQM will help to do so. However, persistent improvements do not come without an organized process of TQM. Only organized quality management is good quality management.

6. Maturity in the Quality Culture is a progressive phenomenon. Regular progress can only be guaranteed through institutionalization of TQM processes. Just off-and-on

sermons, preaching, and passing decree is an habit of incompetent and disabled managers and CEOs. Intellectual discussions that do not lead to practical changes and improvements must be discouraged. Action oriented strategies, programs, reviews, and discussions must be encouraged.

7. Lack of quality culture is usually the result of ineffective corporate quality planning due to insufficient quality management skills in management.

8. Finally, quality by itself is a culture, not a system. In order to develop this special form of culture, it requires modifications in our current management approaches, styles and techniques. TQM tools provide the new strategies and management style. The difference is known only to those who practice these tools, not even to those who only teach, preach for write about it.

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OBITUARIES

MAY THEIR SOULS REST IN PEACE

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COMPARISON OF DESIGN METHODS FOR SCOUR AT BRIDGE SITES

by

Ghulam Qadir*

ABSTRACT

Over the past many decades numerous model studies have been carried out and design methods developed to predict scour at bridge pier. Most of these design methods were developed using laboratory data and some-times tested using limited field data. There is considerable uncertainty in the use of these equations to predict scour depth in the field conditions. Although range of data used in laboratory study is unknown, it is quite uncertain as to how those ranges using small scale models correlate to field conditions. Therefore it is necessary to assess the validity of scour design methods before applying them in the field conditions. In this regard, the prototype scour data of some bridges on alluvial rivers have been collected from Kafi, M and Alam: 1995, for analysis to determine the range of applicability and suitability of commonly used scour design criteria for field conditions.

1.0 INTRODUCTION

The problem of adequate allowance for the effect of scour around bridge piers is one that continually arises in bridge design. The designer requires a reliable formula by which he can determine in-advance the maximum depth of scour under the available information. Further, the estimation must lead to both safe and economic design. Interest in local scour stems from a lack of confidence in the present methods for scour estimation.

There are three main factors which may lead to the change of channel bed elevation at a bridge site. Firstly, there may be progressive aggravation or degration of bed levels associated with a change in river regime. Secondly, there may be temporary scour associated with changes in river stage, or with shifting of the deep-water channel. Thirdly, the presence of the bridge itself may cause scour. Scour caused by the bridge may be general and due to constriction of flow or local scour due to the presence of abutments and piers in the flow.

Since the causes of scour are a result of different phenomena, it is impossible to find a single criterion to predict the maximum scour at a bridge pier, due to their combined effect. Rather, the designer must study each possible cause separately and then consider their total effect at a bridge site. The field data being used herein includes, median particle size, pier width, river discharge and observed scour depth.

This work is concerned primarily with local scour at bridge site. The purpose of the work is three fold i.e. firstly, to summarize and classify few applicable existing methods of scour estimation; secondly, to compare these methods by using prototype data; and thirdly to attempt a design recommendation for estimation of local scour.

2.0 REGIME EQUATIONS

Regime equations have been derived empirically from measurements in irrigation canals of subcontinent and are supposed to describe the conditions under which these

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canals are stable for the existing sediment supply. Algebraic manipulation of regime equations yield the equation:-

$$\text{Flow depth} \propto q^{2/3}$$

The regime method for estimating scour at bridges depends essentially on this relation. It is assumed that the depth as calculated by this equation is the average " Flood Regime Depth " corresponding to an average discharge intensity across the clear water way at flood stage (q). It is then further assumed that the maximum scour depth at an obstruction can be estimated by multiplying this flood regime depth by a factor dependent on the geometry of the obstruction, generally of the order of 2 or 3. In this regard, popular regime design methods have been selected to assess them on prototype data.

Blench (1965) presented equation

$$\frac{Ds}{Yr} = 1.8\left[\frac{b}{y}\right]^{1/4} \qquad (1)$$

Where Ds = Scour depth below the water surface in meters.

Yr $= 1.48\sqrt[3]{\frac{q^2}{Fb}}$ = Regime flow depth

Fb $= 1.9\sqrt{d_{50}}$

d_{50} = the mean bed diameter in mm.

b = Pier width in meters.

which is similar in nature to Lacey 's Regime equations. Blench uses Fb, the bed factor in place of Lacey's silt factor.

Inglis - Poona (1942) equation

$$\frac{Ds}{b} = 2.32\left[\frac{q^{2/3}}{b}\right]^{0.78} \qquad (2)$$

was based upon the results of model tests carried out at the Poona Research Station by Sir Claude Inglis.

In Practice, no distinction is made between clear water scour and scour with continuous sediment motion, although Thomas (1962) states explicitly that the Poona experiments were run without sediment load.

Chitale (1960) presented formula:

$$\frac{Ds}{Yo} = 6.65\,Fr - 0.51 - 5.49\,Fr^2 \qquad (3)$$

Where ds = Scour depth below the bed level

Yo = Upstream depth of flow

$$Fr = \frac{Vo}{\sqrt{g.Yo}}$$

Vo = Upstream velocity of flow

which is based upon an extension of the original Poona experiments. The tests were mostly performed without sediment transport. In the few tests in which the upstream bed was scoured, the depth of scour was measured before deposition had occurred.

Inglis - Lacey (1949)

$$\frac{Ds}{Yo} = 0.964 \left[\frac{Q}{f} \right]^{1/3} \qquad (4)$$

Where Q = Flood discharge in m^3/Sec.
F = a silt factor given by Inglis = $1.76\sqrt{d_{50}}$
(Lacey Silt factor = $1.59\sqrt{d_{50}}$)

This equation resulted from the collection of prototype scour data at various bridge sites in India. Inglis reasoned that the effect of bridge piers is to deflect the current like a bend, and therefore proposed that the maximum depth of scour, Ds, is proportional to Lacey's Regime Depth.

In the case of bridge piers, technical co-efficient was given as 2. The above equation is merely a statement of this fact; that is the maximum scour depth around piers is equal to twice Lacey's Regime Depth. Neill (1964) states in his comments on Lacey's equation, that "Lacey's Silt Factor constitutes a weak point because a satisfactory method of defining it in terms of sediment properties and loads has never been established".

The equation by Ahmad (1962)

$$Ds = K.q^{2/3} \qquad (5)$$

Where K = a multiplying factor dependent on the shape of the pier or abutment and ranging 1.9 to 3.4,

was derived for bridges crossing alluvial rivers in deep fills in Pakistan. The Experiments were performed so that there was good general movement of the bed. In practice, the equation is very dependent on choice of K, which is inadequately defined.

2.1 THEORETICAL AND EMPIRICAL EQUATIONS

U.S. Department of Transportation (1993) equations

$$ds = Y_o\, 2.0\, K_1 K_2 \left(\frac{b}{Y_o}\right)^{0.65} Fr^{0.34} \qquad (6)$$

This equation is recommended by FHWA, the United States Federal Highway Authority. The Froude number, Fr, of flow, given by,

$$Fr = \frac{U}{\sqrt{gyo}}$$

The factor K_1 is to account for pier nose shape and K_2 accounts for angle of flow incidence. The equation was developed from laboratory data and is recommended for both alive and non-alive beds. It is also recommended that the limiting value of ds/yo is 2.4 for Fr< 0.8 and 0.3 for Fr > 0.8.

Neill (1973) designed basic equation for local scour for well-aligned piers is;

$$Ds = 1.5b \text{ for } Yo < 5b \quad \textbf{(7a)}$$

$$Ds = 2.2b \text{ for } Yo > 5b \quad \textbf{(7b)}$$

This equation gives, for example, a value of ds = 2.25m. Correction factors to account for pier skewness or angle of flow incidence and length to width ratio of the pier may be applied when necessary. The factor relevant for this example is 2.0.

Melville and Sutherland (1988) presented design method;

$$ds = 2.4b\ fu\ (U.\ Uc.\ Ua)\ fy\ [\frac{yo}{b}]\ fd\ (\frac{d}{b})\ fs\ (shape)\ f\propto(\propto\frac{L}{b}) \quad \textbf{(8)}$$

For this method, the basic scour depth 2.4b term is modified by various factors.

Function *fu* takes account of the erosion resistance of the bed, allowing for the flow velocity U; the critical velocity for the bed material Uc and armouring effects Ua. The value of *fu* depends on the size and grading of the bed material. If this information is not available, a conservative estimate of scour may be obtained if a value of 1.0 is assumed for *fu*.

Function *fy* is included for reducing estimate of scour where the flow depth is shallow compared with the pier width. A conservative estimate will be obtained if *fy* is taken to be 1.0. For the example, the ratio of the flow depth to the pier width is 2.67 and the value of *fy* (2.67) is, in fact 1.0. Only when the flow depth reduces to below 2.5b, approximately, does the function *fy* have a significant effect in reducing estimate for local scour.

Function *fd* is included to take account of the effects of sediment size. The factor is generally 1.0 except where the sediment size is larger than (Y_o/25). For this example the function would only affect estimate of local scour if the medium sediment diameter was greater than 0.16 m. In the absence of further information, the conservative approach is to assume that *fd* is 1.0.

Function *fs* takes account of the shape of the upstream nose of the pier. Rounded or streamlined piers normally result in less scour than rectangular nosed pier. The factor for a circular nose is 1.0. The function f$\propto$ takes account of the angle of flow incidence and the pier length to width ratio. It is evaluated from the same source as that used by Neill (1973). The value in this case is therefore 2.0.

Coleman (1971) plotting of experimental results gives the equation:

$$\frac{Vo}{\sqrt{2gds}} = 0.6\left[\frac{Vo}{\sqrt{gb}}\right]^{0.9} \quad \textbf{(9)}$$

The equation relates the scour Euler Number and pier Froude Number. Experiments were performed under conditions of continuous sediment supply.

Jain and Fisher (1980) developed a set of equations based on laboratory experiments. For (F-Fc)< 0.2

$$ds = 2.0b\,(F - Fc)^{0.25}\,(Y/b)^{0.5} \qquad \textbf{(10a)}$$

Where Fc = critical Froude Number = $Vc/\sqrt{gy}$

for $(F - Fc) < 0$, $ds = 1.85\,b\,(Fc)^{0.25}(y/b)^{0.5}$ **(10b)**

for $0<(F - Fc)<0.2$ the larger of the tow scour depths computed from (10a) and (10b) is used.

3.0 LOCAL SCOUR

Scour can be defined as the enlargement of a flow section by the removal of the material composing the boundary through the action of the fluid in motion. Local scour, that is scour which occurs due to the presence of an obstruction to the flow causes a decrease in the bed elevation only in the area surrounding the obstruction. The flow structures which cause this erosion are called the " mechanism of local scour".

Expressing the rate of scour from a scour hole as difference between the supply of material to the scour area and the capacity for transport out of the area gives a useful classification of scour types.

$$qs = qs_1 - qs_2$$

Where qs is sediment flow intensity.
Two types of scour may be identified:-

i) **Clear Water Scour Case:**

($qs_2 = 0$), where material is removed from the scour hole and not replaced. Maximum scour is reached when the transport capacity out of the scour hole is zero. This condition is reached when the boundary shear becomes equal to critical value for the bed material.

II) **Alive Bed Scour Case**

where the scour hole is continuously supplied with material from the sediment load carried on the stream bed. In this case, limiting scour is reached when the capacity for transport of sediment out of the scour hole becomes equal to the supply of sediment to the scour hole ($qs_1 = qs_2$)

Applying the Shield's criterion and Manning equation in order to estimate the critical mean velocity (Melville, 1975).

$$Uc = \frac{1}{ng^{1/2}} R^{1/6} Uc^* \qquad \textbf{(11)}$$

Where R is hydraulic mean radius in meters & Uc* is critical shear velocity for investigating whether the scour phenomenon is alive or non - alive bed:

4.0 DATA ANALYSIS

Before applying the field data to the selected scour criteria for computation of scour depth, investigations were made by Equation - 11 to assess the type of scour observed in nature i.e. alive or non-alive bed. The computations made in this regard, enabled to proceed further for scour estimation through scour design methods described in preceding section.

Computations pertaining to scour depths were carried out using Equations (1) to (10) and data described in Table - 1. Several simplifications and assumptions in scour computation were made in most of the cases. The piers were assumed to

be aligned with river flow, while their alignments were not known in data points. In scour design methods, pier alignment and its size are multiplicative factors and the effect of piers in computation have equal weight-age in all cases.

Scoured flow depths were computed using the regime scour design methods by Equations (1) through (5) with simplifications described earlier. For each of the methods, the computed values are given in Table - 2 and graphical comparison made between predicted and observed scoured flow depths has been shown in Fig.1.

Similarly scour depths were estimated using scour criteria, by Equations (6) to (10) and for each of this method computed values are given in Table 3. A graphical comparison between predicted and observed scour depths has also been made, which is shown in Fig. 2.

Form these efforts, an endeavour have been made to determine the range of applicability and suitability of these scour criteria for local field conditions.

5.1 Discussion

i) Assuming flat bed conditions, the Shields criterion for threshold of particle transport and the Manning equation showed alive bed scour in case of all points of data.

ii) The observed scoured flow depth in river Ravi at Dera Baba Nanak bridge is seemed to be unrealistic.

iii) The regime equations applied to the field data gave reasonable scoured flow depths for site investigations. The Blench, Lacey with Inglis silt factor, Ahmed & Chitale equations are rejected since they failed to give an adequate scour estimate at most of the bridge sites investigated. The Inglis - Poona equation gave conservative estimate of scoured flow depth for field investigations. This can be visualized from computed values as well as its graphical presentation in Fig. 1.

iv) The empirical / theoretical design methods applied to the field data and found that the Neill, USDT & Jain et-al equations gave under-estimation of scour depth. The Melville et-al and Coleman gave adequate estimate of scour depth as shown in Fig. 2.

5.2 CONCLUSIONS

There are many design methods available for the estimation of depths of local scour at piers. Many of these are similar and all are based on experimental data. In general, they are only applicable to conditions similar to those from which they are obtained. Because measurements of scour collected from the field and those predicted from various methods can not be adequately checked against reality. Hence, it is impossible to be entirely confident of any one method of scour estimation. The following points seem to be generally acceptable amongst investigators on bridge scour.

i) There is a difference between clear water scour and sediment transporting scour, clear water scour is probably more dependent on sediment characteristics than sediment transporting scour.

ii) The depth of local scour is proportionate to the width of the obstruction or the depth of flow.

iii) The followings are the probable important factors affecting the depth of scour.
   a) Size & orientation of pier.
   b) Velocity & depth of flow.

c) Size and grading of the bed material and
d) Geometry of the water way.

iv) In establishing design criteria, it is necessary to estimate the equilibrium depth of scour and plus a factor of safety. The factor of safety will vary from site to site, but generally, due to a lack of confidence in scour equation it should not be less than 1.5.

5.3 RECOMMENDATIONS

i) The Inglis - Poona (1942) and Melville et-al (1988) relationships from regime and theoretical approaches respectively are acceptable for design purpose, but both the equations are without any factor of safety. It is therefore essential that a factor of safety be incorporated in design computations.

ii) In-sufficient information are available to suggest whether the regime or theoretical approach is more preferable. It is therefore recommended that the larger of the scour depths estimated by these two approaches should be adopted for design purposes with the additional factor of safety.

iii) The data regarding bridge hydraulics, sediment hydraulics and river hydraulics be collected from field with the colaboration of I.R.I trained staff to conduct further extensive study on the subject.

Table - I
Prototype Data of Bridges on Alluvial Rivers
(Kafi and Alam: 1995)

Bridge Site/River	Year	Q m^3/S	q m^2/S	Pier Width b (m)	d_{50}(mm)	Flow Depth y (m)	Observed Scoured flow Depth Ds (m)
Hardinge Bridge Ganga	1938	47468	52.51	11.27	0.37	18.36	35.67
Bramhaputra Bridge at Amingaon	1938	63763	52.04	6.1	0.39	18.09	31.71
Par Railway Bridge	1941	4761	22.58	3.96	0.33	10.66	17.84
Jhelum Bridge Shahpur	1938	1706	8.51	6.1	0.32	5.59	14.63
Alexandra Bridge Over Chenab	1938	2922	11.15	3.05	0.37	6.53	12.71
Chenab Bridge at Shershah	1933	4421	13.75	6.1	0.34	7.62	13.72
Chenab Bridge at Chiniot	1932	4743	14.31	7.62	0.34	7.83	12.88
Ravi Bridge at Dera Baba Nanak	1942	1977	9.2	6.1	0.24	6.18	19.35
Satlej Bridge near Phillaur	1929	1738	8.6	6.1	0.32	5.63	11.92
Satlej Bridge near Adamwahm	1933	3025	11.43	4.27	0.2	7.36	14.98
Chenab Bridge near Chund	1936	3113	11..99	6.1	0.3	7.1	12.62
Deaver Crossing	1962	567	10.33	1.83	0.5	5.9	9.76

Table -2
Showing the Scoured Flow Depth, Computed By Regime Approach

Bridge Site/River	Year	Q m^3/S	q m^2/S	Pier Width b (m)	d_{50}(mm)	Flow Depth y (m)	Observed Scoured flow Depth Ds (m)	Calculated Scoured Flow Depth Ds				
								Blench (1965)	Inglis - Poona (1942)	Chitale (1960)	Inglis - Lacey (1960)	Ahmad (1962)
Hardinge Bridge Ganga	1938	47468	52.51	11.27	0.37	18.36	35.67	30.92	41.37	30.81	34.64	35.07
Bramhaputra Bridge at Amingaon	1938	63763	52.04	6.10	0.39	18.09	31.71	26.24	35.95	30.58	37.88	34.84
Par Railway Bridge	1941	4761	22.58	3.96	0.33	10.66	17.84	15.24	19.26	17.60	16.40	19.97
Jhelum Bridge Shahpur	1938	1706	8.51	6.10	0.32	5.59	14.63	10.86	12.29	9.19	11.71	10.42
Alexandra Bridge Over Chenab	1938	2922	11.15	3.05	0.37	6.53	12.71	10.28	12.28	10.97	13.67	12.48
Chenab Bridge at Shershah	1933	4421	13.75	6.10	0.34	7.62	13.72	13.72	16.34	12.64	15.92	14.35
Chenab Bridge at Chiniot	1932	4743	14.31	7.62	0.34	7.83	12.88	14.80	17.56	12.98	16.30	14.74
Ravi Bridge at Dera Baba Nanak	1942	1977	9.2	6.10	0.24	6.18	19.35	11.72	12.87	9.76	12.90	10.98
Satlej Bridge near Phillaur	1929	1738	8.6	6.10	0.32	5..63	11.92	10.94	12.37	9.25	11.78	10.50
Satlej Bridge near Adamwahm	1933	3025	11.43	4.27	0.20	7.36	14.98	12.23	13.54	11.34	15.33	12.67
Chenab Bridge near Chund	1936	3113	11..99	6.10	0.30	7.10	12.62	13.02	15.06	11.57	14.46	13.09
Deaver Crossing	1962	567	10.33	1.83	0.50	5.90	9.76	8.39	10.58	10.34	7.52	11.85

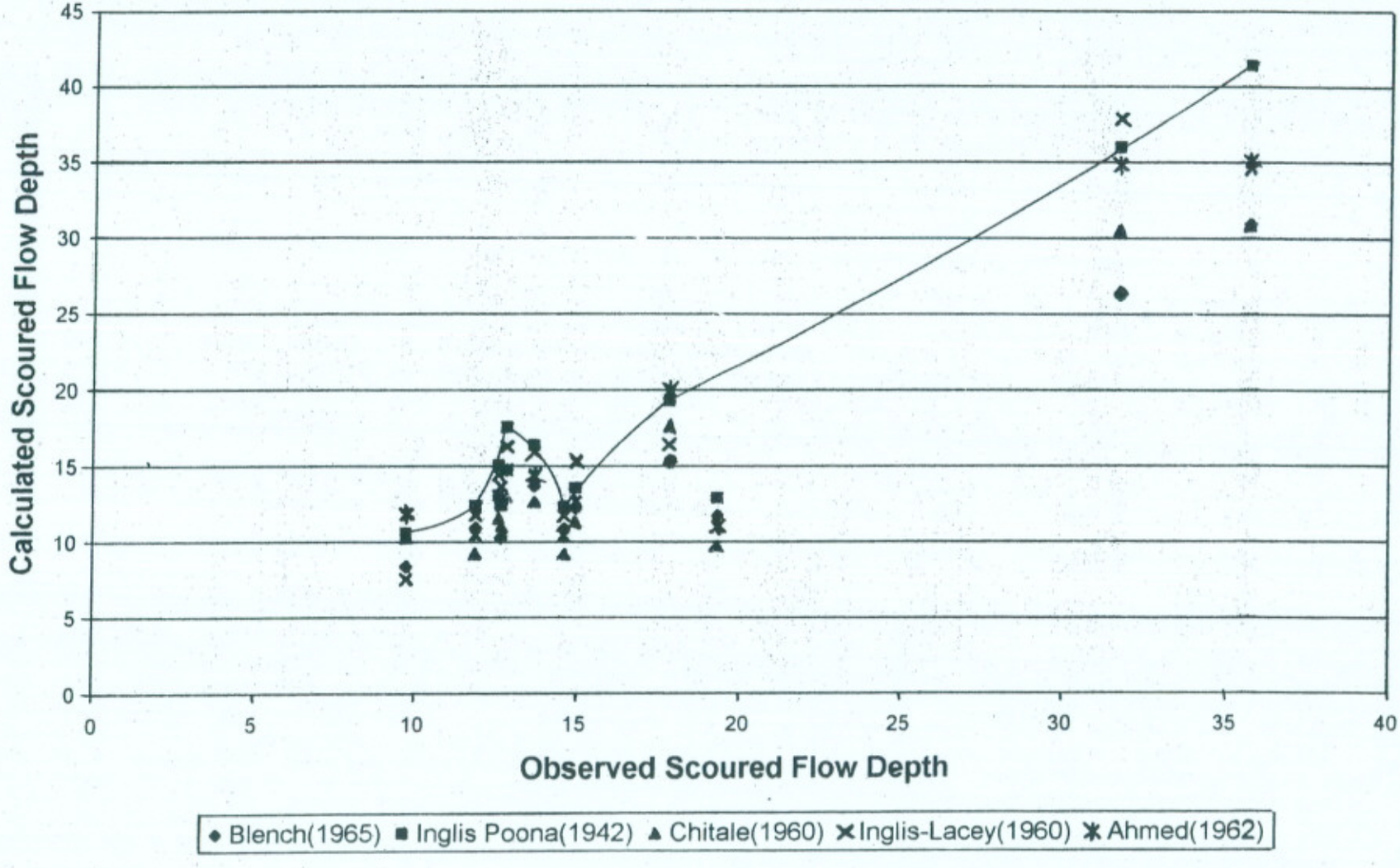
Table - 3

Showing the Scour Depth Computed By Empirical Approaches

Bridge Site/River	Year	Q m^3/S	q m^2/S	Pier Width b (m)	d_{50}(mm)	Flow Depth y (m)	Observed Scoured flow Depth Ds (m)	Calculated Scoured flow Depth Ds				
								Neill (1973)	Jain et . al (1938)	USDT (1993)	Cole-man (1971)	Melville et. al (1988)
Hardinge Bridge Ganga	1938	47468	52.51	11.27	0.37	18.36	17.31	16.90	18.00	13.76	18.77	23.80
Bramhaputra Bridge at Amingaon	1938	63763	52.04	6.10	0.39	18.09	13.62	9.15	13.17	9.24	9.21	14.64
Par Railway Bridge	1941	4761	22.58	3.96	0.33	10.66	7.18	5.94	7.94	5.69	6.00	8.14
Jhelum Bridge Shahpur	1938	1706	8.51	6.10	0.32	5.59	9.04	9.15	6.92	5.99	9.52	11.13
Alexandra Bridge Over Chenab	1938	2922	11.15	3.05	0.37	6.53	6.18	5.60	5.37	4.10	5.22	6.96
Chenab Bridge at Shershah	1933	4421	13.75	6.10	0.34	7.62	6.10	9.15	8.23	6.73	9.85	12.15
Chenab Bridge at Chiniot	1932	4743	14.31	7.62	0.34	7.83	5.05	11.43	9.33	7.84	12.60	14.45
Ravi Bridge at Dera Baba Nanak	1942	1977	9.20	6.10	0.24	6.18	13.17	9.15	7.20	6.02	9.84	11.42
Satlej Bridge near Phillaur	1929	1738	8.60	6.10	0.32	5..63	6.29	9.15	6.95	6.01	9.53	11.27
Satlej Bridge near Adamwahm	1933	3025	11.43	4.27	0.20	7.36	7.62	6.40	6.56	4.98	6.94	9.23
Chenab Bridge near Chund	1936	3113	11..99	6.10	0.30	7.10	5.52	9.15	7.86	6.47	9.72	11.85
Deaver Crossing	1962	567	10.33	1.83	0.50	5.90	3.86	2.75	4.00	2.93	3.33	4.39

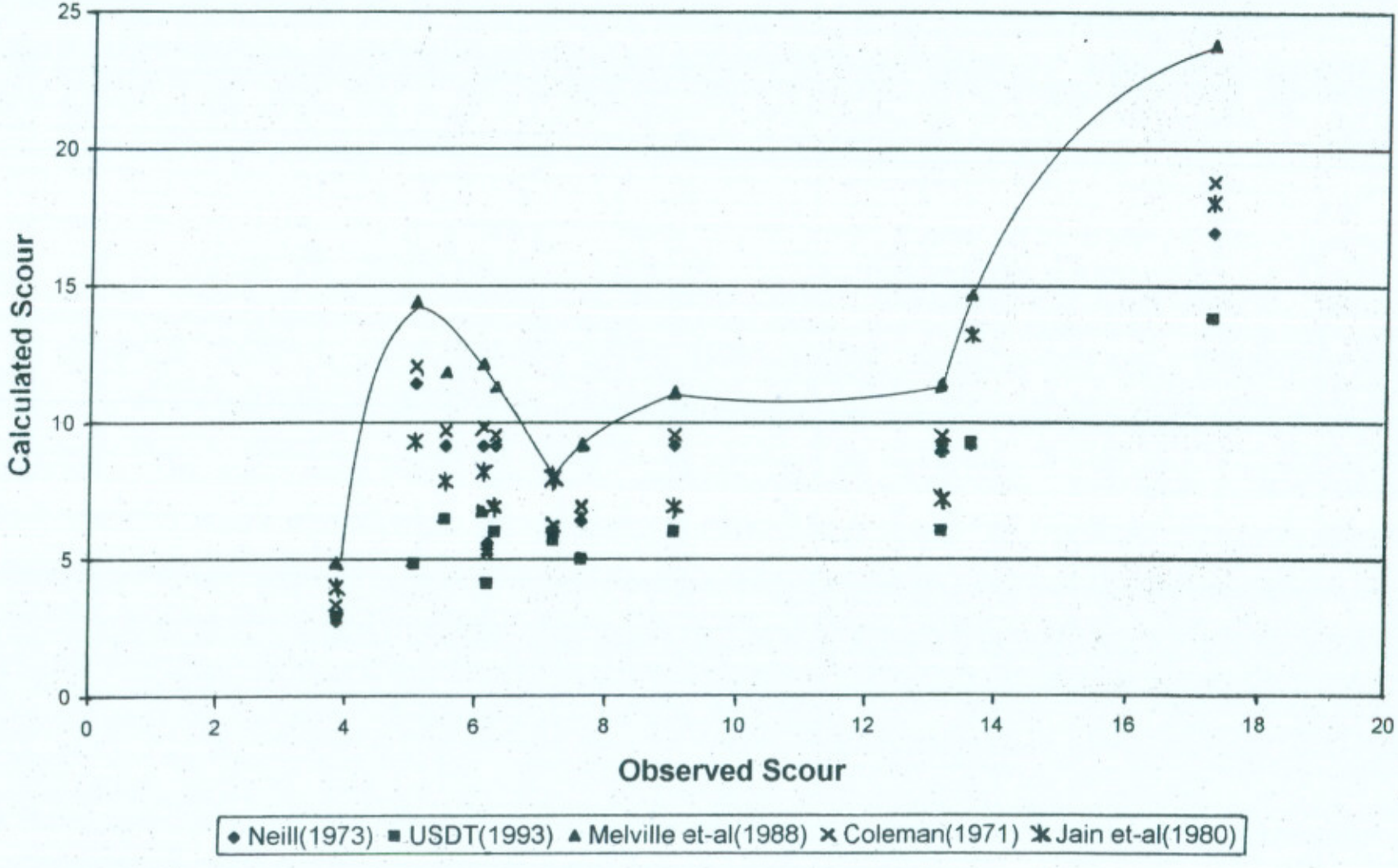
Comparison of Calculated & Observed Scoured Flow Depth (m)

Fig-1



Comparison of Calculated & Observed Scour Depth (m)

Fig- 2



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QUALITY - OF - LIFE VALUES COMPONENT IN ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

by

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ABSTRACT

The paper discusses the importance of quality-of-life value component in Environmental Impact Assessment (EIA) process for development projects. It emphasizes the need of a detailed survey of the affected communities and holding interviews with the people to know their opinion about the project. Major factors affecting the quality-of-life values have been identified as socioeconomic and health considerations and aesthetic and cultural values. All these have been discussed in detail to highlight their importance in EIA studies.

1. INTRODUCTION

Many development projects, such as the construction of a dam/reservoir or establishment of a thermal power plant, result in benefits that are distributed over geographical and social class boundaries. However, these may cause high concentrated local community effects. Under such conditions, people in the local community may perceive that they are bearing unduly high costs or assuming disproportionate risks. Such a situation may bring rejection/opposition to the project from the local communities. The developer should, therefore, ensure that the project brings significant socioeconomic development and subsequent improvement in the quality-of-life values for the communities located in the project area.

It is for the above reasons that in Environmental Impact Assessment (EIA), general characteristics/ attributes of the community including socioeconomic data and local values and concerns, relevant to the project are discussed. Predictions are then made of the impacts that would be caused to the communities during the construction and after the operation of the project. Based on predictions, appropriate mitigating measures are suggested in EIA to obtain the support of the local community for the success of the project. This exercise ultimately leads to a fair evaluation of the net worth of the project.

2. QUALITY-OF-LIFE VALUES

Quality-of-life is an expression of the degree to which people may enjoy their lives in good health, in economic securities and in general peace of mind about the present and the future (Fitzsimmons et al., 1977) `Value' refers to people's sense of how things ought to be. Quality-of-life values generally include concerns about opportunity for a reasonable income, a reasonable standard of living, healthy development of the family and a happy family life, decent home and neighbourhood, recreation etc. (Goodman, 1984).

To study the quality of life values, a detailed survey of the project area is undertaken. The relevant data are collected and interviews held with the people. Such a survey also assists in public involvement programme and to predict benefits for the unemployed and under-employed labour.

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An assessment of quality-of-life values includes the study of the following aspects:

2.1 Socioeconomic Considerations

Socioeconomic aspects in the area are primarily concerned with the nature of the economic base of the area and its implication with the employment, basic communication and transportation characteristics of the area (Goodman, 1984). Socioeconomic considerations form an integral part of EIA for most of the development projects. The scope of such studies has been defined in guidelines published by various agencies such an NEB (1980), the World Bank (1991), ESCAP (1990) and the Asian Development Bank (1988). The following information is collected to evaluate the socioeconomic conditions of a community.

- Population, gender and population projection.
- Economic resources of the area.
- Occupation.
- Employment pattern.
- Income level.
- Land use.
- General life-style, crime, poverty, quality of houses.
- Traditions, customs, beliefs, etc., religious institutions.
- Presence of ethnic groups.
- Mass communication/education facilities.
- Transport facilities.

Evaluation of the socioeconomic data should indicate the possibilities and the extent of employment of local people for the construction and operation of the project. If qualified and skilled persons are indicated to be available in the area, they should be preferred for employment.

With the implementation of the project, a favourable change in the life-style of people is generally expected due to changes in the local economy. Operation of a plant would also create indirect opportunities through the transport sector and other service industries. These employments should result in better living standards of the local communities.

The socioeconomic survey should be helpful to predict the impact of the project on the land use pattern. A change in land use from no activity to industrial, commercial or residential development will result in positive or more beneficial use. However, sometimes the changes in the land use occur from agriculture to industrial or other uses compelling the local communities to find their occupation elsewhere. In some cases the houses and crops in the plant site may have to be removed and the land owners required to find a new place for settlement. Examples to this effect are the construction of a dam/reservoir or establishment of large industrial estates. Such a situation may bring numerous problems for the resettlers. The affected may not be able to achieve an earning level equal to that of without project conditions. such people would also need training on how to manage the new occupation. EIA report should discuss these aspects and emphasize that the provision of funds for rehabilitation must form an integral part of the project core budget.

Data on housing facilities in the area would be useful to indicate the capacity of the local community to absorb the influx of outsiders with respect to the project and allied activities. Housing shortage in the area and the exploitation of the commercial activities along the access road sides may result in the appreciation or prices of land and houses in the area. High volumes of influx of outsiders may give rise to slums and haphazard settlements which may lead to social problems. In particular, the unemployed outsiders may cause an increase in crime rate. All such possibilities

should be explored and discussed in EIA. The EIA should emphasize the need for proper land use planning by the government officials in the project area.

Based on the traffic data collected through the survey, traffic volumes projections during construction and operation phases of the project may be carried out to identify locations of traffic congestion on the access roads. Increased traffic volumes may also put the community to accidental hazards and air pollution problems. Transportation of workers/operators from outside to the plant site should also be considered in the EIA report to predict all such impacts and suggest appropriate mitigation measures. Based on EIA recommendations, the developer should establish continuous liaison with the local government officials for widening of the access roads and routine maintenance.

The influx of outsiders in the area needs special considerations. Local people may have particular lifestyle and cultural values. Consequently many social problems and conflicts may arise when outsiders try to settle in the area. In the light of the survey results, the outsiders could be warned by the developer about the local traditions and customs to avoid conflicts. To minimize the conflicts EIA should recommend the management of the plant to initiate some sort of training programme to ensure the maximum utilization of local people as labourers, effectively bridging the gap between locals and outsiders. The plant management may also consider to use local contractors who are prominent in the local society for hiring workers for the plant.

The socioeconomic survey would also identify the community leaders and officials in the area with whom the developer may establish close liaison. Through such contracts the community can be approached to promote public awareness of the project and gain acceptance for the activity. The developer may be informed about the community needs. As such the construction of a mosque or a school by the developer in the area can win favours of the people for the project establishment.

Some adverse impacts on socioeconomics may also result due to the projects. These effects include inflation in the prices of goods and services. At the end of the construction phase a large number of local labour may become jobless. In such circumstances, EIA may recommend the developer to consider the provision of some loan to the affected so that they are able to start some business (EGC at al., 1994).

In some projects, the plant operation may have adverse impacts on other economic resources of the area. For examples, emissions from a cement or fertilizer plant may result in poor growth and low yield of certain crops in the project area. Likewise, the elevated temperatures and high chlorine content of cooling water from a thermal power plant may affect the fisheries in the receiving water body resulting in low income to the fishermen. These aspects should be addressed in EIA and the appropriate mitigation measures recommended.

2.2 Public Health Aspect

These aspects include the followings:

- Health care facilities.
- Prevalent diseases.
- Water supply, sewerage, drainage and sanitation facilities.
- Public utilities.
- Social welfare services.
- Effects of pollutants from the proposed activity.

- Safety services e.g., police, fire-fighting.
- Work place safety provisions.
- Occupational health aspects.

Any successful project should bring improvement in community health, infrastructure and other services in the area. To achieve the objective, potential public health problems and nuisance from plant operation should be identified and evaluated in EIA.

The influx of the people into the area will strain existing facilities, such as housing, water supply, sanitation, health and education. During construction phase, the contractor should be made responsible for providing the basic infrastructure in the form of water supply, electricity, sanitation and health care facilities to the workers. For outsiders, residing in the area, the responsibility of the provision of basic infrastructure facilities should lie with the concerned local government officials. The developer should approach the relevant public offices for allocation of necessary funds and provisions in this respect.

To avoid adverse health impacts due to plant operations, the developer is responsible for the provision of necessary facilities to plant workers. These should also include occupational health and safety or industrial bygiene training programme for workers during both construction and operation phases.

Local communities would readily welcome the project if it brings public health benefits to them; e.g. when the developer is able to supply good quality drinking water and/or medical care not only to the plant workers but also to the community in general.

2.3 Aesthetic Values

These are the perceptual stimuli that provide diverse or pleasant surroundings for human enjoyment. Included in this category are sights (landscape), sound, scent and taste (Goodman, 1984).

Much attention should be given to changes in landscape that can be caused through project activities. The establishment of a cement plant, for example, may ultimately have a significant visual impact on landscape through consumption of hillocks of limestone for cement production. A plantation programme may sometime help to restore the beauty of the area (EGC and ETC, 1990).

Ambient noise levels in the project area must be considered while proposing mitigating measures for noise due to plant operation. To minimize noise transmission from the plant operation to local communities, the management may be recommended in EIA to establish a buffer strip around the plant boundary with heavy tree plantation. The tree plantation will not only beautify the site but also discourage the entrance of wind-blown dust into the plant area.

In general the plant site should preferably be not a prime area for tourism, recreation or aesthetic pursuit. In other words no depreciation of environmental aesthetics should be faced due to the plant location (EGC, et al, 1994).

2.4 Cultural Values

There are evident of the past and present habitation that can be used to reconstruct or preserve human life-ways. Included in this category are structures, sites and artifacts. Cultural

values are found in archaeological remains (Goodman, 1984). The survey must point out if such sites are available in the area and any adverse impact that might be caused to these due to the project activity. Appropriate mitigation measures should then be proposed to save these treasures. EIA way recommend to shift the location of the plant elsewhere, or to develop plans to relocate valuable artifacts, buildings etc. (ESCAP, 1990).

3. CONCLUSIONS

The above discussion leads to the following conclusions.

1. In any development project, assurances must be provided to bring socioeconomic development of the communities located in the project area.

2. While conducting EIA, impacts during construction and operation of the project on the local communities should be predicted and appropriate mitigation measures suggested.

3. To study the quality-of-life values, a detailed survey of the project area is needed along with interviews held with people.

4. The assessment of quality-of-life values should address the socioeconomic and public health aspects. There is also need to evaluate the impacts with respect to aesthetic and cultural values of the concerned communities.

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LESSONS FROM ROAD IMPROVEMENT WORKS IN LAHORE

By
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Billions of rupees have been spent on improvement of roads in Lahore during the last decade or so. In return we have new roads with two, three or four lane dual carriage ways running through heart of Lahore to remove traffic congestion and avoid hold ups. At least that is what was projected to the decision makers by the consultants. All the roads were not approved or taken up for construction simultaneously but were spread over long time and executed bit by bit and road by road. But sadly enough, the consultants followed the same strategy throughout without even evaluating the effect of improvements already carried out. The consultants ruthlessly ignored intermediate turning points, discarded most of the intersections, disregarded the existing trees, made no distinction between residential and commercial needs of the city and treated improvement works as construction of highways on virgin sites. They imposed limited access roads with barren and shadeless pavements on the citizens which become unbearably hot in summers due to high speed traffic, where residents of one side have been completely cut off from the opposite neighbours, where trading activity has been strangulated and one has to travel and extra K. M. or two before finding a 'U' turn.

The so called improvements in Lahore roads of drastically reducing 'U' turn have not been in the best national interest. This decision needs to be revised in view of the fact that city roads are not long distance highways and have to be treated separately from highways where needs of the citizens and those residing or trading along the roads should receive some consideration. The interest of those passing through an area should receive lower priority in designing or improving urban roads. Moreso in our country with mixed traffic like rehras, cyclists and pedestrians, which cannot be ignored.

The only community that might have benefited from the present 'improvement' is the traffic police who have got their burden slashed after elimination or intermediate 'U' turns. They have less crossings to manage now and have, therefore, started crowding at 'chowks' to guard the lane markings and to find an excuse to prosecute a motor cyclist or a car driver for crossing a lane. A novel method of drawing continuous line near a signal has been introduced which has created long bottlenecks at chowks and increased idle waiting time. The practice of placing steel barriers has further reduced effective metalled width of roads and has further strangulated the 'chowks' of which the traffic police is unmindful. Unnecessary bans are imposed for parking on main road without realising that alternate parking place is not available within easy reach.

An innovation introduced on the Mall is to urge the pedestrians to cross at Zebras which is alright in theory but cannot be practiced in Lahore where Zebras are provided near traffic lights at an average distance of about 1/2 Km. One should not expect the pedestrians in a highly commercialised area to walk an extra Km or so just to fulfill an empty slogan of banners. The traffic police is under a mistaken notion that by simply painting the road surface with Zebra lines, the safety of pedestrians is ensured and that no pause in traffic lights in required for them to cross, who must do so at their own risk. A recent innovation pertains to disallowing 'U' turn even on some of the crossings and traffic signals on the Mall. This must be hurting the traders around and the shoppers from all over the town, not to speak of extra petrol consumed on longer route and mental irritation. Apparently this intervention is designed to provide quick passage between GOR and the Secretariat and not for convenience of public. After 'improvement' of Gulberg boulevard which resulted in death of couple of pedestrian (as reported in the press) the traffic experts got steel studs fixed on both the carriage ways over a distance of about 1000 ft in front of 'Pace' store. This

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intervention, which cost the tax payers about 5 lac, is in fact a tyre bursting device and should not have been imposed. It would have been better to pave the stretch with bricks (as in Holland) or use surface dressing instead of carpet to slow down the traffic and prevent accidents.

The following calculations show that extra 150 gallons of petrol per day is wasted by locating 'U' turns 1 Km away instead of say 1/2 Km assuming only 6000 vehicles per day (or 4 vehicles per minute) making 'U' turns at each end:-

i)	Traffic taking 'U' turn on both ends.	= 2 x 6000	=	12000
ii)	Extra travelling distance per day.	= 12000 x 0.5	=	6000 Km.
iii)	Extra petrol consumed daily @ 10 Km/Lit.	= 600 litres	=	150US gallon.

A conservative estimate of petrol wasted on a four way crossing comes to 600 gallons or 15 barrels per day which works out to 5400 barrels per year costing $160000 in foreign exchange. If there are only 100 such situations in Lahore (which is probably an under estimation) the wastage of petrol is causing drain of about $ 16.0 million per year on our foreign exchange which can be easily saved by merely reducing the distance between 'U' turns in Lahore alone.

On the national scale, this seemingly insignificant step would save about $ 100 million per year for a poor country like ours. It is, therefore, worth considering whether providing additional ' U turn on roads leading to a crossing serves the national interest or not. There is no denying the fact that 'U' turns every 1000 to 1500 ft away on city roads are annoying for the drivers and reduce the speed of traffic and increase travelling time. The brighter side of this retrogression is that it may inculcate the habit of patience amongst the drivers besides avoiding serious fatal accidents due to high speeds that the vehicles pick up on uninterrupted longer stretches. We have to remember that our culture, traffic pattern and living habits are so different from the West that we cannot follow their standards or precedents when we have to import petrol. A saving of a few minutes of travelling time or inconvenience to through traffic can and should be tolerated particularly when time has very little value in our society; if we just look at the percentage of latecomers in offices, work places & shops.

One reason for increased traffic on major roads and congestion on chowks is because of bad state of internal roads leading to main roads. If the side roads are improved and intermediate 'U' turns also provided, the traffic will get dispersed in the side streets, crowding of crossings will be avoided and the need for expensive or overbridges will be averted.

A theoretical model of 'U' turns at 1000, 1500, 2000 and 3000 ft apart has been analysed in Table 1 on following premises:-

a) Maximum approach speed of 50, 60, 70 or 80 Km per hour respectively is attained over distance or 1000, 1500, 2000 and 3000 ft between two 'U' turns.
b) Maximum exit speed of 20, 25 and 30 km per hour has been adopted.
c) Average vehicle length is 20 ft.
d) Signal time of 20, 30 and 40 seconds has been adopted.
e) 1 Km per hour speed is equivalent to 1 ft per second.

It is seen from table 1 that:-

1. Smaller the distance between 'U' turns, lesser the build up of traffic.
2. Longer the duration of signal, more the build up of traffic at cross roads.
3. As the backlog of uncleared vehicles at traffic lights decreases at higher exit speeds, the aim should be to reduce the distance between opposite stop lines.

4. Longer signal time does not increase the clearance capacity at the chowk at all. Manual control of traffic should, therefore, be avoided.

A better way to avoid congestion at 'chowks' is to increase the number of lanes at crossings or widen the road at crossings. A two lane road if widened to 3 lanes or is allowed to accommodate 3 lines of vehicles, the capacity would increase by 50 %. But unfortunately our traffic experts practice opposite measures and choke the crossing by erecting concrete dividers or placing temporary steel barriers at the crossings. What we should really be doing is to widen the roads at crossings or allow 3 vehicles line on 2 lane carriage way and 4 vehicles on 3 lane carriageway near the crossings. The international traffic lane of 12 ft width is actually prescribed for highways and fast moving traffic but the city roads and crossing are different. Since the traffic is required to stop at red signal, it has to slow down on approach in which state no vehicle requires 12 ft space. One can easily squeeze into 8 to 9 ft wide opening. Lane marking with continuos line near the crossing (within 200 ft or so) be replaced with broken line for fast evacuation at the 'chowks'.

Following basic design and management tools are being suggested for adoption in future to suit our conditions:-

i) Since the approach speed of vehicles to a crossing is more than at the exit, it is never possible to completely vacate a traffic lane. Shorter duration signals are always better than those or longer duration.

ii) 'U' turns on major city roads be provided at 1000 to 1500 ft interval.

iii) In view of mixed traffic involving cyclists, tongas, rehras and pedestrians besides vehicles, the city roads must not be provided with continuous lane mark in dual carriage ways.

iv) The practice of placing steel barriers near crossing to bifurcate a carriageway or a turning lane be stopped.

v) The traffic police be barred from tinkering with signal switches or resorting to manual control which always increase build up of traffic on opposite roads.

vi) Adequate amber light interval is not being provided at our signals, which is an essential ingredient of any traffic management.

vii) Concrete dividers for separating service road from main carriage ways reduce the available width and be replaced by broken paint line gradually which will be more convenient for residents and traders besides being economical.

viii) Expensive concrete kerb stones should not be provided which have to be uprooted when a road is recarpetted. The plastered brick kerb is not only cheaper but can also be raised subsequently.

ix) The height of footpath should preferably be kept as 7 1/2" (and in no case should it exceed 9") so that pedestrians can mount and dismount easily and permit unhindered opening of car doors.

x) Instead of recarpetting with fresh aggregates at high cost, we should develop a technology of recycling and reusing the worn out carpet as practiced in the Far East so that level of roads is not raised and the adjoining property is saved from raising plinths.

Urban traffic encompasses all type of traffic of a city including pedestrians and cyclists who are unfortunately ignored like the city dwellers by all traffic engineers and administrators in our country. The earlier this situation is corrected the better it will be for all of us in the long run.

Table 1

Collection and Evacuation of vehicles at a crossing in Urban Roads.

Sr. No.	Item		Distance (ft) between crossings or U turns.											
			1000			1500			2000			3000		
1.	Max. approach speed (Km /Hour)		50			60			70			80		
2.	Average Speed. (ft/Sec)		25			30			35			40		
3.	Signal duration (sec.)		20	30	40	20	30	40	20	30	40	20	30	40
4.	Length of road occupied (ft)		500	750	1000	600	900	1200	700	1050	1400	800	1200	1600
5.	No. of vehicles collected.		25	37.5	50	30	45	60	35	52.5	70	40	60	80
6.	Max. exit speed (km/hour)		20	25	30	20	25	30	20	25	30	20	25	30
7.	Average exit speed (ft/sec)		10	12.5	15	10	12.5	15	10	12.5	15	10	12.5	15
8.	Distance (ft) cleared between signals at exit speed (ft/sec) of	10	200	300	400	200	300	400	200	300	400	200	300	400
		12.5	250	375	500	250	375	500	250	375	500	250	375	500
		15	300	450	600	300	450	600	300	450	600	300	450	600
9.	Vehicles cleared in Above time at speeds (ft/Sec) of	10	10	15	20	10	15	20	10	15	20	10	15	20
		12.5	12.5	18.75	25	12.5	18.75	25	12.5	18.75	25	12.5	18.75	25
		15	15	22.5	30	15	22.5	30	15	22.5	30	15	22.5	30
10.	Back log of Vehicles at above exit speeds of	10	15	22.5	30	20	30	40	25	37.5	50	30	45	60
		12.5	12.5	18.75	25	17.5	26.25	35	22.5	33.75	45	27.5	41.25	55
		15	10	15	20	15	22.50	30	20	30	40	25	37.5	50
11.	Clearance capacity per hour at speeds (ft/sec.) of	10	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
		12.5	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250
		15	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700

Conclusion:

1. Longer signal duration collects more vehicles (lines 5)
2. Vehicles cleared at a signal depend on exit speed and duration of signal but has no relation with distance between 'U' turns (line 9).
3. Back log of uncleared vehicles at a signal increases as the distance between 'U' turns is increased (line 10).
4. Number of vehicles cleared per hour is constant irrespective of duration of signal (line 11).

Chemically:

86 gypsum = 49 sulphuric acid

Or 1 gypsum = 0.5696 sulphuric

Or = 0.57 sulphuric acid

It could be only, when the weight of sulphuric acid is of one equivalent, but the avaliabl sulfuric acid in the market is of 36 equivalents. So to get its equivalent, it should further b divided by 36.

Thus 1 gypsum is equivalent to $\frac{0.57}{36}$ = 0.01583 sulphuric acid

Or 1 sulphuric acid = 63.171 gypsum

Thus one ton of sulphuric acid = 63 tons of gypsum

The market price of gypsum is about Rs. 800 per ton and that of sulphric acid is R 6000/- per ton.

So the Price of 1 tone gypsum produced with sulphuric acid in a calcaious soil is F 95.24.

It is quite cheap. The farmers should be educated to make use of sulphuric acid inste of powdered gypsum.

References:

1. David W. James, R. John Hanks, Jerome J. Jurinak, 1982.

2. Manual of Salinity Reaserch Methods, 1992, IWASRI and UNDP.

USE OF GYPSUM AND SULPHURIC ACID AS SOIL AMENDMENTS

by

MUHAMMAD ALTAF HUSAIN*

In arid lands the moisture movement trend is generally upward. The salts dissolved therein, accumulate close to the soil surface; consequently these lands are salt affected.

The salts they contain, are mostly Sodium Chloride (NaCl) and Sodium Sulphate ($Na_2 So_4 XHO_2$). The Sodium Adsorption Ratio (SAR) of the solution of these lands is high. It shows that sodicity is also a part of them.

These lands also contain large amounts of Calcium Carbonate. It is insoluble in water and remains as an innert material in the earth mass. These lands are calcarious.

The excess of salts could be removed with the application of an adequate amount of irrigation water. The solution formed therefrom is removed by drainage, but sodicity persists. It needs the provision of an equivalent amount of calcium ions to a specific depth of the soil which the sodicity is desired to be eradicated.

The easy source for this is gypsum ($Ca\ So_4\ 2H_2o$) Sulphuric acid, when put in up to soil, also produces gypsum.

There are some other soil amendments also. Some of them provide the calcium ions directly, while the others are acid forming substances. The acid they produce reacts with the calcium carbonate in the soil to give their respective salts. A list of them is given here under:

Table: Chemical Amendments and their Relative Abiltiy to Supply Calcium

Amendment	Tons Equivalent to 1 Ton Gypsum[a]
Gypsum ($CaSo_4\ 2H_2o$)	1.00
Sulfur(S)	0.19
Sulfuric Acid (H_2So_4)	0.57
Ferrous sulfate ($Al_2(So_4)_3\ 18H_{20}$)	11.29
Lime - sulfur (9% Ca + 24% S)	0.78
Calcium chloride ($CaCl_2.\ 2H_20$)	0.86
Limestone ($CaCo_3$)	0.58

[a] All values are based on 100% pure material.

Here the ratio of gypsum to sulphuric acid is shown 1.00 to 0.57. The equivalent weight of gypsum is 86 and that of sulphuric acid is 49.

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