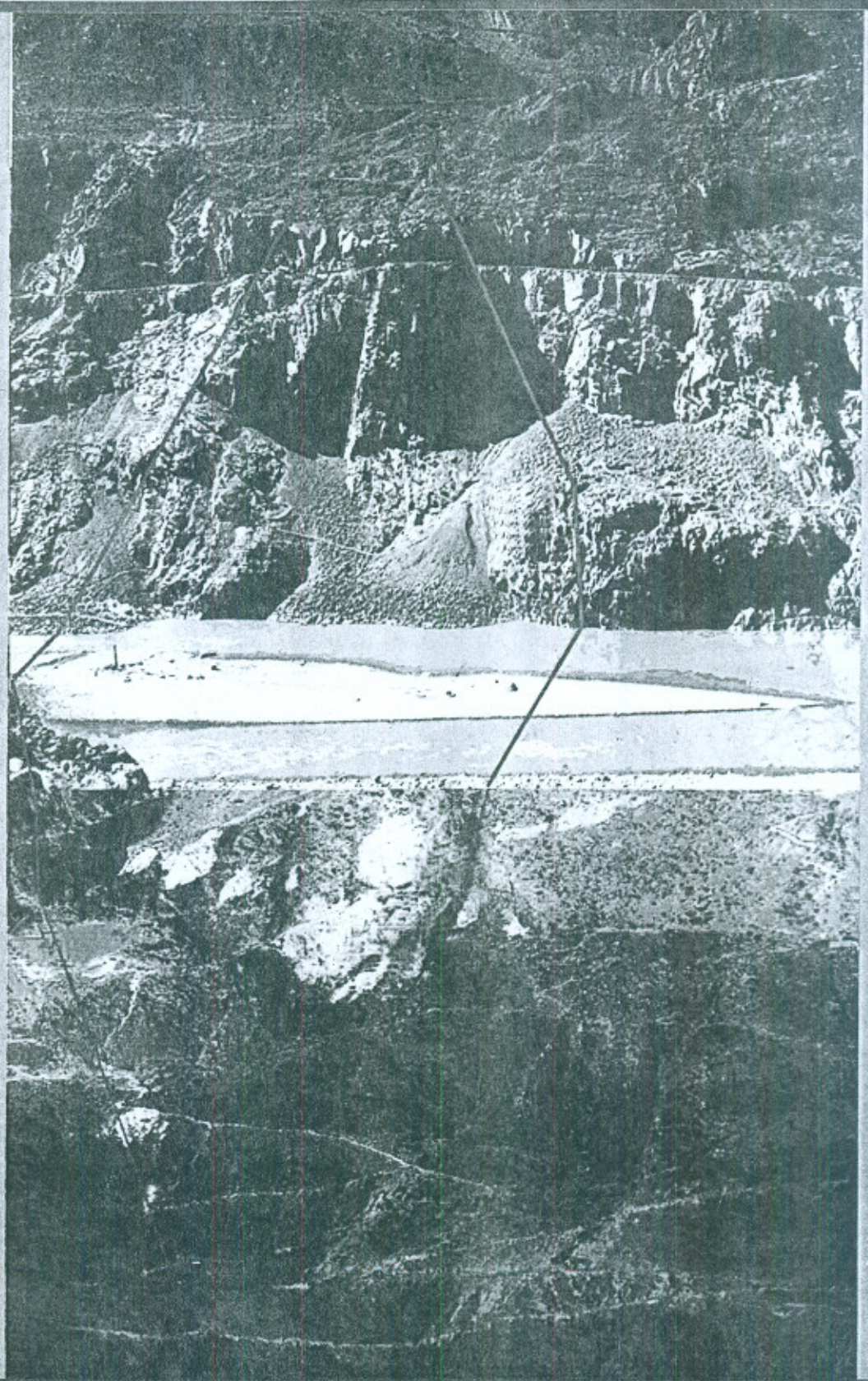
Engineering News

A Quarterly Journal of the Pakistan Engineering Congress

Vol: 43 July - September 2007 No: 3



PAKISTAN ENGINEERING CONGRESS
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COVER PHOTO

Diamer Basha Project Site
Proposed Footprint of Dam

48th YEAR OF PUBLICATION

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ON OTHER PAGES

IN THIS ISSUE

NEWS

TECHNICAL VIEWS

PUBLISHED BY
Pakistan Engineering Congress
Ph: 5784237-5784238 Fax: 5784236

FOR MEMBERS ONLY

Pakistan Engineering Congress is a prestigious professional body established in 1912 dedicated, interalia to technical advancement of Science & Engineering in the country.

News

WAPDA MAKES ALL OUT EFFORTS TO OVERCOME EVER GROWING ENERGY CRISIS

BY

ENGINEERING NEWS JOURNAL REPORTER

After commissioning of Tarbela Dam Multipurpose Project in mid seventies, construction of no water conservation / energy generation hydropower worth the name could be undertaken in the hope against hopes that construction of Mega Project of Kalabagh Dam, ready to be embarked upon, could be undertaken on the basis of consensus to be achieved by the Federal Government. But alas, ready with construction drawings, it fell a victim to the politics. And with the awful elapse of time and uncontrolled population explosion, the energy supply with no substantial addition continued to worsen.

Rising to the occasion WAPDA with the approval of the Government of Pakistan (GoP) took a bold decision to tap run of the water from rivulets in all the Provinces through construction of small dams both for generation of energy and supply of potable and irrigation water, wherever feasible. Besides, after policy decision by GoP, it embarked upon Review of Feasibility Report, Engineering Design and Tender Drawings / Documents of Diamer Basha Dam Project in July 2005. For this task of a mega Project WAPDA engaged Diamer Basha Dam Consultants (DBC) comprising M/s Lahmeyer International of Germany as Lead Firm in association with M/s. NDC, BARQAAB and PES of Pakistan. DBC undertook this assignment in September 2005 after mobilization.

For developing a feasible design configuration, DBC had to undertake a Conceptual Design Phase before the Tender Design activities could commence. The Conceptual Design Phase comprised two parts.

During the first part, from December 2005 to April 2006, Diamer Basha Consultants (DBC) presented a compact, relatively cheaper and functional hydropower scheme of the project with dam of a slightly reduced height, dam integrated powerhouse, and elimination of large underground works. The dam was proposed to be located at about 1 km downstream of the one already proposed in Feasibility Report of August 2004 prepared by NEAC, (NESPAK and ACE Consultants).

In the second part, from May to September 2006, DBC evaluated various options proposed by the Panel of Experts (PoE) and under the guidelines of WAPDA. The resulting three (3) alternative concepts of power schemes and the integrated dam concept were summarized of which the optimum power scheme configuration with Cavern Type powerhouses on the left and right banks was concurred by WAPDA for the purpose of Tender Design.

Over the period October 2006 to September 2007 DBC;s tender design activities relating to refinement of the conceptual design finally selected for the tender design including: further optimization of the layouts for each of the two underground powerhouses; fixing alignment for the waterways of left bank (LB) and right bank (RB) power schemes; and preparation of an updated exploratory investigation programme comprising Adit No. 4 (left bank) and 5 (right bank) and drillings to provide necessary information required for the detailed design.

In November and December 2006 concentration was directed on: provisional design of the main dam including diversion works to evolve its shape for adequately withstanding the higher stresses in the upper third portion through alternative analysis for dynamic and thermal stresses; layout of right bank powerhouse with due consideration of the available

geotechnical information; and modification of conceptual layout of the left bank powerhouse by realigning the power intakes underneath the dam and consequently shifting of the cavern about 50m further downstream.

In January 2007, activities related to: hydraulic design, design of structures for main dam and underground powerhouses; and start on preparing provisional drawings. These drawings were subject to further refinement on the basis of progressive availability of in-situ test results, data and analysis regarding: project layout including diversion works; main dam including longitudinal section along the axis; analysis of six alternative cross-sections to evolve a shape of the dam capable of withstanding excessive stresses in the upper third portion; left bank power scheme; and right bank power scheme. Activities on tender documentation and prequalification of contractors were initiated concurrently.

In February 2007, the activities related to start of tender design based on 'engineering judgment', subject to verification by fundamental design studies based on results of ongoing field exploratory investigations and proposed in-situ rock mechanics tests. The resulting 'Provisional Drawings' covered: project layout; dam shape including longitudinal and cross sections; left bank power scheme; and right bank power scheme. Preliminary work of contract documentation, covered: definition of five (5) lots comprising 2 civil and 3 E&M works; and evolution of 'draft outline of Lot 1 – Civil Works and preliminaries of pre-qualification documentation.'

During March 2007, work continued on detailed design on the basis of 'engineering judgment'; seeking guidelines from WAPDA for Lot 1 - Civil Works regarding prequalification and contract documents; and initiation of physical hydraulic modelling studies through Irrigation Research Institute (IRI) at Nandipur.

In April 2007, work continued on: detailed design based on 'engineering judgment' supplemented through feedback from the ongoing field investigations; drafting of outline documents for Lot 1 - Civil Works regarding prequalification and procurement. Comprehensive documentation was prepared and submitted to WAPDA for review by PoE in May 2007 including a presentation earlier on 30 April 2007 to WAPDA and PoE.

In May 2007, the activities covered: response to various comments / suggestions contained in PoE Report of May 2007; modification to the design of right bank powerhouse by about 6 m lowering of turbine setting (similar to right bank powerhouse) in the light of tail-water rating derived from bathymetric survey; continuation / modification of provisional design based on 'engineering judgment', progressive feedback from field investigations and accepted suggestions in PoE Report; and drafting of prequalification documents for Lot 1 - Civil Works on the basis of related World Bank guidelines as agreed, including submission to WAPDA for comments / concurrence; continuation of activity for procurement documents of Lot 1 - Civil Works; an d start on modification of 1:80 scale comprehensive model at Nandipur for the proposed diversion scheme.

In June 2007, work continued on: modification and refinement of the tender design based on 'engineering judgment', progressive feedback from field investigations and accepted suggestions of PoE Report No. 6; drafting of procurement documents for Lot 1 - Civil Works on the basis of related World Bank guidelines as agreed, initiation of spadework for formatting of procurement documents of E&M Contracts, start on preliminary implementation scheduling with particular focus on PoE's suggestion for reduction of 1.5 years in construction period, completion of stage 1 modification of 1:80 scales comprehensive physical model at Nandipur including start on that running for the proposed Diversion Scheme.

In July 2007, the activities covered refinement of dam design through use of iterative combined thermo-dynamic analysis for the whole structures; design improvements of surge

shafts and transformer caverns for the two underground powerhouses based on 'Engineering Judgment' and progressive feedback from field investigations; modification to electrical design of various items in the light of WAPDA's confirmation regarding 765 KV transmission system; rechecking of Lot1 – Civil Works tender documents on the basis of feedback from WAPDA including resubmission to elicit final instructions of the Client, continuation of spadework on drafting of tender documents for Hydraulic Steel Structures Lot 3 and Mechanical and Electrical equipment Lots 4 and 5 start on revision of the project preliminary implementation schedule with particular focus on placement of very large quantities of RCC supervising of proposed stage 1 experiments for the diversion scheme(s) on 1:80 scale physical hydraulic model.

During August 2007, work continued on: refining of RCC placement schedule as prerequisite for thermo-dynamic analysis of the dam structure and establishing of Project's overall work programme; preparation of contour map of bed rock surface derived from available geological investigations and interpretable geophysical survey; establishing of 3D FE model of dam; FE-model analyses for upstream facing of dam (sealing component); design of grout curtain and drainage system of the dam and drainage system for steel lined pressure shafts of LB power scheme; design of transformer caverns; design of LB and RB intake structures. All design activities continued on the basis of 'Engineering Judgment and progressive interpretation of field investigations. Specific instructions were also sought from WAPDA regarding final adoption of World Bank Guidelines for preparation of pre-qualification / procurement documents for various contract lots. In the meantime, drafting of tender documents continued for E&M Contracts (LOT 3, 4 and 5).

In September 2007, DBC's main activities concentrated on:

i. Modification and finalization of excavation plan for dam foot print on the basis of established bed rock contour map and subsequent adaptation of RCC placement schedule.

ii. Finalization of the 3D Stability Model and commencement of initial 3D stability test runs.

iii. Program and Data updates for thermal analyses in relation to the adapted ROC placement scheduling and latest temperature data.

iv. Continuation of FE analysis for design of the dam upstream facing concrete as sealing component.

v. Design of shafts for instrumentation.

vi. Design of left and right bank intake structures.

vii. Design of transformer caverns.

viii. Continuation of activities on the basis of 'Engineering Judgment' and progressive programme interpretation of field investigations.

ix. Start on preparation of pre-qualification / tender documents for various lots on the basis of WAPDA's instructions to follow World Bank Guidelines without deviation.

x. Provision of 'Preliminary Drawings' to WAPDA for decision taking whether these should be used by IRI for undertaking modifications of existing models for Stage LI of Physical Hydraulic Modelling.

With active pursuit of the activities at existing tempo, it is envisaged that DBC would substantially complete their assignment by March 2006 through submission of the draft tender documents to WAPDA. By the time these documents are finalized on the basis of

comments of WAPDA, the on-going process for prequalification of international contractors would also be completed. In addition, DBC would prepare for WAPDA PC-1 Proforma for Diamer Basha Dam Project. This, after approval by GoP, would provide the basis for undertaking project implementation during the financial year 2008-2009.

With construction period of about 9 years the project could be fully commissioned during 2017.

Upon full commissioning of the project, besides providing a storage water of about 60.4 MAF, an annual energy generation of about 18,000 MW would become available to the National Grid of Pakistan. This would go a long way in alleviating the Energy crisis.

OBITUARIES

May their souls rest in Peace

1. Mian Abdur Rashid, a well known Contractor of the Punjab Irrigation Department and WAPDA died at his residence in Ichhra Lahore July 01, 2007. Mian Rashid was working on the construction of Rasul Hydel Project at the time of partition. Later he undertook construction work on the famous defence line, Bombanwala Ravi Bedian Dipalpur (BRBD) Link running along the Indo-Pakistan Border, Balloki-Suleimanki (B. S.) Links I & II, Remodeling of Balloki Barrage on the River Ravi, Taunsa Barrage on the River Indus, Jhelum River Bridge on G. T. Road and the crossing of Lahore Multan Road over the Railway Line near Bhai Pheru and many other Mega Projects in the Punjab. He was known as a pioneer in the construction industry of Pakistan.

2. Mr. Mukhtar Ahmad, Junior Office Assistant, Pakistan Engineering Congress, passed away on 22.8.2007

PAKISTAN ENGINEERING CONGRESS
DELEGATES VISIT FAISALABAD

In pursuit of one of the objectives of the Pakistan Engineering Congress, aimed at promoting science and engineering knowledge, the following twenty seven members assembled at Engineering Congress Head Office, Liberty Market Roundabout, Gulberg-III, Lahore at 08:30 hours on August 4, 2007 for a technical visit to Faisalabad engineering works:-

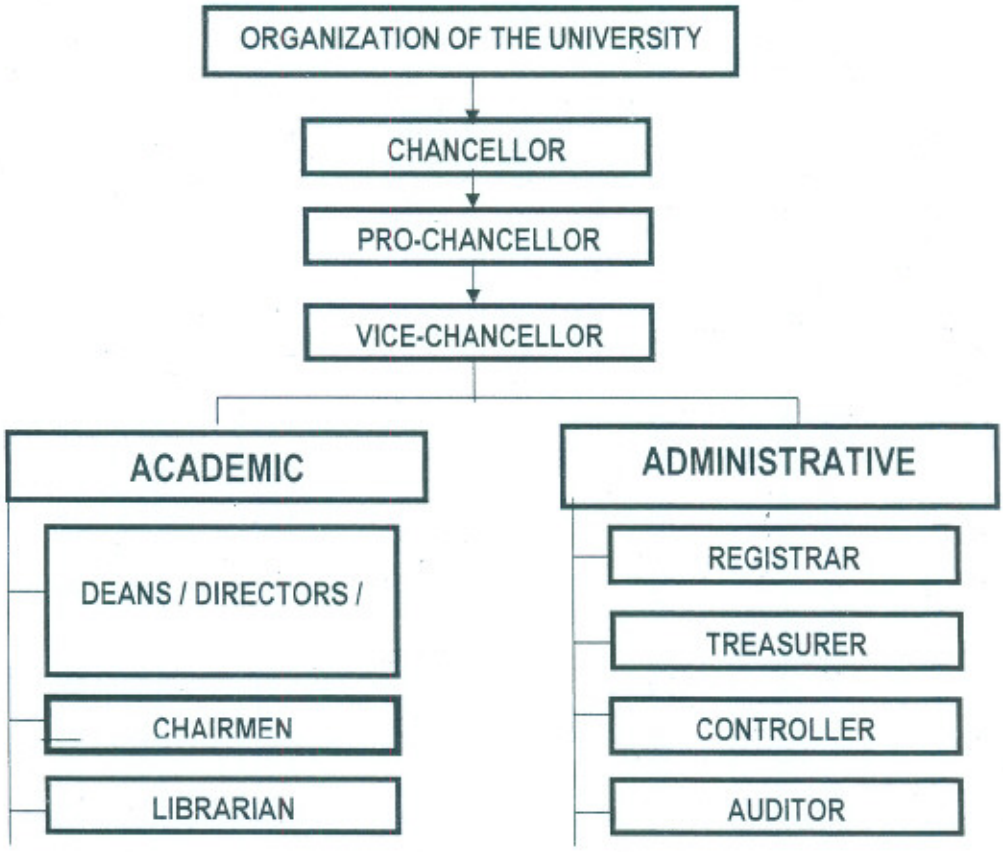
1. Engr. Husnain Ahmad, President
2. Engr. Ch. Muhammad Rashid Khan
3. Engr. Iftikhar Ahmad
4. Engr. Syed Saleem Akhtar
5. Engr. Mirza Farid-ud-Din
6. Engr. Abdul Sattar Khan Lillah
7. Engr. Ch. Foad Hussain
8. Engr. Tahir Anjum Qureshi
9. Engr. Prof. Mian Zia-ud-Din
10. Engr. Shahid Ahmad
11. Engr. Faisal Shehzad
12. Engr. Malik Ata-ur-Rehman Khan
13. Engr. Muhammad Saeed
14. Engr. Malik Abdul Sattar
15. Engr. Rana Asif
16. Engr. K.B. Nasir
17. Engr. Jamil Ahmad
18. Engr. Usman Tehsin Shah
19. Engr. Muhammad Naeem Ahmad
20. Engr. Usman-e-Ghani
21. Engr. Usman Haider Shah
22 Engr. Muhammad Khalid Bhatti
23. Engr. Muhammad Aslam
24. Engr. Amir-ud-Din Qureshi
25. Engr. Fateh Muhammad
26. Engr. Shaikh Muhammad Yousaf
27. Engr. Abdul Jabbar Uppal

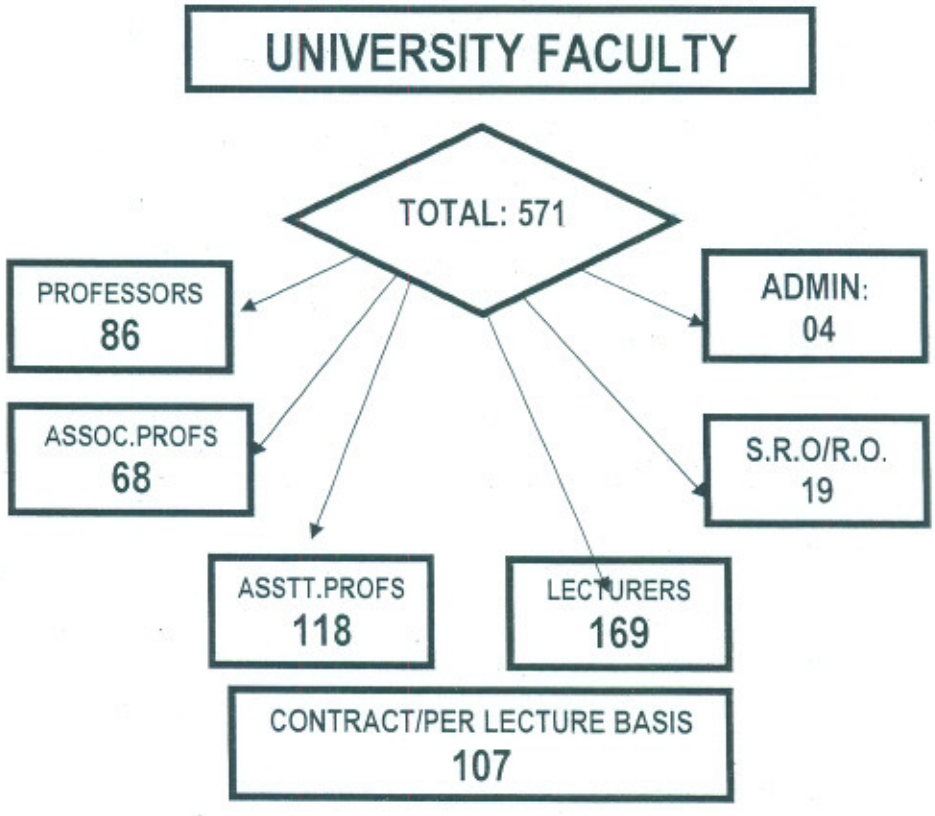
As scheduled they left the office at 09:00 hours and reached spacious Campus of the University of Agriculture Faisalabad at 12:00 hours. The delegates were received by the Vice-Chancellor and the Senior Faculty echelons.

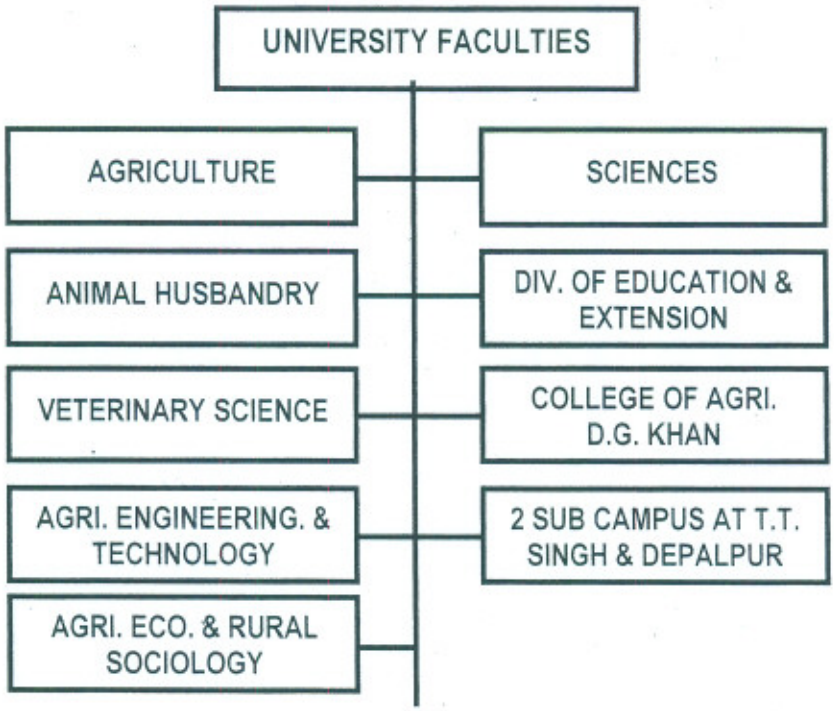
The Vice-Chancellor gave an elaborate presentation about the evolution of Agricultural Education and Research in the Punjab. He illustrated with the help of slides that Punjab Agriculture College and Research Institute were established in the year 1906. B.Sc Agriculture Degree course was affiliated with the University of Punjab in 1917, M.Sc Agriculture in 1923 and Ph.D in 1942. In the year 1961 Research Institute was separated.

OBJECTIVES OF THE UNIVERSITY

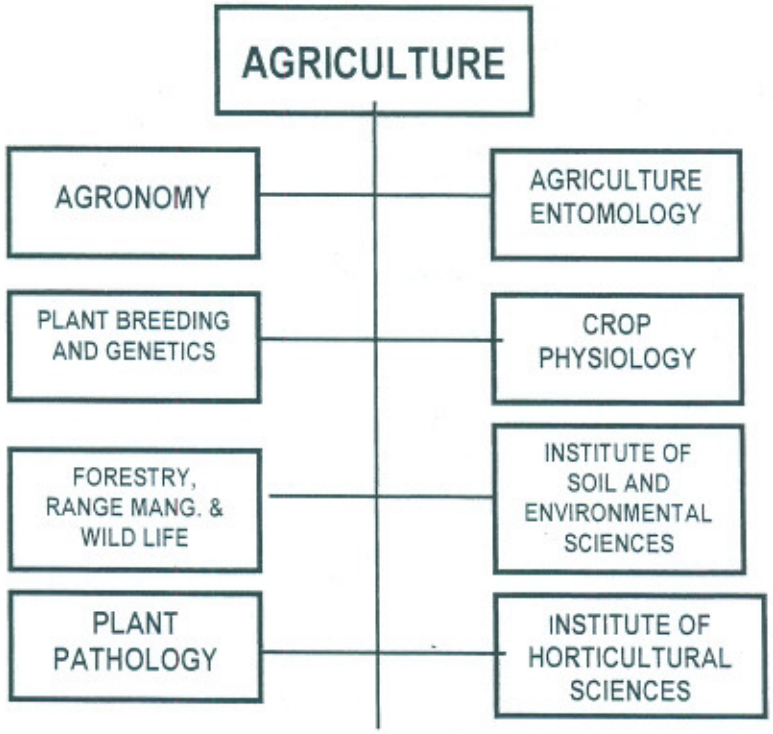
TO PROVIDE INSTRUCTIONS FOR AGRICULTURAL SOCIAL AND NATURAL SCIENCES, HUMANITIES AND SUCH OTHER BRANCHES OF LEARNING AS IT MAY DEEM FIT, AND TO MAKE PROVISIONS FOR RESEARCH, ADVANCEMENT AND DISSEMINATION OF KNOWLEDGE IN SUCH MANNER AS IT MAY DETERMINE.

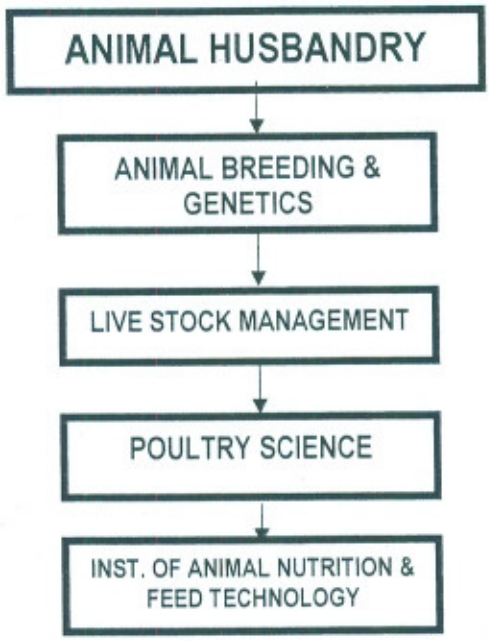

ORGANIZATION OF THE UNIVERSITY
CHANCELLOR
PRO-CHANCELLOR
VICE-CHANCELLOR
ACADEMIC
ADMINISTRATIVE
DEANS / DIRECTORS /
CHAIRMEN
LIBRARIAN
REGISTRAR
TREASURER
CONTROLLER
AUDITOR

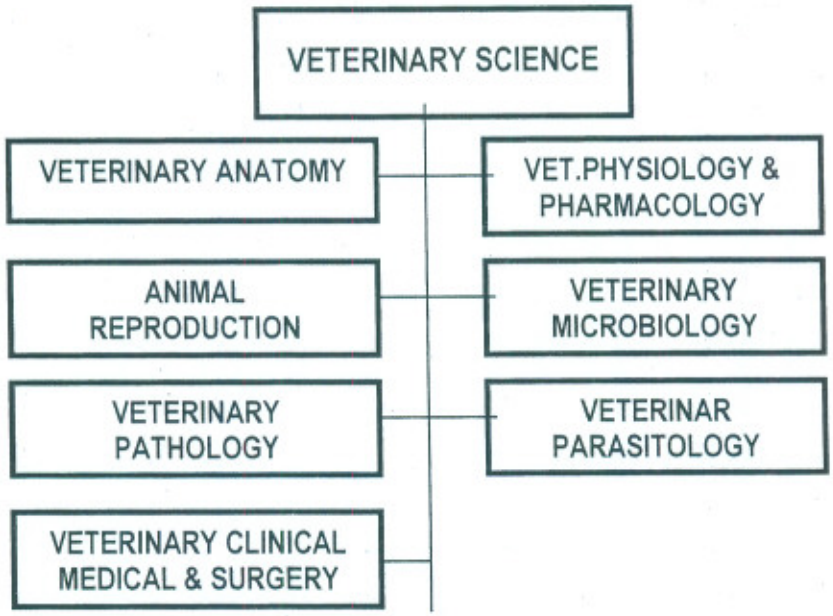

UNIVERSITY FACULTY
TOTAL: 571
PROFESSORS
86
ASSOC.PROFS
68
ASSTT.PROFS
118
LECTURERS
169
CONTRACT/PER LECTURE BASIS
107
ADMIN:
04
S.R.O/R.O.
19

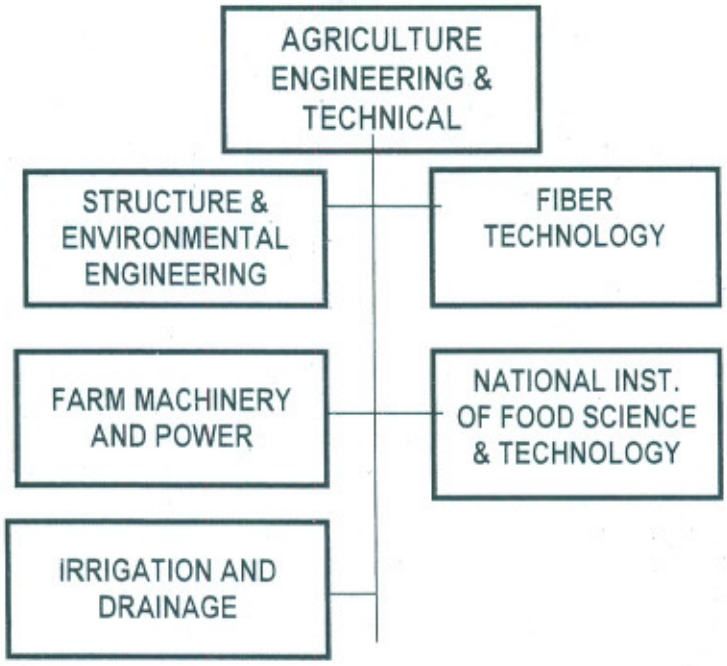


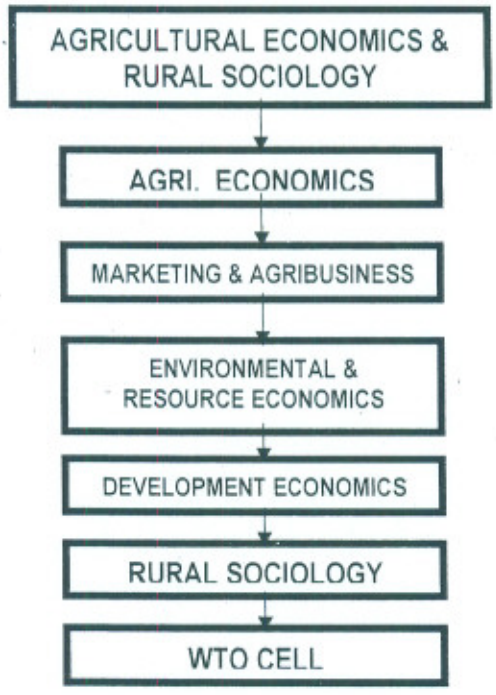
The above Faculties respectively conduct the Degree Courses mentioned against these appear at the next page:

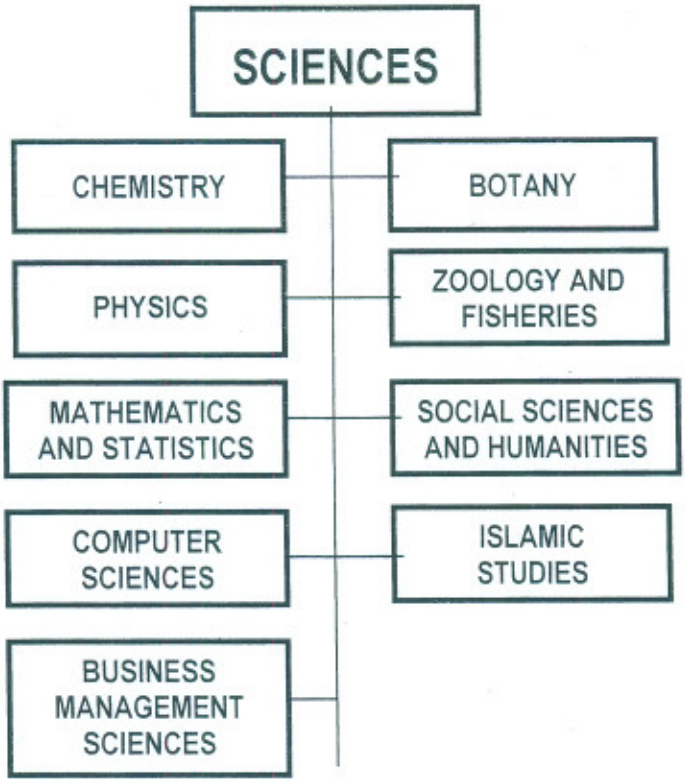


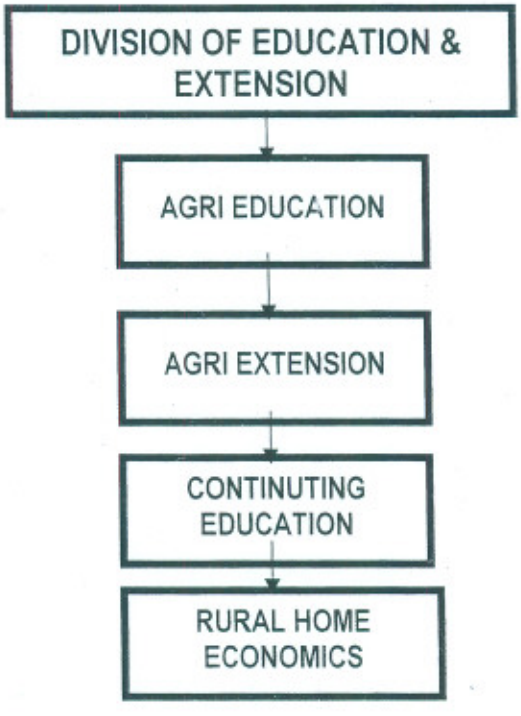

ANIMAL HUSBANDRY
ANIMAL BREEDING & GENETICS
LIVE STOCK MANAGEMENT
POULTRY SCIENCE
INST. OF ANIMAL NUTRITION & FEED TECHNOLOGY


VETERINARY SCIENCE
VETERINARY ANATOMY
VET.PHYSIOLOGY & PHARMACOLOGY
ANIMAL REPRODUCTION
VETERINARY MICROBIOLOGY
VETERINARY PATHOLOGY
VETERINAR PARASITOLOGY
VETERINARY CLINICAL MEDICAL & SURGERY

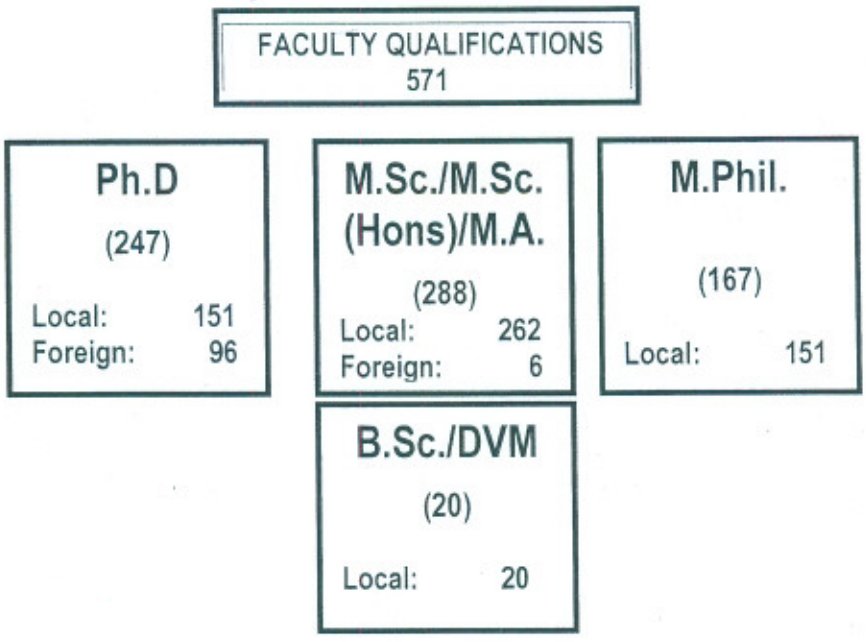

AGRICULTURE ENGINEERING & TECHNICAL
STRUCTURE & ENVIRONMENTAL ENGINEERING
FIBER TECHNOLOGY
FARM MACHINERY AND POWER
NATIONAL INST. OF FOOD SCIENCE & TECHNOLOGY
IRRIGATION AND DRAINAGE

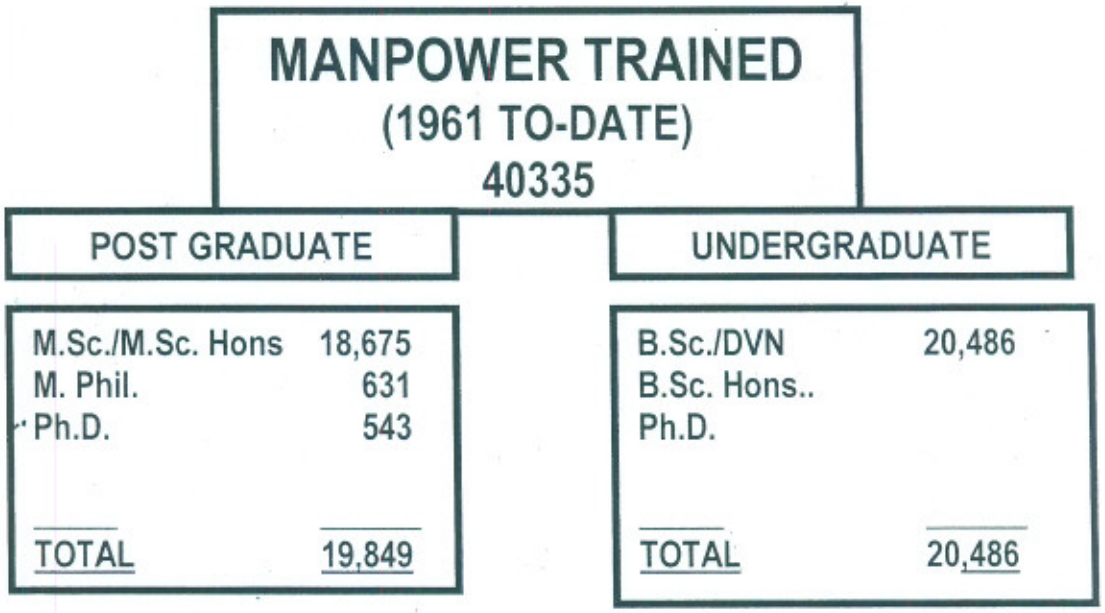

AGRICULTURAL ECONOMICS & RURAL SOCIOLOGY
AGRI. ECONOMICS
MARKETING & AGRIBUSINESS
ENVIRONMENTAL & RESOURCE ECONOMICS
DEVELOPMENT ECONOMICS
RURAL SOCIOLOGY
WTO CELL


SCIENCES
CHEMISTRY
BOTANY
PHYSICS
ZOOLOGY AND FISHERIES
MATHEMATICS AND STATISTICS
SOCIAL SCIENCES AND HUMANITIES
COMPUTER SCIENCES
ISLAMIC STUDIES
BUSINESS MANAGEMENT SCIENCES


DIVISION OF EDUCATION & EXTENSION
AGRI EDUCATION
AGRI EXTENSION
CONTINUTING EDUCATION
RURAL HOME ECONOMICS

The Vice-Chancellor informed that since 1961 the University has achieved a remarkable milestone of trained man-power as under:-





Objective achievement of any viable solution of a given issue is the successful research for the award of Ph.D Degree. The University has set the guidelines for such a fulfillment as under:-

DIRECTION OF RESEARCH

- Addressing national issues on Agriculture.
- Role in formulation of national Agriculture policies.
- International trends in Agriculture Research and Development.
- On-Farm Research.
- Non-traditional but economical crops.
- Economics of various agricultural commodities / products.
- WTO – Issues and Challenges.
- Medicinal and aromatic plants.

SALIENT RESEARCH

- Research on high yielding varieties.
- Establishment and application of successful methods for land reclamation
- Development of indigenous agronomic standards for optimum crop production.
- Significant contribution in the research on plant protection.
- Cultivation of roses for cut flower production.
- Cultivation of roses for essential oils and dried petals for medicinal or other uses.
- Cultivation of peppermint (*Mentha arvensis*) - Menthol production.
- Cultivation of Eucalyptus for essential oil.
- Development of socio-economically based agricultural models for local adoption (cost of crop/livestock production etc.)
- Successful handling of animal health and production issues through improved management, vaccine production and other diagnostic and preventive medicinal practices.
- Invention of environmental and farmer friendly agriculture machinery.

FUTURE THRUSTS IN RESEARCH

- Marketing of Agriculture Products.
- Water economy through better management.
- WTO Regime implications for Agriculture Sector.
- Biotechnology.
- Impact of Climatic changes on Agriculture.
- Modeling for Precision Agriculture.
- Increasing fecundity in buaffaloes.
- Breeding of Poultry parent stock.
- Development of crop hybrids.
- Die Back of Shisham and other trees.
- Environmental issues.

On conclusion of the presentation the delegates were taken around the laboratories and were then treated to a sumptuous lunch.

The delegation departed at 15:00 hours to visit City District Government Faisalabad and reached there at 15:30 hours.

The delegation was received by the DCO. Members were briefed about the most exquisite and Scientific Call Centre encompassing the entire district of Faisalabad.

Its objectives are:-

- To ensure an integrated 'One Organization' approach to dealing with all customers of district, TMAs and agencies & organization and other decentralized departments services;
- To act as the main gateway and first point of call for the customers;
- To provide a single point resolution of simple transaction;
- To use real time information to identify the correct District, TMAs and other departments service to deal with a customer's request;
- To resolve customer's needs in 60% increasing to 80% of cases (within six months of operations) with the remaining 20% of customers referred on with more complex needs referred on for resolution to back office support functions;
- To produce an audit trail for unresolved customer queries and clear accountability for resolution within standard time;
- To streamline business processes so that customers are dealt with as efficiently as possible at the lowest cost necessary; and
- To market proactively the services of the local governments and other departments and potentially provide services on behalf of partner organizations should there be a demand to i.e. be a multi agency call centre, as capacity permits.

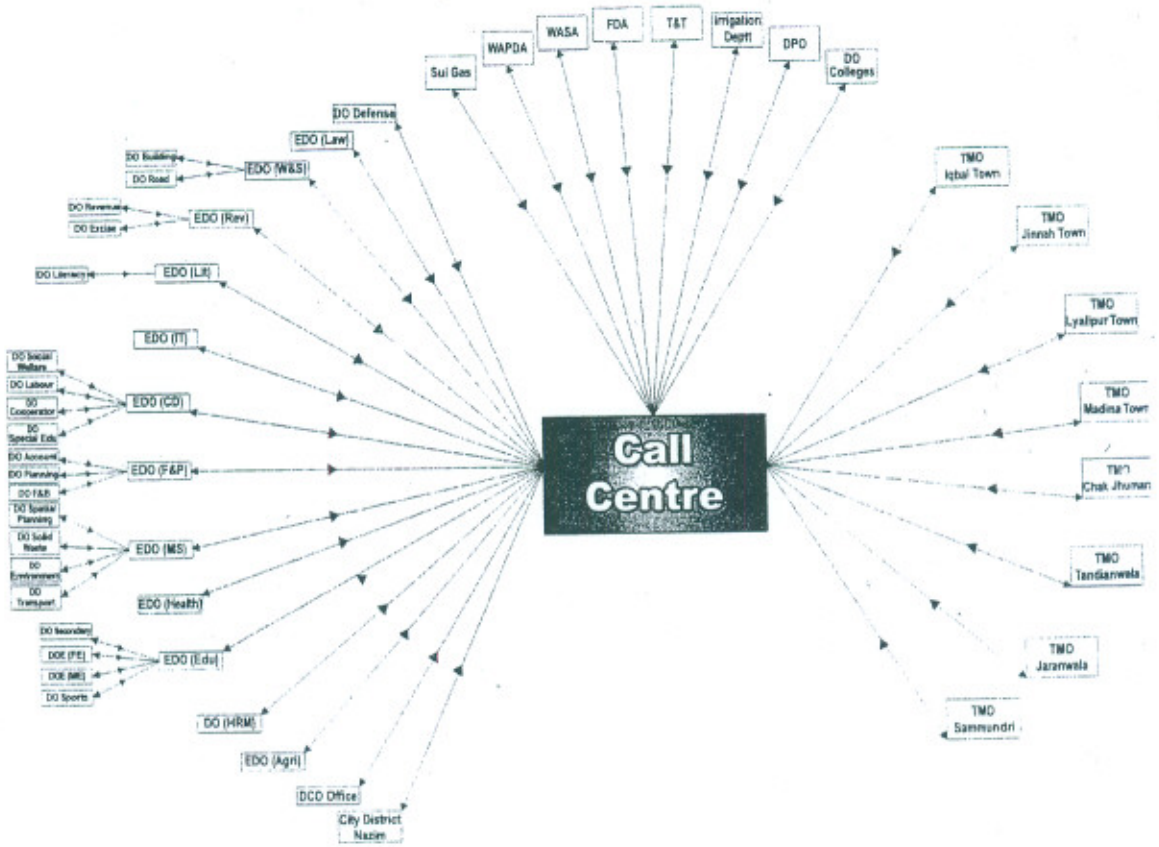
FEATURES OF COMPLAINTS CENTRE

1. Centrally Located.
2. Toll Free Telephone Number Facility.
3. Call Logging System.
4. Call Management System.
5. Web Based Accessibility

Possible Services of the Call Centre are:

- Health Services and facilities.
- Educational Services and facilities.
- Clean Water Supply
- Proper Sanitation.
- Drainage and Sewerage
- Pollution free environment
- Uninterrupted electricity supply
- Sui Gas
- Telephone
- Social security services
- Cooperative department services
- Promulgation of wage awards
- On-Farm water management services
- Forest advisory services
- Fisheries advisory services
- Police services
- Agriculture loan services
- Canal irrigation services
- And so many other services.

The diagram showing redirection of complaint received in the Call Centre for redressal appears below:



The goals to be achieved with the introduction of Service delivery Customers Call Centre (Complaint Centre) are:-

- Monitoring & Evaluation of departments
- Assessment of Performance of the offices/officials
- Community based planning
- Quality Services
- Poverty Reduction.

The members evinced keen interest in the working of City District Government Faisalabad Call Centre. They wished that such Call Centres were established in all districts of the country.

They were also briefed about the strategic Development Plan of the District for the period from 2006 to 2011.

The Summary of Development Plan of the District is as under:-

Faisalabad is the third largest city of Pakistan and has grown rapidly since Independence. Faisalabad plays a very important role in the economy of the country and the City is known for the production of textile products. About 60% of the total textile exports of Pakistan are from Faisalabad. The District also has an important agricultural sector, with almost 82% of its 2,256 square miles currently used for agriculture.

The District faces many problems. Not least of these is the need to provide employment for a

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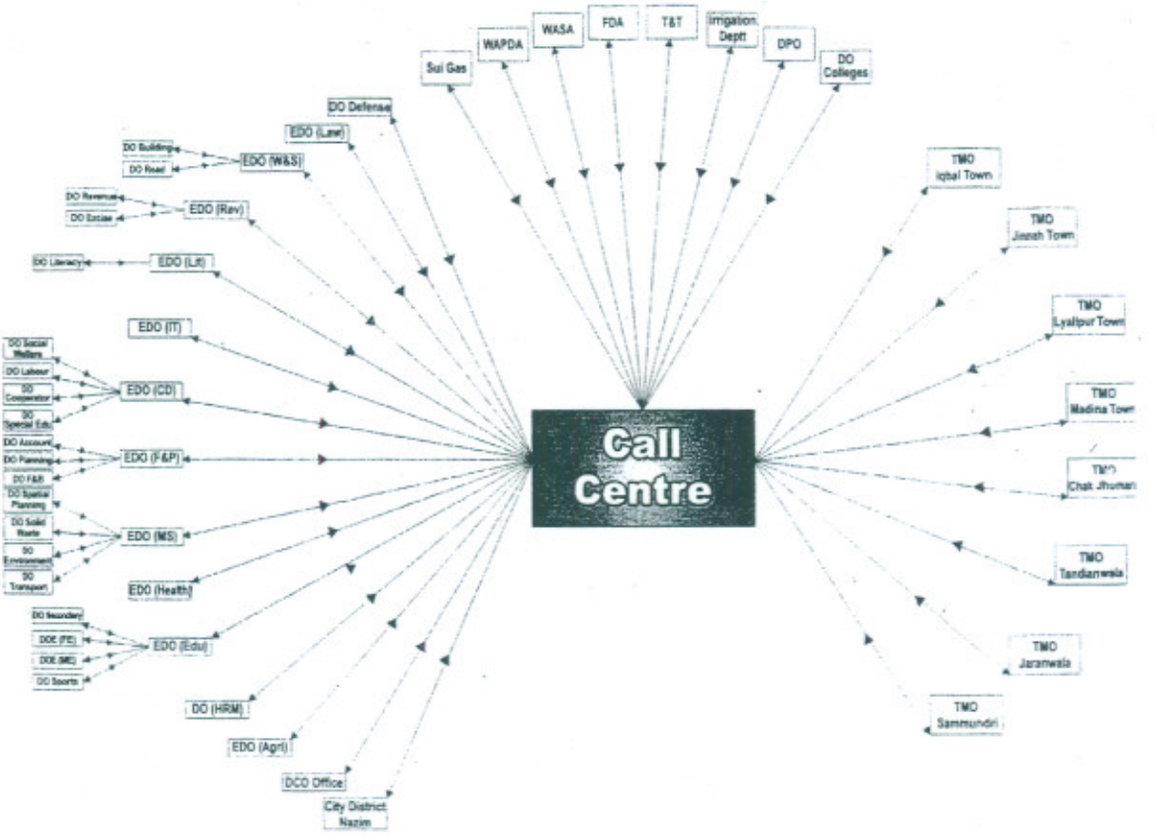
4. Call Management System.
5. Web Based Accessibility

Possible Services of the Call Centre are:

- Health Services and facilities.
- Educational Services and facilities.
- Clean Water Supply
- Proper Sanitation.
- Drainage and Sewerage
- Pollution free environment
- Uninterrupted electricity supply
- Sui Gas
- Telephone
- Social security services
- Cooperative department services
- Promulgation of wage awards
- On-Farm water management services
- Forest advisory services
- Fisheries advisory services
- Police services
- Agriculture loan services
- Canal irrigation services
- And so many other services.

The diagram showing redirection of complaint received in the Call Centre for redressal appears below:



The goals to be achieved with the introduction of Service delivery Customers Call Centre (Complaint Centre) are:-

- Monitoring & Evaluation of departments
- Assessment of Performance of the offices/officials
- Community based planning
- Quality Services
- Poverty Reduction.

The members evinced keen interest in the working of City District Government Faisalabad Call Centre. They wished that such Call Centres were established in all districts of the country.

They were also briefed about the strategic Development Plan of the District for the period from 2006 to 2011.

The Summary of Development Plan of the District is as under:-

Faisalabad is the third largest city of Pakistan and has grown rapidly since Independence. Faisalabad plays a very important role in the economy of the country and the City is known for the production of textile products. About 60% of the total textile exports of Pakistan are from Faisalabad. The District also has an important agricultural sector, with almost 82% of its 2,256 square miles currently used for agriculture.

The District faces many problems. Not least of these is the need to provide employment for a

rapidly growing population. At the same time, there is potential for the District's activities to diversify and grow, creating opportunities to meet employment needs. The present population of the district is approximately 6.5 Million, of which around 2.5 million people live in Faisalabad City itself and the remainder in secondary towns, the most important of which are Chak Jhumra, Jaranwala, Sammundri, Tandlianwala and Khurrianwala. Low income and poverty groups, form up to 75% of the district's population, and are mainly found in rural and unplanned urban expansion areas.

The City District is divided into eight Town Municipal Administrations (TMAs), four of which are predominantly urban. These are further divided into 289 Union Councils, with an average population of slightly under 25,000.

The City District Government of Faisalabad has established a vision for itself which is "***Pre-empting poverty and promoting prosperity***" and wishes to eliminate poverty by taking a number of initiatives. However, it is well aware of the fact that the institutional capacity needs to be developed and as such the City District Government Faisalabad produced a Corporate Plan for the District in 2004, which in turn is supported by evidence-based departmental Strategic Operational Plans (SOPs). In the Corporate Plan the District has established a mission statement in for itself which states that:

"We will provide high quality services which compare with the best in the country. We will work with everyone who wants a better future for our District. We will establish an efficient, effective and accountable District Local Government, which is committed to respecting and upholding women, men and children's basic human rights, responsive towards people's needs, committed to poverty reduction and capable of meeting the challenges of the 21st century. Our actions will be driven by the concerns of local people"

Recently, there have been several discussions on the need to ensure that the future development of Faisalabad occurs in a planned and holistic manner. As a result, the concept of a Strategic Development Plan (SDP) of Faisalabad has been developed after consultations with relevant stake holders. The need for this SDP was also felt after the visit of President of Pakistan back in March 2006, when socio economic justification of any developmental needs of the district were required by the President before making any financial commitment.

As a result, Faisalabad, has carried out a review of the existing policies and proposed capital spending programmes and has identified a need to:

- Address deficiencies in infrastructure and social services;
- Cope with the population growth and creation of new jobs
- Improve the operation and maintenance of public facilities, in all sectors; and above all

Directly address the needs of poor communities.

The master planning experience of Karachi and overseas cities were especially studied by a team of experts. After these desk studies, the Strategic Development Plan (SDP) of Faisalabad was based upon the concept of Concentric Zoning which is recognized globally in the field of Town planning. Starting with the core central, the concentric zoning comprises a Central zone, a Peri-central zone, Metropolitan zone, a Peri-urban zone and a Suburban zone. This SDP is in line with the District Corporate Plan. Unlike the master plans, this SDP caters all the infrastructural & socio economic needs of the district in an integrated and holistic manner. The preparation of this SDP took over six months of an intensive work.

In view of the scale and severity of the problems faced, Faisalabad recognizes the need to adopt a new approach in order to provide the services and support, which its citizens

deserve. The approach recommended in this plan is based on a dual-track strategy of pre-empting poverty and promoting prosperity. This requires action to both create employment and so tackling immediate causes of poverty and to take action to change the lives and living conditions of the poor. In other words, while the creation of productive employment accompanied by the education and skills development is a necessary condition, to be meaningful, the poor also need to be able to have easy and affordable access to the basic necessities of life such as water, housing, health and education. This will require a pro-poor planning approach that recognizes the value of both the formal and informal sectors and links structure and strategic infrastructure planning to economic enterprise and business development planning.

Simply put, while physical infrastructure and Social Service programmes will be a key outcome of this SDP, the financing and provision of the programmes will depend on the ability of the District to use land as an economic resource rather than merely as a location for particular activities. Similarly, the provision of physical infrastructure should be recognized as a powerful tool in guiding and directing urban growth and development and enhancing the value of land, while improving health and facilitating the livelihood strategies of the poor. The detailed SDP comprises 3 parts:

- Strategic Development Plan Concept and General Outlines,
- Zone-Wise Summary of Project Proposals and
- Detailed Project Proposals and Justifications

It concludes that there is an urgent need for a much more detailed piece of work to be done in order to develop a detailed multi-year Strategic Development Plan for the district, which will examine the viability & necessity of all the proposals in detail and that will also blend infrastructural and spatial planning with enterprise and business development planning. The City District Government Faisalabad therefore, proposes to prepare a detailed Strategic Development Plan (SDP), with the assistance of international and local consultants, which will integrate and amalgamate;

- Strategic Infrastructure Development Planning (SIDP)
- Enterprise Development Planning (EDP) and
- Business Development Planning (BDP)

In addition to setting out the overall strategy, the SDP also identifies a range of short to medium term actions that have been proposed by various departments. These proposals should be regarded as preliminary, and need to be further assessed and developed in the course of a full planning exercise. The total financial requirement for implementation of this SDP is Rs. 87.109 Billion. There are three partners who will share this funding namely; ADP of Sponsors, private sector and special grants.

The City District Government would like to thank all EDOs, attached departments, Strategic Policy Unit, TMAs especially the Town Nazims, local heads of non devolved departments and the engineers & town planners of FDA, under the dedicated guidance of its Director General, for providing valuable technical and strategic support in finalizing this document.

The delegates thereafter left at 17:20 hours to visit the AMTEX Mills. There they were welcomed with a Hi-tea and then taken around various processing sections of the Mills. The Mills are equipped with the ultra modern machinery and production units from spinning to stitching. It has a diversified portfolio and holds a special position in the textile industry in the sense that it provides the largest variety and combination of products under one roof.

The delegates left the mills at 20:00 hours for Lahore the same day.

DEEP GROUND IMPROVEMENT TECHNIQUES USING KELLER DEPTH VIBRATORS

with reference to the lecture delivered

by

Muhammad Munawar Zaman*

on August 24, 2007 at Pakistan Engineering Congress Hall

Introduction:

The main principal inherent in all soil improvement techniques is the transformation of soils, which are in their original state unsuitable for foundation purposes, into load bearing strata capable of safely carrying structural load.

This is also the main difference between soil improvement method and standard pile foundation, where generally unsuitable soils need to be bypassed by the piles. Amongst the many different in-situ soil improvement methods, the process of deep compaction employing depth vibrators is probably the oldest and most refined system available today.

Developed in Germany in the mid 1930's the value of compaction of loose sands by the poker vibrator was widely recognized after world war-11 notably by the use of Vibro-compaction techniques for major structures not only in Europe, but also increasingly outside for projects such as Indus River Valley Projects in Pakistan and Aswan High Dam in Egypt.

In late 1950's Vibro compaction process has been further extended into treatment of cohesive soils by reinforcement using stone columns to carry structural load, which can improve the bearing capacity of nearly all soil types and in particular, fill materials & weak soils.

The choice between the deep vibratory treatment techniques follows primarily grain size distribution of the soils requiring improvement.

Vibro Compaction:

Vibro-compaction is the in place densification of loose cohesion-less granular soils, i.e. sand and gravel. Generally imported granular backfill is used in this process only when sands are to be compacted by the influence of vibratory motion. Consequently this technique is employed whenever bearing capacity and density of granular soils need improvement at greater depths. The most suitable depth range is between 3m to 25m, however, in special cases Vibro-compaction has been carried out to depths of 60m. The process is very versatile; by a grid like arrangement of the Vibro compaction probes any size and shape of the foundation can be treated to any practical necessary depth. The increase in relative density of sand goes together with an increase of friction angle and modulus and results consequently in higher bearing capacity and less total and differential settlement, which represents together with the reduction of liquefaction potential the main objectives of the Vibro compaction.

The general criteria used for best application of this method is to the soils having percentage fines less than 15%, with results as obtained from sieve analysis method.

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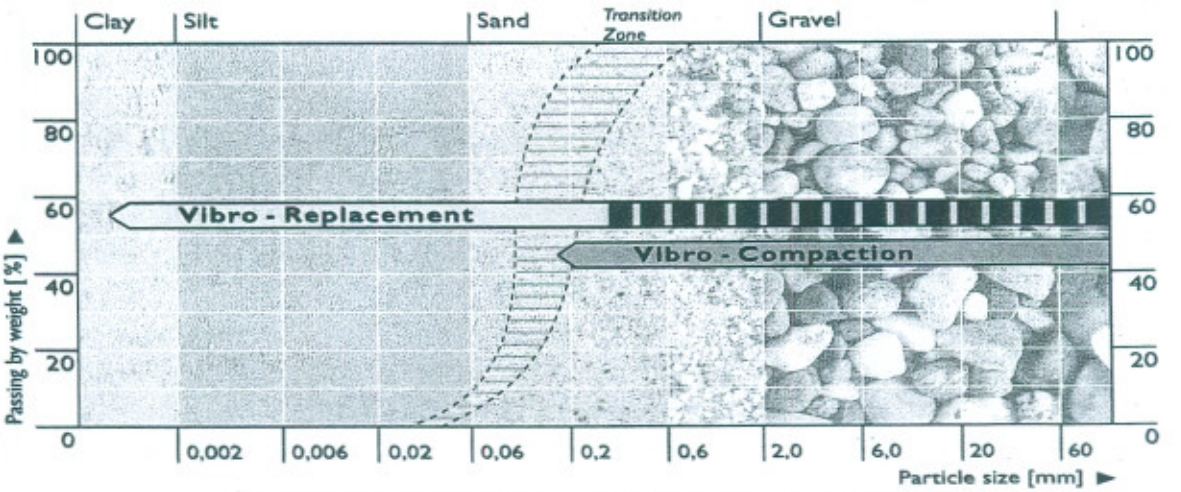


Fig: 1 Selection of Vibro method based on sieve analysis

Out of two commonly used methods of particle size determination, wet method is more recommended than dry method, because of accurate measurement of percentage fines as compared to dry method.

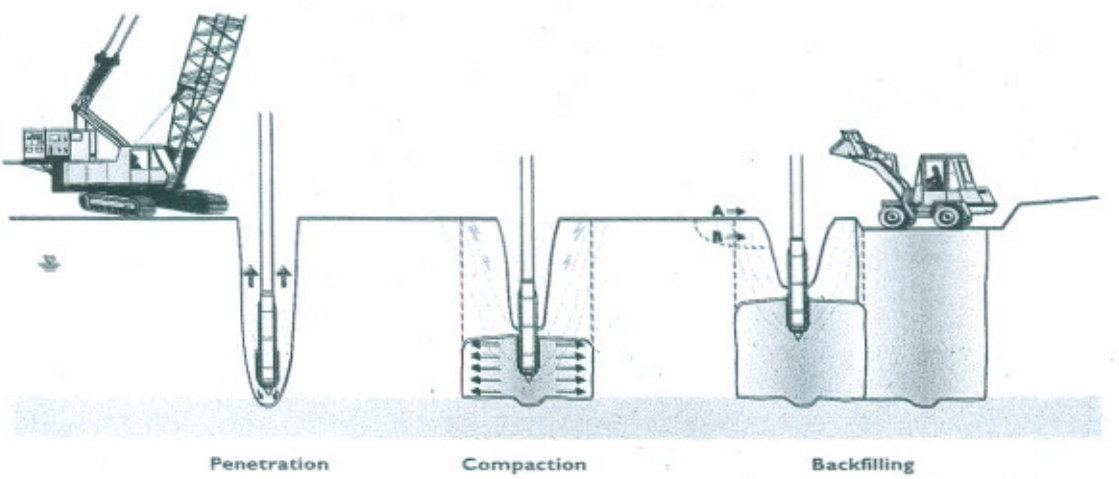


Fig: 2 Vibro-Compaction Processes

Vibro Replacement:

Vibro replacement achieves improvement and reinforcement of soft cohesive soils by installation of stone columns using generally the same vibratory treatment. These stone columns improve foundation bearing capacity and reduce overall settlement because they are stiffer than soils, which they have replaced. The extent of improvement that can be gained in a given soil depends on the geometry of the stone columns. The relative arrangement of columns to each other and stiffness their itself, which is influenced by the lateral support provided by the surrounding soils after Vibro replacement composite soil stone column mass represents a foundation soil of enhanced bearing capacity, shear strength and stiffness.

Column diameters typically range between 0.7m to 1.1m and spacing range between 1.5m to 2.5m. Column lengths depend on soils encountered on site but typically range between 6m to 20 m.

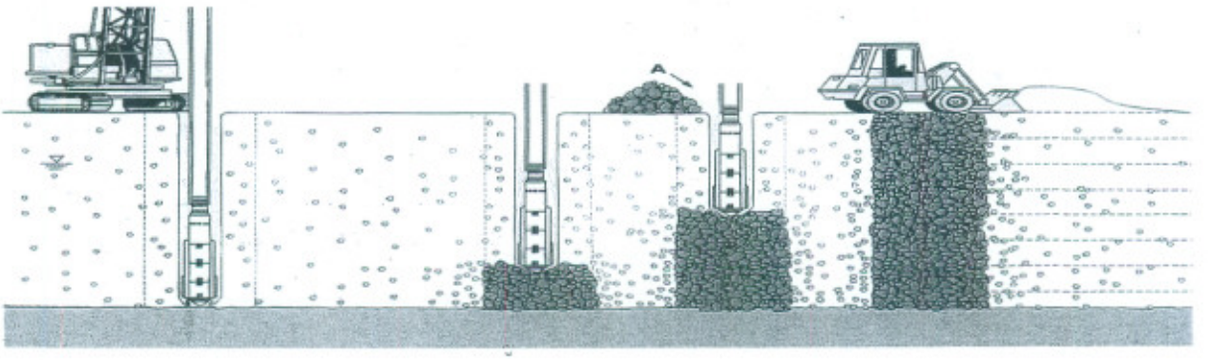


Fig: 3 Vibro-Replacement Processes

Keller Depth Vibrators:

Depth vibrators are poker vibrators with diameter ranging 300mm to 450mm, approximately 3-5m long, weighing some 2-4 tonnes.

The main features of these vibrators are that they contain eccentric weights mounted at the end of a vertical shaft directly linked to a motor in the body of the machine.

Consequently the vibratory motion is horizontal with the vibratory energy being applied directly to the ground though the tubular coring of the machine. The compaction thus remains constant ever the depth of penetration.

Depth vibrator consist of a long heavy and rigid tube, enclosed within are electric motor and eccentric weight. The motor rotates the eccentric weight that consequently generates the vibrations due to centrifugal force.

Vibrators are of many types based on their amplitude, power, centrifugal force and motor; these types include S, M, T and L etc.

A number representing vibrator's power to generate centrifugal force is included in vibrator name of each type. For example the term S-300 represents the type S vibrator able to generate centrifugal force of 320 KN. The latest development in vibrators is S-700 (CF=700KN and amplitude =50mm) completed in 2003 and achievable depth for improvement is 60m.

Single or even up to 4 vibrators can be attached to a single crane to get maximum production.

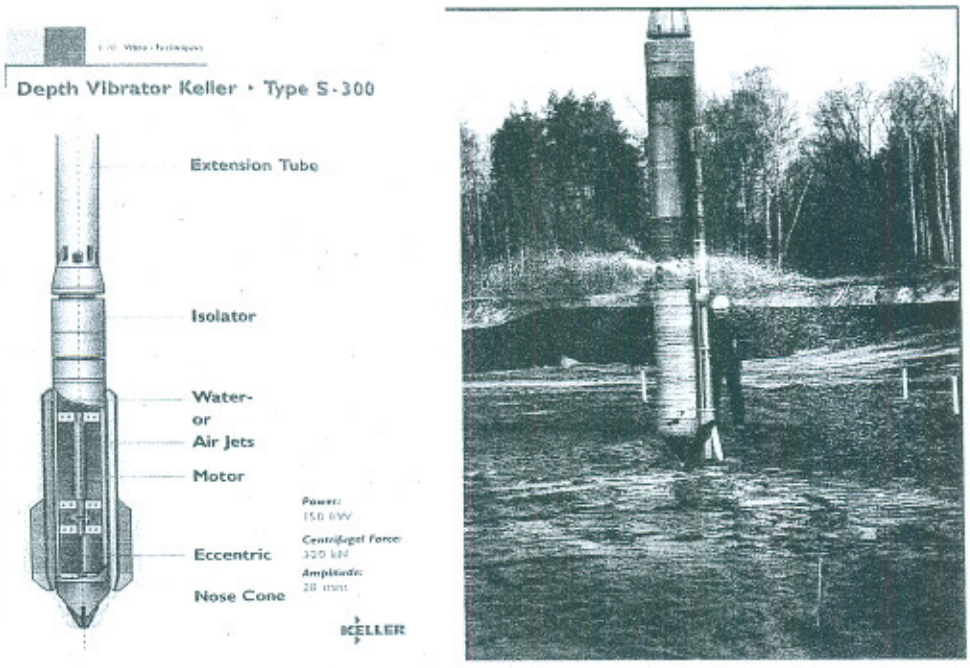


Fig: 4 Section and Elevation View of Depth Vibrator

General Method Statement For Vibro-Replacement Techniques:

1-Wet Method for Stone Column Installation:

The essential equipment for this process is a vibrator – a long heavy tube enclosing eccentric weights driven by an electric motor. The vibrator is connected to a source of electric power and a high-pressure water pump. Extension tubes are added as necessary and the whole assembly is suspended from a crane.

With the electric power and water supply switched on, the vibrator is lowered into the ground. The combination of vibration and high pressure water jetting causes liquefaction of the soils surrounding the vibrator that assists in penetration.

Following penetration of the vibrator to the designed depth, the water jets at the tip of the vibrator continue to flush out the fines and maintain an overpressure on the soil surrounding the liquefied zone around the vibrator. An assorted mix of stones of size 1" to 4" are then pushed into this temporarily liquefied soil zone which readily allows the stones to travel along the vibrator tubes to the oscillating tip of the vibrator. As the stones fill up, the vibrator is surged up and down pressing the stones vertically and laterally and in the process builds up a densely packed column of stones and soil. This process continues till ground level. The confirmation of adequately packed column comes from the ampere readings that can be seen on the panel board rising to the desired value. Thus a stone column network of low compressibility and high shear strength is included in the soil which was originally of high compressibility and low shear strength.

Inclusion of stone columns thus increases the bearing capacity of the ground, reduces foundation settlements and allows rapid dissipation of pore water pressure. Hence, in cohesive soils rapid mitigation of pore water pressure helps in shortening the total settlement period from long-term consolidation to more or less immediate settlements. The rapid pore pressure mitigation also is a major advantage in areas of seismic activity as it prevents soil liquefaction in granular soils.

The compaction probes are arranged so as to accommodate varying combinations of load and foundation configuration.

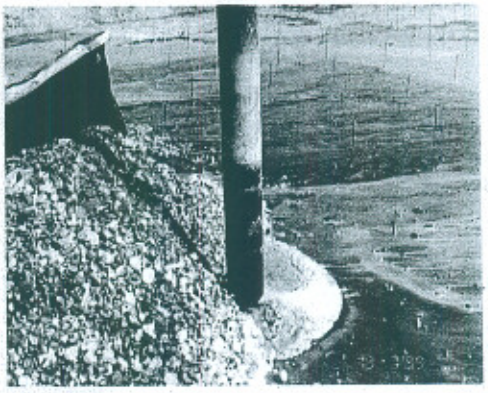


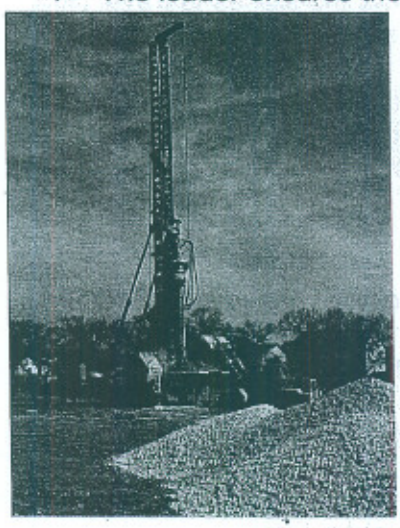
Fig: 5 Vibro Replacements with Wet Method

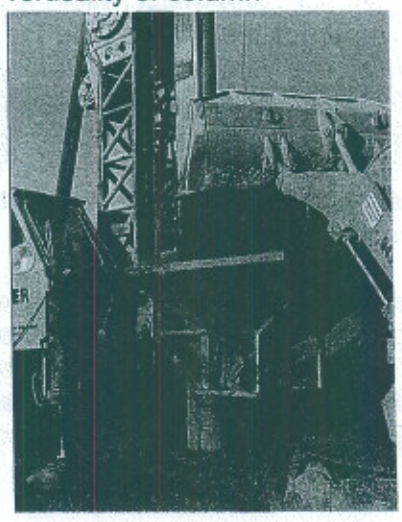
2-Dry Method for Stone Installation:

This technique uses the same vibrator probes as standard Vibro-Replacement Stone Columns, but with the addition of a hopper and supply tube to feed the stone backfill directly to the tip of the vibrator with the aid of pressurized air. To optimize the performance of this process and to accommodate the specialized equipment, Keller has developed the VIBRO-CAT base unit which guides the vibrator on its leader and allows the exertion of additional pull down force during penetration and compaction. Bottom Feed Vibro-Replacement is a completely dry operation where the vibrator remains in the ground during the construction process. The elimination of flushing water in turn eliminates the generation of spoil, extending the range of sites that can be treated. Treatment is possible up to a depth of 21m and is not inhibited by the presence of groundwater.

This method has few advantages over wet technique;

1- Can be used where no water is available
2- Site can be used immediately after installation as no mud is produced
3- Vibro-cat is fitted with special computer-M4 that directly measures amperage, depth, energy, time etc
4- The aggregate is always fed directly to the tip of the vibrator, creating a continuous column
5- Only a single penetration is required
6- The collapse of the hole is not possible even in critical soils
7- The leader ensures the verticality of column





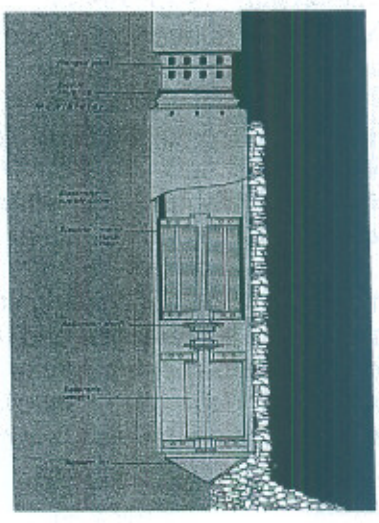


Fig: 6 Vibro Replacements with Dry Method (Vibrocat)

3- Follow-up after ground improvement:

After completion of ground improvement works the topsoil should be cleaned of loose muddy deposits and re-compacted in layers using approved fill material. The thickness of the fill depends on subsoil conditions, foundation level and ground water level. A minimum of 20cm is recommended and the layer should be compacted to 95% proctor density. Similarly if the fill thickness is 30cm then it should be placed in 2 layers of 15cm and each layer should be compacted to achieve 95% proctor density. This activity does not fall in the scope of soil improvement contractor and is to be executed by others.

Special Application of Deep Vibratory Techniques:

Silos, tanks, power plants, bridges, roads, airports, dams, hydraulic structures, embankments can be well designed and constructed over ground improved by Vibro techniques.

Apart from need to densify newly dredged sand in reclamation areas for the safe construction of warehouses and the like, the foundation of quay walls and berths, the installation of sheet and anchor piles and safe placement of caissons often require special measures which can be best obtained by the use of depth vibrators.

With depth vibrators, slender elements such as dolphins, soil anchors or steel profiles can be sunk into sandy soils and securely anchored.

A further field of application is the densification of wall zones and excavation bases to reduce their permeability.

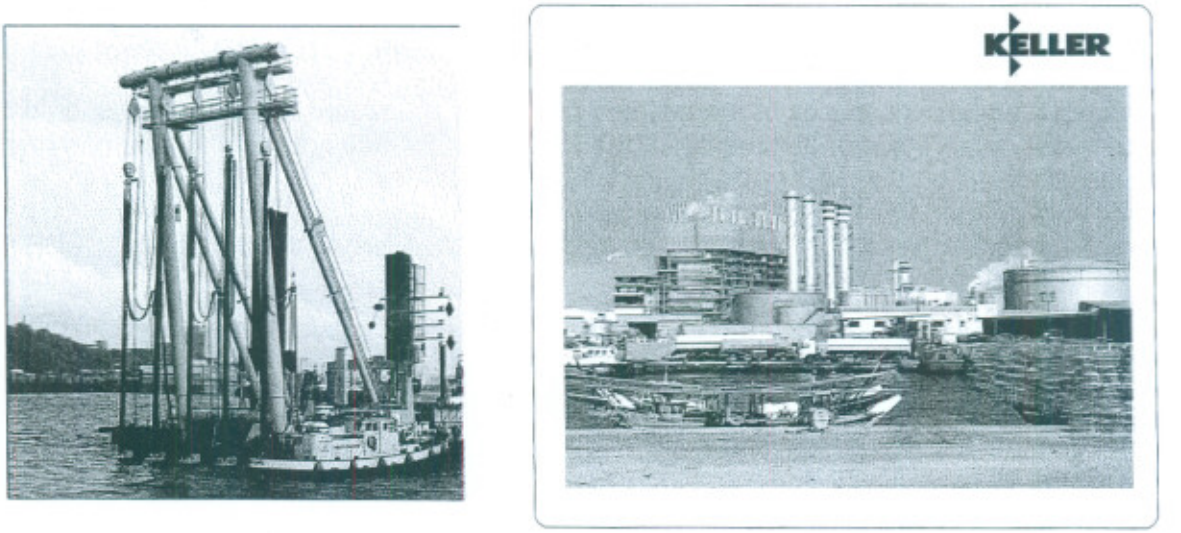


Fig: 7 Offshore Applications of Vibro Techniques

Multiple Vibrators and offshore compaction:

Vibro compaction of large areas both onshore and offshore can be carried out with multiple assemblies.

Quality Control:

To control the process, monitor the quality and for production records, the relevant construction parameters for each compaction probe can be measured, saved and printed.

The measurement device consists of;

1- The display unit in the operators' cabin
2- The CPU with data storage
3- PC with printer

During compaction a number of different site and production parameters are automatically recorded.

Values such as time, depth, penetration, pullout speed, pull down force, and current can be graphically displayed and printed. If required the energy consumption can be also be recorded.

Fig: 8 M4 Computer

The improved bearing capacity of the soil can be directly measured by performance of load test on small or large scale, depending on the foundation for which the stone columns have been installed.

Different methods to verify the improvement imparted by the Vibro techniques are;

1- Standard Penetration Test (SPT)
2- Cone Penetrometer Test (CPT)
3- Pressure-meter Test (PMT)
4- Dilatometer Test (DMT)
5- Load test (Plate load test and Zone load test)
6- Shear Wave Velocity Profiling

Advantages of Vibro-Techniques:

1. Foundation construction can start almost immediately after treatment, i.e. no curing period is required.

2. VIBRO techniques offer a very flexible foundation approach, which allows changes in design and layout to be readily accommodated with minimum delay and expense.

3. The VIBRO technique can be applied in close proximity to existing structures and safe working distance as near as 2.0m is usually permissible.

4. Provides slope stabilization

5. Permits construction on fills

6. Permits shallow footing construction

7. Prevents earthquake-induced lateral spreading

9. No concrete is directly exposed to possible aggressive soil and ground water.

10. The depth of the ground water table has no influence on the performance of the VIBRO process.

11. Tidal variations and natural changes in ground water table do not affect the stability of the improved soil.

12. VIBRO techniques improve bearing capacity, slope stability and safety against liquefaction.

13. The depth of 60 meters and more can be improved.

14. High level of compaction with the improvement of vibrators- latest is S-700

15. Reduced settlement and reduction in foundation size as well.

16. Mitigation of Liquefaction potential.

17.A wide range of soils can be improved.

18. In areas of seismic activity, VIBRO techniques play an important role as relative density and shearing resistance of liquefiable soils can be improved and by introducing stone columns, the soil permeability improves thus minimizing pore water pressure build up during an earthquake.

19. No special ground preparation is required to start VIBRO works that can be executed at any given level.

20. With short mobilization time, no dewatering requirement and speedy execution, VIBRO techniques can significantly reduce overall contract periods.

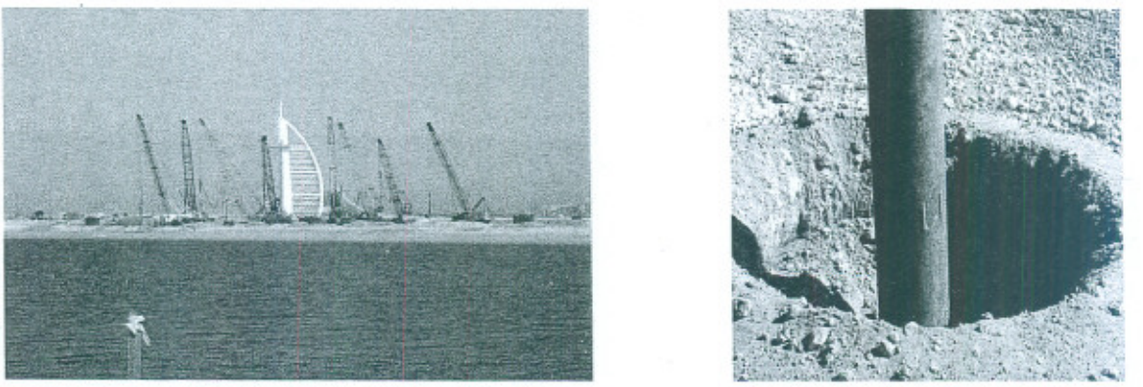


Fig: 9 Sand Compaction at Palm Jumeirah-Dubai

Conclusion:

The deep vibratory techniques present a very versatile ground improvement method that can be adjusted to a variety of ground condition and foundation requirement. Its execution is comparatively large even if large volumes of soils are to be improved and subsequent

construction works can follow very quickly. The soil improvement enables the contractor to construct shallow foundations, which, in turn gives additional savings. Another advantage is the environmental friendliness of the deep Vibro techniques, as natural and in situ materials are used.

Out of the deep vibratory compaction techniques Vibro replacement covers the widest range with regard to the application in different soils. Whilst Vibro compaction is restricted to compactable sand and gravel, the replacement method extends principally over the total range in grain size of loose soils.

Use of Vibro techniques commenced in Pakistan when construction of Hydraulic structures started under Indus Basin Treaty in late sixties. This method is highly preferable for construction of barrages, dams, and soil stabilization requirement for different projects in sandy areas of Sindh in particular and over all areas of Pakistan in general.

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3- Ground Treatment by Deep Compaction. I.C.E London 1976
4- Mitchell J.K., Katti R. K. Soil Improvement State of The Art Report. I.C.S.M.F.E, Stockholm.
5- Dipl.-Ing K. Kirsch, Application of Deep Vibratory Compaction in Harbour Construction

Snaps taken on the eve of the Lecture

(From Left to Right)
Muhammad Munawar Zaman,
Speaker,
Engr. Husnain Ahmed,
President
Pakistan Engineering Congress
Engr. Ch. Ghulam Hussain,
Secretary,
Pakistan Engineering Congress

A section of the audience

SAFETY, COMPLIANCE AND THEN PRODUCTION MAXIMIZES BOTTOM LINE

COURTESY
POWER, July 2006

When injuries or accidents occur, the employer ultimately loses on two counts: increased medical costs and employee absences. A policy of "safety, compliance, and then production" is more than just good business; it's also good stewardship of the health and safety of employees who deserve no less.

A safe work environment is not an unreasonable expectation for every type and class of worker. From the laborer digging a trench to the office engineer to the site manager – all anticipate arriving home each evening without having been injoured on the job. Accidents do happen, but major construction projects and operating power plants now routinely surpass the million man-hour milestone without a lost-time accident. That's only because those projects or facilities have instilled a culture of safety throughout their organizations and accept nothing less.

Sadly, not every organization understands that safety is good business – not just an expense line item. The U.S. Bureau of Labour Statistics recently summarized the type and number of fatal occupational injuries for its 2005 annual report:-

- A total of 5,702 fatal work injuries were recorded in the US. That was a decrease of about 1% from the year before.

- Fatal highway incidents increased by 2% and remained the most frequent type of fatal workplace event, accounting for one in every four fatalities nationally.

- Fatalities due to exposure to harmful substances or environments rose 7%. Buried in this statistic is the sharp increase in the number of workers who died after exposure to environmental heat: from 18 fatalities in 2004 to 47 fatalities in 2005. Higher number of fatal work injuries resulting from the inhalation of caustic, noxious, or allergenic substances also contributed to the overall increase.

- The private construction industry accounted for 1,186 fatal work injuries (the most of any industry sector) and about one out of every five fatal work injuries recorded.

By comparison, work areas regulated by government entities – such as the Department of Energy, Nuclear Regulatory Commission and Environmental Protection Agency – fatal occupational injuries are rare. Safety in these organizations is promoted to such a degree that even minor injuries requiring simple first aid (such as cuts and scraps) are viewed as un-acceptable. A fatality will stop a project in its tracks and prompt an extensive investigation that could delay a project for months. It will also, inevitably, generate negative publicity. For major projects, the resulting costs can run into seven digits or more very quickly.

These comments may not be misinterpreted as over looking the incalculable cost of the loss of a human life; they simply are meant to illustrate that safety is just all around good business.

Overtime, Injuries, and Accidents

Although acute injuries and fatalities receive most of the attention within a typical safety programme, a growing body of evidence suggests that long work hours also adversely affect

worker's health and well-being. A study by the National Institute for Occupational Safety and Health provides a comprehensive review of 52 research reports that examined the relationships between long work hours and illnesses injuries, health behaviours and performance. A variety of the reports noted that overtime was associated with poorer perceived general health, increased injury rates, more illnesses, or increased mortality. To be fair, some of the reports did not support these findings, but a relationship between long work hours, decreasing worker performance and higher accident rates seems intuitive.

Work schedules differ among power plants in many ways and each plant has its own approach to accommodating the needs of employer and employees. The research reports could not come to a consensus on the best work schedule, based on the available data. For example, the major arguments against 12 hours shifts tend to revolve around increased fatigue and compromised alertness, which thereby reduces safety. The potential for impairment arises because shift work, especially the night shift, can disrupt our circadian rhythms. On the other hand, 12-hour shift can be popular with workers because they compress the work week and increase worker time to pursue other interests.

Several of the reports did fail to account for potential contributing factors. For instance, jobs performed during long shifts might be inherently more dangerous, or people working extended hour schedules may have different personal characteristics (including those related to age, gender, parental responsibilities, or underlying health status) that affect their risk of injury and stress.

Most of these studies used only self reported job evaluations and the vast majority of the published studies were conducted in Europe, Asia and Scandinavia. Only a handful of studies have been conducted in the U.S, none of those was with a large sample size, and the U.S studies were typically industry-specific, thereby limiting their general usefulness.

The Dembe Study

The most useful study that analyzed the relationship between overtime and extended working hours and the risk of occupational injuries and illnesses was published by Dembe, et al. This study used a nationally representative sample of working U.S. adults. Dembe's hypothesis was that those working overtime or an extended work schedule would have an increased likelihood or reporting an occupational injury or illness compared with those working less-demanding schedules.

The study was based on responses from the National Longitudinal Survey of Youth (NLSY). The database contains 110,236 job records representing 89,729 person-years of accumulated working time over a 13-years period (1987-2000). NLSY was used to evaluate workers job histories, work schedules and incidents of occupational injury and illness. Multivariate analytical techniques were used to estimate the relative risk of long working hours per day, extended hours per week, commute times, and overtime schedules on reporting work related injuries or illnesses after adjusting for important factors such as age, gender, occupation, industry sector and geographic region.

The study found that jobs with over time schedules were associated with a 61% higher injury hazard rate compared with jobs without overtime. Also, working at least 12 hours per day was associated with a 37% higher hazard rate and working at least 60 hours per week was associated with a 23% higher hazard rate. In addition, jobs with long work hours were not necessarily more risky merely because they were concentrated in inherently hazardous industries, hazardous occupations, or due to the demographic characteristics of employees working those schedules. The findings confirmed the hypothesis that long work hours

indirectly precipitated workplace accidents through a process that introduced fatigue or stress in affected workers.

Programme Opportunities

Whatever the industry, instituting safety related programmes at the company level and wisely using mandate government programmes can minimize accident incidence rates.

For example, fitness-for-duty and workplace substance abuse programmes, such as those involving random drug screenings, may provide reasonable assurance that employees are not under the influence of any controlled substance or impaired in any way that may adversely affect their ability to perform their duties. In most instances, employee assistance programmes (for example, counseling, referral and educational services) are in place to assist with employee rehabilitation.

In the case of workman's Compensation (WC), employers pay a premium to an insurance company in return for insurance coverage. An individual company's premiums are based on its Experience Modification Rate (EMR) set by the insurance industry for a particular industry classification or sector. The EMR is designed to reflect variation of an employer's actual experience from the expected or average experience for the industry classification. This comparison can result in either a reduction or increase in premiums. Companies with lower-than-average losses are assigned an EMR <1.0, while companies with higher-than-average losses are assigned an EMR>1.0.

The following example dramatizes the impact of EMR on the company's bottom line. Assuming an average workers' compensation rate of $25 for every $100 dollars of payroll, a small 30-employee firm with an EMR of 1.3 (based on worse-than-average losses) and an annual payroll of $600,000 pays $ 195,000 in annual WC premiums. A similar-sized firm with an EMR of 0.7 (due to fewer-than-average losses) would pay only $105,000 per year, a difference of $90,000. Because understanding the impact of the EMR is key to reducing WC premiums. Greater savings in direct WC costs can be realized when a company's EMR is <1.0.

Even so employees may not recognize the magnitude of the indirect costs. For example, if an employee falls from a defective ladder, WC pays for the direct medical expenses, say $10,000. But the indirect costs to the employer can be more than double that amount – as high as 20 to 1. Indirect costs can consist of production losses, replacing the injured worker, WC premium increases, and possible fines. These increases can have a negative impact on a company's ability to complete for future contracts, because controlling direct and indirect costs of work-related injuries can be difference between a profitable company and one that is forced to close.

Statistically Significant

The Tennessee Chapter of the Associated General Contractors of America (AGC) performed a cross-sectional study of 305 Tennessee-based AGC-member companies designed to identify and assess the impact of safety programme elements on safety performance. The study instrument consisted of 48-item self-report questionnaire designed by the University of Tennessee Department of Health and Safety Sciences and the Department of Industrial Engineering. The 48 items were derived from a literature review of programme elements considered to be indicative of a sound safety programme (such as policies, procedures and processes).

Of the 305 companies surveyed 89 (29%) responded. Results identified a significant statistical economic advantage in the marketplace for those companies reporting the following:-

WC Costs. WC Cost were evaluated by comparing contractor EMRs. Companies with an EMR <1.0 reported a significantly higher number of key safety programme elements, such as employing a full-time safety manager (68%), the use of pre-job safety briefings (51%, and a greater number of written drug/alcohol prevention programme (91%).

Company Size. Safety performance and programme content were a function of company size. A significant higher number of small companies, defined as having fewer than 50 employees, reported having an EMR >1.0 than did midsize companies employing 5' to 100 employees and large companies employing more than 100 workers. A greater number of midsize-to-large companies reported that they performed drug testing and participated in safety conferences than did smaller companies. In addition, management commitment and safety expenditures (such as safety incentives) were consistently identified as essential components of an aeffective safety programme.

Full-time Safety Manager. Employing a full time safety manager was predictive of safety processes and practices. A significantly higher number of companies reported that they presented pre-job safety briefings when employing a full time safety manager (53%); such companies also reported having a written drug/alcohol prevention programme (92%) and drug testing (100%). In addition, companies with full-time safety managers were significantly more likely to report that they:

- Tracked Injury and illness costs (74%),
- Performed weekly walk-around safety inspections (70%), and
- Attended safety training programmes (77%).

Safety Roles Responsibilities and Training. Companies that reported defined roles for employees responsible for safety reported a higher number of key safety programme element. A significantly higher number of companies having written and clearly defined safety roles and responsibilities reported having drug and alcohol prevention (91%) and emergency preparedness programmes (62%) and conducting safety training (86%) reported tracking of:

- Injury/illness costs (74%),
- First-aid cases (69%),
- Near-misses (33%), and
- Walk-around safety inspections (67%).

Companies having these key safety programme elements noted that the safety representative reported to executive management and attended senior management meetings. Furthermore, employee involvement (in, for example, safety committees and employee concerns programme) and viewing employees as the "ultimate shareholders" increasingly came to be recognized as one of the primary keys to an effective safety programme. Training, such as attending local and regional AGC safety events was an essential component that contributed to a higher presence of clearly defined roles and responsibilities.

Theory into Practice

The programmatic elements discussed in the AGC study had already been implemented as part of Weskem LLC's corporate safety programme (Oak Ridge, Tenn). The company

employs salaried, bargaining-unit, and subtier sub-contractor employees who are responsible for the characterization, sorting, treatment, packaging, interim storage and transportation associated with asbestos, polychlorinated biphenyles and hazardous, radioactive and mixed wastes. Over a six years period (2000-2006), Weskem's combined injury/illness recordability and lost workday case rates were <1.1, thus contributing to an EMR of 0.94 in 2006.

According to Weskem's safety director Todd Potts, "These significant achievements can be traced back to the president, senior management and employees actively participating in the Company's safety and health programme, and challenging everyone to continuously improve in the areas of safety, compliance and then production. This success was achieved while performing high hazard, invasive field activities involving hazardous, radioactive, and explosive waste materials. Even with overtime, accident and injury rates over the past six years remained steady and below industry averages, thus reducing Weskem's EMR below 1.0, while meeting all production goals.

Conclusion

Employees' risk perceptions, behaviours and attitude are adversely affected when they perceive that safety is no longer a company priority, or when resources that are normally devoted to safety are diverted elsewhere. Therefore, resources such as hazard identification, prevention and mitigation are often credited as the most important elements directly reducing workplace accidents and injuries.

However, Making the most of these resources requires multifaceted approach that combines worker training and involvement, ergonomic job design, medical surveillance, competent supervision, and a corporate organization that promotes safety. Companies experiencing unacceptable safety performance metrics can reduce losses and improve their overall "Safety, compliance and then production" goals by adopting key programmes that have been shown to enhance a positive safety culture without sacrificing production or the bottom line.

FEELING THE COOL BREEZE

COURTESY
The News Week

Building Asian cities on environmental principles is the fastest and cheapest way to reduce its demand for energy – and cut greenhouse-gas emissions.

Fraser place may someday loom large in the annals of environmental history. Completed in Shenzhen in 2005, the crescent-shaped service apartment is China's first green commercial building. The windows are designed to capture breezes, reducing the need for air conditioning. Rainwater runs off the roof and into an irrigation system for the surrounding gardens. With a combination of advanced design concepts, new technologies and safe materials, the building is healthy for its occupants, efficient for its owners and light on Mother Earth. The best measure of its success comes on the bottom line: it delivered $177,857 in energy savings during its first year in operation, compared with a similar-size conventional structure.

That puts Fraser Place and the handful of similar buildings in Asia at the center of today's climate debate. Asia's growing demand for energy is the main driver of $100-per-barrel oil, and makes it the hottest market for biofuels that threaten food supplies. Thanks to its metastasizing power grids, which rely mainly on coal-fired plants using technology from the 1950s, it is also the fastest-growing contributor to the greenhouse-gas emissions that cause global warming. Clearly, China and India need cleaner power plants, but it is becoming increasingly clear that the fastest, cheapest way to reduce emissions is to build more energy-efficient cities, using proven green technologies. "Success in confronting climate change depends very heavily on how we house Asia," says Daniel Esty, Yale University environmental-law professor and coauthor of "Green to Gold?' "This is a huge challenge but also a huge opportunity?'

Why Asia? Because breakneck economic growth and the region's still-huge rural population make it the epicenter of urbanization in the 21st century. The challenge (as is so often the case in the region) lies in not repeating the West's developmental missteps. Rural-urban

migration now lands millions of Asians a year in apartments replete with TVs, refrigerators and air conditioning. Every day more of them obtain the ultimate urban accessory: the automobile. If current patterns persist, by 2020 China alone will import half the world's coal, a fifth of its oil and will have 158 million cars on its roadways compared with just 30 million today.

The alternative: apply existing green building techniques—most of which are neither high tech nor costly—to grow healthier Asian cities. Doing so, most experts concur, could yield urban areas that consume 30 to 50 percent less energy than conventional cities, for a small additional construction cost. At a recent conference on sustainable building in Singapore, Ché Wall, former chairman of the Australia-based World Green Building Council, said that "we have to recalibrate our thinking" about cities as smog-spewing symbols of environmental degradation. Cities, he argues, can be efficient, sustainable environments, especially when created based on sound ecological practices. They put people in closer proximity to their work, generate less energy-intensive economic growth and lend themselves to mass transportation. "The building sector is where the biggest opportunities lie:' he says.

Today buildings account for roughly half of all energy consumption globally, and transport gobbles up an additional quarter. Both are rising in percentage terms (in contrast to industrial power use, which is falling) due to urbanization. Still, cities are potentially big energy savers. A recent study in The McKinsey Quarterly reviewed all the realistic ways of reducing greenhouse-gas emissions by 2030, and found that 75 percent of the potential reductions either would result from broader use of proven technologies (insulation for buildings and hybrid technology for cars) or are not technology related (a well-designed building can save a lot of energy simply by the way it sits on the site, captures natural light and garners rainwater). It also found that green building is one of the cheapest ways to cut greenhouse emissions (and "clean coal" technologies are among the most expensive). Data from the U.S. Energy Information Administration shows that buildings account for almost half of all greenhouse-gas emissions; green-building advocates say better design and construction could cut this in half. "It is better to reduce demand through making buildings more energy-efficient than it is to try and 'solve' the clean-energy problem' says Jason Hainline, whose firm, EMSI, consulted on Fraser Place. "The first step always is to reduce demand through design. And in essence, that's free".

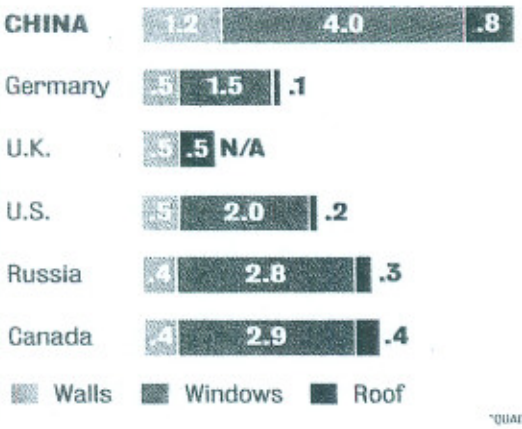
The global green-building boom owes much to the nation that refused to ratify the Kyoto Protocol and still carries a well-deserved reputation for resource gluttony, the United States. In Asia the clearest sign of American influence is the growing cache of the Leadership in Energy and Environmental Design (LEED) awards, granted since 1998 by the U.S. Green Building Council. The system grades buildings for factors like indoor environmental quality, resource use and consumption of energy and water, and awards certifications that can raise the market value of buildings by up to 10 percent. "The [US.] Green Building Council's promotions have been very influential:' says K. S. Wong, vice chairman of Hong Kong's equivalent body. "In terms of market perception, LEED is really seen as the global standard".

CASE STUDY: CHINA

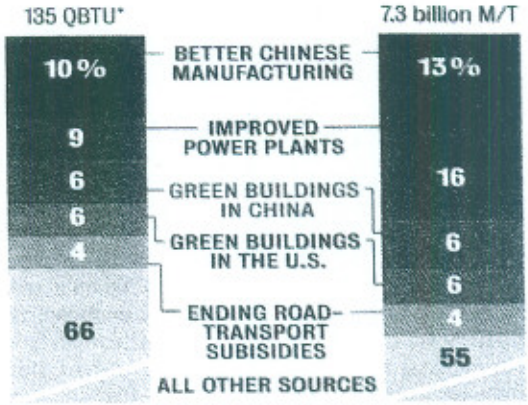
Building Better

China's buildings lag behind global standards for energy efficiency. Upgrading would help.

Units of heat loss per square meter allowed under national building codes



Potential for energy savings (left) and CO_2 emission cuts (right) by source



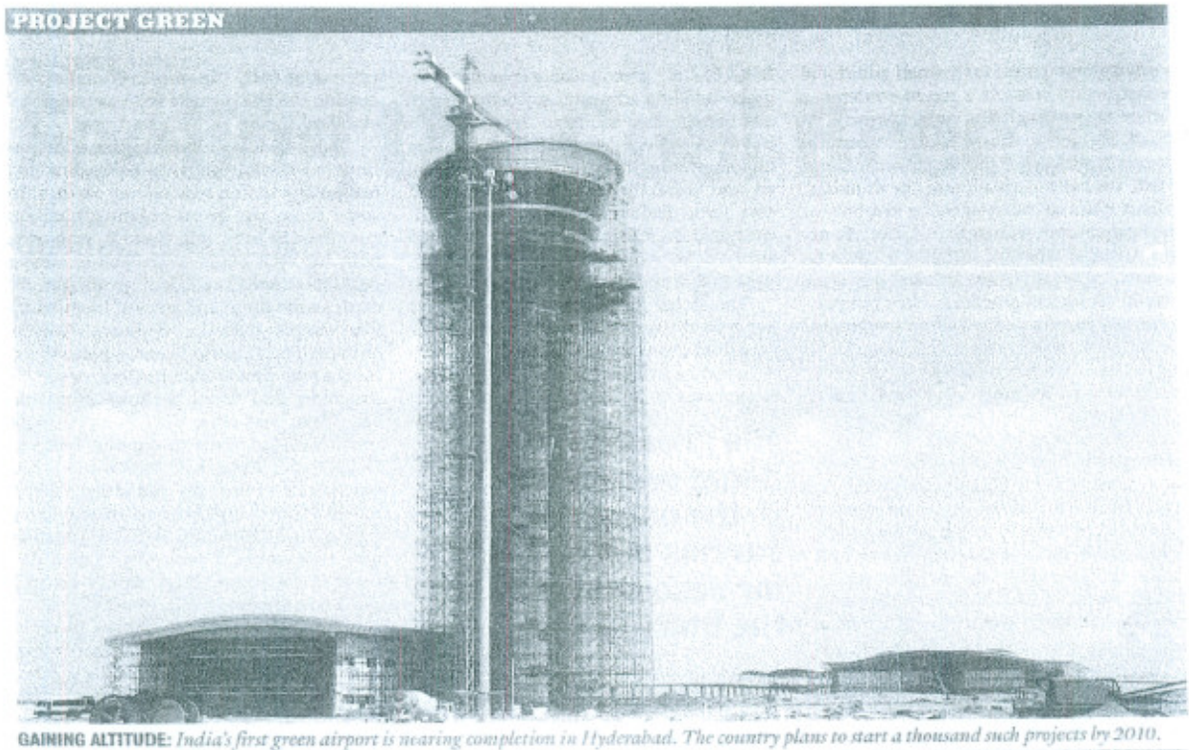
*QUADRILLIONS OF BTUS. NUMBERS DO NOT ADD TO 100 DUE TO ROUNDING. SOURCE: MCKINSEY GLOBAL INSTITUTE

Today India is arguably the Asian nation most enthusiastic about using old technology to find new energy savings. In some sense the green-building tradition goes back to Mahatma Gandhi, who once built his own house from wattle (woven wooden strands) and daub (a mixture of earth, cattle dung and straw). Inspired by that simple esthetic, visionary British-born architect Laurie Baker, a naturalized Indian who first landed in 1945, designed structures that could be built affordably from local materials, with scooped roofs and perforated walls to capture breezes. "The trend in India in the 1960s and 1970s was climate-sensitive, naturally cooled and very local:' says Abhin Alimchandani, director of architecture at STUP consultants in Mumbai, a prominent green designer. "Those buildings would very well score under the LEED system".

Since 2003, some 30 Indian projects have won LEED certification, according to the Indian Green Building Council. They include India's first green airport, now nearing completion in Hyderabad, as well as prominent corporate headquarters in New Delhi, Mumbai and Bangalore and a city-size special economic zone called Blue Ridge in Pune. "Five times as many are now in the pipeline:' says Alimchandani, and by 2010 the council hopes to have a thousand green projects underway nationwide. "There is a huge requirement for LEED-accredited professionals:' IGBC chairman Prem C. Jam told the Deccan Herald in September. "In fact, we need an army to overlook the commissioning, simulation and operations of these buildings".

Singapore's most ambitious green project stands out for targeting the mass market. Called Eco Precinct, the 712-unit residential complex incorporates eco-friendly innovations into affordable, efficient flats more notable for their underlying design logic than for high-tech wizardry~ "It is not our mandate to do cutting-edge," says Johnny Wong of the city's Housing Development Board unapologetically. Instead, Eco Precinct gets the basics right. Solar heat is absorbed on insulated "cool walls:' green roofs and a tree-shaded Eco-Deck that covers the car park. Windows face the north-south axis to avoid morning or evening glare, while the thin towers maximize air flow-through. Solar cells power lights in common areas and the capture of rainwater irrigates dense landscaping that could cut outside temperatures at the complex by up to four degrees Celsius. The project is already 80 percent sold and represents about a third of all public housing to be built in the city-state in 2009.

Eco Precinct is a case study in adapting to local conditions. Its flats aren't double-glazed, tightly sealed units like those favored in colder climes, because in the tropics this type of design tends to encourage air-conditioning use. The project's green roof was another area of focus. Plant and soil mixes favored in temperate climates would require irrigation and could breed deadly mosquitoes, HDB experiments concluded. So experts at the National University of Singapore and the city's parks service were called upon to select appropriate plants. And instead of soil, pebble-size ceramic shards keep roots from rotting and water from pooling. Eco Precinct will cost 5 to 8 percent more to build than conventional public housing, says Wong, and it's "too early to tell how much energy we will save".



GAINING ALTITUDE: *India's first green airport is nearing completion in Hyderabad. The country plans to start a thousand such projects by 2010.*

The challenge ahead - for Asia and the world - is to move beyond the green-building beachhead by making key elements in today's experimental buildings tomorrow's norm. The trends are encouraging. The number of projects seeing green certifications (by LEED and others) is increasing virtually everywhere, albeit from a low baseline; leading corporations see the PR advantage to having LEED-certified headquarters, and developers are discovering that resource-efficient buildings command premiums on the market (for sale or lease) that outweigh additional building costs. Perhaps the best barometer is that the cost of non-compliance is rising. "New non-green buildings face early obsolescence", forecasts Wall.

More important to the big picture, governments are reviewing outdated building codes in the light of the impact green buildings have on climate change. Hong Kong's top leader hinted in his recent annual policy address that tougher efficiency standards are on the way. Singapore has declared its lowest Green Mark certification the minimum standard for all new constructions. And this month China sent a delegation from the powerful construction ministry to the USGBC"s annual Green Build convention in Chicago, where members presented a rating and certification system under development in Beijing as part of a strategy to reduce energy use and carbon emissions in 2010 to 1990 levels. "This could get beyond the handful of sample projects," says Hainline. "With China's goal of becoming a world leader they have the ability to make things happen not only by reversing their own environmental path but by setting the example for others".

Asia would do well to emulate the U.K.'s quest for sustainability. The government has already begun to phase in building regulations that aim to render all new homes built after 2016 carbon-neutral. Its Code for Sustainable Homes sets standards for water use, waste building materials and energy consumption that will escalate three times over the next nine years as the zero emission deadline approaches. "This is an excellent example of a long-term legislative framework," says Nigel Banks, a consultant at the environmental firm Fabor Maunsell. "It has allowed developers to test ideas on a small scale and invest in new technologies with the knowledge that their investment will be rewarded."

The benefits of applying similar standards on a global scale are obvious, and the risks of not doing so extreme. Old-style buildings contribute heavily to global warming but new ones needn't. And with the bulk of new urbanization set to take place in Asia, it is there that greenhouse gas emissions – and thereby global warming – can be contained in the next decade or two and even reversed in the longer term. Or not. Fraser Place may not look all that special, but much is riding on what it represents.

MONITORING KEY GASES IN INSULATING OIL KEEPS TRANSFORMERS HEALTHY

COURTESY
POWER, October 2006

Large T&D-sized transformers age as quickly as generating assets do. But preventing transformers from failing is difficult because they have no moving parts and are sealed up. Tracking the concentrations of certain gases – the more, the better – that are dissolved in a unit's insulating oil is a proven way of detecting damage before it causes a costly problem.

US Electricity consumption continues to increase almost 2% annually. As the local growth spurs call for new power plants and transmission lines, it's easy to forget the impact of the additional current flow on the countless power transformers of utility transmission and distribution systems. Big set-up and step-down power transformers, which are among the most expensive components of the nationwide electricity delivery network, are seeing their average loads inching up as well, especially in regions of high population growth.

The average age of utility power transformers is about 40. Hartford Steam Boiler Inspection & Insurance Co. (www.hsb.com) reports that transformer failures consistently rank among its top five claim types, and the company expects their frequency to rise in coming years. Accordingly, transformer condition assessment and management has become a higher priority for utilities, particularly those that don't wish to see their public image tarnished by a blackout triggered by the burnout of a critical transformer.

HMO for Transformers

The typical transformer failure is caused by the inability of its conductor insulation to handle the stresses that arise during operation. Either the dielectric fails or internal mechanical components – such as winding clamps and bushing connections – loosen, causing short circuit. The challenge isn't so much determining why failures occur but, rather, eliminating them by using methods designed to accurately assess the health of a transformer and predict its remaining life.

Utility managers can avoid surprises by developing long-term health-maintenance procedures for their transformer assets. They include fixing defects, overhauling units (re-tightening and blocking loose windings or doing a complete rewind), relocating transformers to improve their voltage regulation or reduce their loading limitations, and – if all else fails – retiring and replacing a unit. Most utility load assessment programs are based on IEEE Standard C57.91, which provides useful loading recommendations, equation for calculating remaining transformer life, and tips for avoiding hot spots and excessive insulating-oil temperatures. Use of these tools can enable even an old transformer to remain in service past its expected retirement.

Health assessment are a financial challenge for any utility with hundreds or thousands of transformers spread across its service territory. Budget constraints require prioritizing health assessments according to criticality evaluations of the transformers. Such evaluations usually are based on a cursory inspection, monitoring and the application of risk-based analysis tools.

A good condition assessment must balance the age and maintenance history of the transformer against its operating history and the quality of its preventive maintenance regiment (which – it is hoped – would include records of years of oil testing and thermography). The results of the assessment are then interpreted in the context of a system

wide transformer management and prioritization strategy that details where maintenance dollars are actually spent.

Severon Corp (www.severon.com) uses the following categories to differentiate transformers by the consequences of their failure:-

- *Critical.* Units whose failure would have a large negative impact on grid stability, utility revenue and service reliability.

- *Important.* Units whose failure would have a significant negative impact on revenue and reliability. Most transformers found in transmission substations and in major distribution substations are in this class.

- *Recoverable.* Units whose failure would have a low impact on revenue and reliability. Most small transformers in distribution substations fall into this category.

Gas Guzzler

Prior to the 1980s, the only way for utilities to gauge the heath of a transformer was to sample its insulating oil periodically and send it off to a lab for analysis. Then combustible gas monitors, which measured predominately hydrogen, arrived on the scene. The late 1990s saw the introduction of online dissolved gas analysis (DGA) monitors.

Early DGA systems were more art than science. They measured the concentration of hydrogen and/or one other combustible gas in transformer oil as a loose predictor of future transformer problems. Modern on-line DGA systems monitor up to 11 "fault gases" trend their concentrations and other transformer operating parameters in near real time and come up with a suite of diagnostic tools.

Laboratory DGA has given way to portable DGA kits that save money and enable faster detection of malfunctions that could cause a transformer failure within days. Many utilities use both approaches to be safe rather than sorry. The business case for DGA is clear: Utilities have successfully used the technique to detect the imminent or eventual failure of hundreds of critical transformers. Each "save" has prevented the loss of thousands or millions of dollars in revenue – as well as the loss of public confidence that a blackout produces.

One Extraordinary Event

On July 4, 2004, Arizona Public Services (ASP) found out what it's like to have the media and public looking over its shoulder following the catastrophic failure of a huge, 1970s – vintage transformer at the Westwing Substation in northwest Phoenix that it co-owns with other western utilities.

Measurements at the Westwing Substation, a key transmission portal into the Valley of the Sun, gave no advance warning of an impending failure. The resulting fire destroyed the transformer (a single phase unit that steps down 525 kV to 230 kV) and caused much collateral damage.

Fortunately, APS was able to quickly locate a suitable replacement: a spare at Bonneville Power Administration. However, the 4000,000-lb units tedious journey from Washington to Arizona took 21 days, with each move covered by the media as Phoenix teetered close to rolling blackouts. Although Westwing was placed back in service, APS had to ask valley

residents to curtail their electricity usage between 3 pm and 6 pm daily for more than a month.

An independent analysis concluded that the failure of the transformer, in bank TI of the substation, was an "extraordinary event" not attributable to lack of maintenance. The immediate cause of the fire, said the report, was an internal fault that caused high pressure within the transformer, which breached the transformer casing.

The failure, however, was actually the final event in a long chain of problems. A fault on June 14, a 230 kV transmission line caused a grid disturbance that knocked all three units of Palo Verde Nuclear Generating Station Off-line. The disturbance went undetected by a 30 years old relay protecting the transmission line at Westwing, eventually causing a 20-second fault during restoration efforts that appears to have mechanically damaged the transformer's windings. Weeks later, the wound progressed to an internal fault and fire, which destroyed five transformers: all three phases of transformer bank TI, a spare transformer, and Phase-3 of transformer bank T4.

According to Steve Bischoff, General Manager of Construction, Operation and Maintenance for APS – if an online DGA system had been on the job, it could have sensed the pending transformer failure due to the June 14, damage to the windings, and the July 4 fire may have been averted. Post fault DGA and other testing, consistent with industry practice, did not indicate any problems with the transformer. The value of on-line DGA monitoring is being able to detect rapid changes in combustible gases, such as those seen in this case, which would not normally be detected through a manual sampling process.

At the time, APS was actively prototyping online DGA and shortly thereafter completed a critically analysis of all 150 of its transmission level (230 kV and above) transformers. Now APS makes sure that each new high voltage transformer it purchases is monitored by a model TM8 (eight-gas) unit from Serveron – as do 13 other utilities across the U.S. APS has also accelerated the DGA retrofit program; 50 systems are already in service on transformers working at 230 kV or higher. Plans are to complete installation on all 150 transformers by 2010.

DYNAMIC CLASSIFIERS IMPROVE PULVERIZER PERFORMANCE AND MORE

COURTESY
POWER, July 2006

In an earlier issue of POWER, keeping coal-fired steam plants running efficiently and cleanly, one way to improve the combustion and emissions performance of a plant to optimize the performance of its coal pulverizers was discussed. By adding the dynamic classifier to the pulverizers coal particle sizing and fineness can be better controlled and pulverizer capacity can be increased to boot.

No one in this industry underestimates the difficulty of transforming an un-widely and distinctly non-uniform substance like coal into a fuel whose physical and chemical characteristics are consistent enough to supply a workhorse power plant boiler. Designers of fuel-handling and pulverizer systems have wrestled with this problem since the first traveling – grate furnace was invented. The more predictable a fuel is, the easier it is for engineers to tune a boiler burning it for maximum performance and minimum emissions.

Selective Service

From the grizzly to the burner tip, the pulverizer plays an essential role in maximizing the consistency of fuel delivered to the steam generator. Most existing pulverizers – both the vertical shaft and ball-mill types – come with a static classifier. Its blades reject coarse particles to produce a stream of coal particles that are mostly about 0.0029 inches (74microns) across.

Obviously, not all of the particles leaving the pulverizer are that size. The fineness of coal is measured using a US standard sieve with a sleeve opening of 0.0030 inches. Particles smaller than 74 microns will pass through a 200-mesh screen, and those larger will not. Passing coal through several screens in series yields a profile of the particle size distribution (PSD) of a pulverizer/classifier. The industry standard for PSD has been 70% passing through a 200-mesh sieve. Other common US standard sieves are 325 and 50 mesh, which stop particles larger than 0.0017 inches (45 microns) and 0.01117 inches (300 microns), respectively.

Coarse particles of coal don't burn as quickly, easily, or cleanly as finer particles. Because they take longer to burn, coarse coal particles raise a boiler's average NO_x emissions. They also foster agglomeration and deposition of slag, making boilers and heat recovery boilers more vulnerable to fouling. Coarse coal can even poison the catalyst of a selective catalytic reduction (SCR) system. If enough coarse coal passes through a boiler without being burned completely, its fly ash may have too much unburned carbon (UBC) for commercial use.

Classifier 101

Upgrading a pulverizer's classifier from static to dynamic can improve two key pulverizer performance measures: its throughput and its coal fineness. As their name implies, dynamic classifiers (see box below) use static as well as rotating vanes to sort coal particles more precisely by size. Retrofitting a pulverizer in this way:-

- Increases the slope of its fineness distribution on a Rosin-Rammler OSD plot.
- Reduces the amount of superfine and overly coarse material.
- Reduces internal recirculation of partially pulverizer particles.
- Reduces over-grinding, which in turn reduces the mill's wear, power consumption, and vibration.

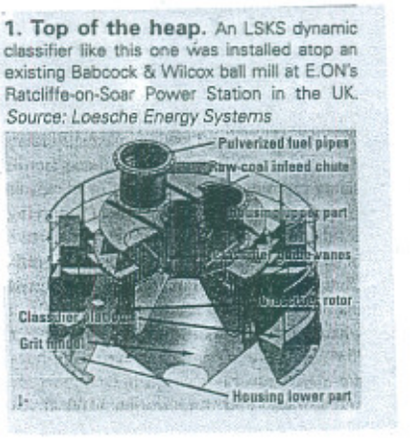
- Reduces the differential pressure across the pulverizer.

> ***What is dynamic Classifier?***
> *A classifier separates coarse from fine coal by allowing the fine coal to pass and rejecting the coarse particles for regrinding. A dynamic classifier has an inner rotating cage and outer stationary vanes. Acting in concert, they provide what is called centrifugal or impinging classification.*
>
> *In many cases, replacing a pulverizer's static classifier with a dynamic classifiers improves the unit's grinding performance, reducing the level of un-burned carbon in the coal in the process.*

The following summaries of dynamic classifier retrofit projects (classified by application) further illustrate the benefits of this technology.

Improving Coal Fineness

A Loesche LSKS dynamic classifier **(Figure-1)** was retrofitted to each of four Babcock & Wilcox (B&W) Model 10E10 ring and ball pulverizers at E.ON's Ratcliffe-on-Soar Power Station in the UK. Ratcliffe has four 500-MW natural-circulation, single-furnace, dry-bottom B&W boilers. Each pulverizer has two coal outlet pipes, which then split into three smaller pipes that each feeds a B&W Mark 3 low-NO_x burner (LNB). Each boiler's 48 burners are arranged as four rows of 12.



1. Top of the heap. An LSKS dynamic classifier like this one was installed atop an existing Babcock & Wilcox ball mill at E.ON's Ratcliffe-on-Soar Power Station in the UK. *Source: Loesche Energy Systems*

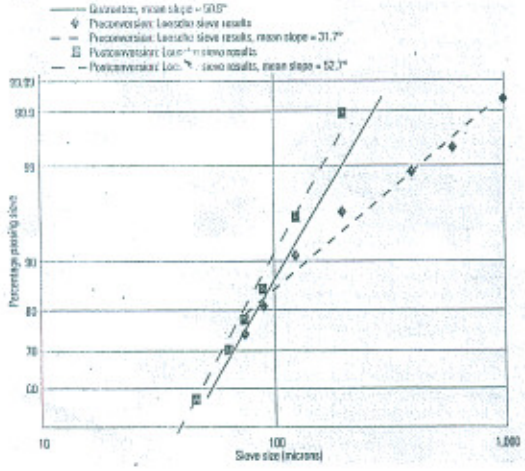
E.ON installed the dynamic classifiers as part of its plan to comply with the new European Large Combustion Plant Directive, which calls for reductions in emissions of NO_x, SO_2, and particulates by 2008 and beyond. Making the typical 35% reduction in a plant's NO_x levels (to 0.42 lb/mmBtu) that the directive requires would normally necessitate adding an SCR system and/or upgrading to LNBs – at considerable cost.

E.ON, however, chose to reduce the NO_x output of the Ratecliffe plant by adding an over fire air (OFA) system and dynamic classifiers. The utility took this approach mainly to ensure an acceptable level of UBC in the plant's fly ash, which is sold as filler to cement makers. But another reason was to reap the classifier's biggest benefit: more consistent coal particle sizing.

The first dynamic classifier was installed at Ratecliffe in July 2003 and six more followed in the summer of 2004. All of them had already passed their tests when the OFA system was installed.

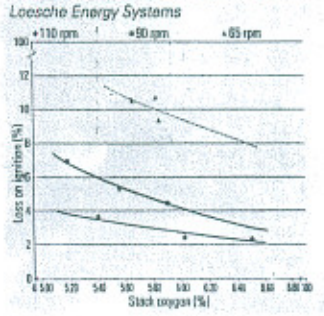
Pre-retrofit data indicated that with static classification, 75% of the pulverizers' output could pass through a 74-micron screen, and 97.5% of particles through a 300-micron screen **(Figure-2)**. After the dynamic classifier was installed, about the same percentage (78%) passed through the 74-micron screen, but far more (virtually all) particles could pass through the 300-micron mesh. In other words, all coarse (>300 micron) coal particles were removed

from the steam of coal fed to the boiler. The slopes of the pre and post-retrofit 31.7 degrees and 52.7 degrees, respectively.



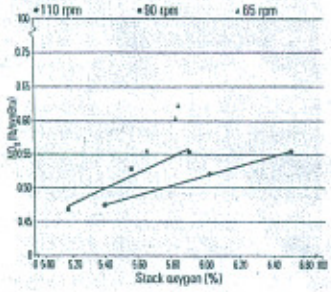
As dynamic classifiers were added in turn to the other pulverizers at Ratcliffe, it became possible to compare their effect on the individual performance of each of the plant's four identical 500-MW boilers. All had been upgraded with B&W UK's LNBs in the mid 1990. A 62% average reduction in UBC levels at normal excess-air levels **(Figure-3)** was noted during port-retrofit testing.

3. Reduced LOI. Plotted here are flyash loss-on-ignition levels (a measure of unburned carbon content) vs. stack O_2 levels at three different dynamic classifier speeds. The data were taken following the retrofit at Ratcliffe-on-Soar Power Station. *Source: Loesche Energy Systems*

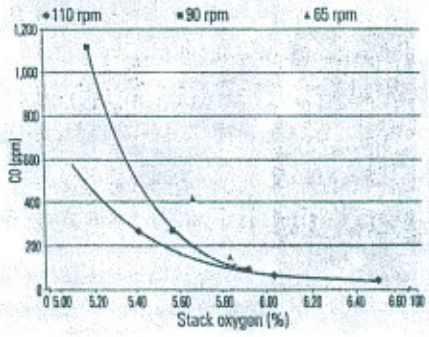


The retrofit's bigger payoff, however, was a 13% average reduction in the plant's NO_x emissions **(Figure-4)**. Testing also produced a plant CO emissions profile **(Figure 5)** that engineers could correlate with the NO_x and UBC profiles to fine-tune operations. For example, knowing that the plant could tolerate a slight increase in CO and UBC levels, the engineers could feel safe lowering the stack O_2 level by 1% or more, in order to further reduce NO_x emissions.

4. Par for the coarse. Eliminating large coal particles from the fuel mix also reduced NO_x emissions of the Ratcliffe plant. Shown are post-retrofit measured NO_x levels vs. stack O_2 levels at three different dynamic classifier speeds. *Source: Loesche Energy Systems*



5. Carbon-friendly. Levels of CO emissions also fell following the retrofit. They are plotted vs. stack oxygen levels at three dynamic classifier speeds. *Source: Loesche Energy Systems*



These results were from tests conducted after adding the dynamic classifiers but before installing the OFA system. Now that the OFA system is in place, the Ratcliffe plant can meet its 2008 NO_x emissions standard using only it and the LNBs at press time, dynamic classifiers had been retrofitted to three of the plant's four 500-MW boilers; the fourth is slated to be upgraded later this year.

Other interesting projects in which Loesche LSKS dynamic classifiers replaced static classifiers to improve pulverizer performance include the three that follow:-

Scholven Power Station in Geisenkirchen, Germany. Loesche dynamic classifiers were first retrofitted to the plant's EVT Model RP 903 pulverizers on a trial basis. Later, they were added to all pulverizers of the 2,300-MW E.ON plant.

Tilbury Power Station in the UK. In 2006, dynamic classifiers were retrofitted to the five MPS Model 180 pulverizers feeding the 300-MW front-wall-fired Foster Wheeler boiler of this RWE plant. Two similar units are scheduled to be similarly retrofitted this year. Results for the project's first phase are just in: a 50% reduction in UBC (enabling the unit's fly ash to be sold, rather than land filled) and a distinct improvement in particle fineness. Now, >99.8% of particles can pass through a 300-micron screen (vs 99% before), while 85% can pass through a 75-microns screen (vs. 70% before).

J.B. Sims Power Plant in Grand Haven, Mich. Dynamic Classifiers were retrofitted to three B&W Model EL56 ball mill pulverizers feeding an 83-MW B7W front wall-fired boiler. As at Tilbury Power Station, the upgrade improved particle fineness. Now, 98.8% of particles can pass through a 150-micron screen (vs 95% before), while 92.1% can pass through a 75-micron screen (vs. just 72% before).

Increasing Pulverizer Capacity

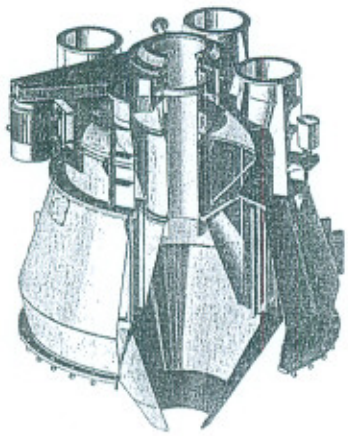
Dynamic Classifiers can increase the throughput of a pulverizer while maintaining the fineness of its output. Such retrofits make the most sense for units burning Powder River Basin coals, whose lower heat content and higher ash and moisture content require an increase in fuel flow to maintain unit rating. They also are applicable to units that blend high-heating value and PRB coals to maintain their output. Experience with vertical-shaft pulverizers used in the coal mining industry suggests that replacing a unit's static classifier with a dynamic classifier would increase its throughput by more than 30% and simultaneously increase coal fineness by 10%.

Dynamic classifiers can increase both fineness and capacity, but to a lesser extent than a system optimized to increase one or the other. Again experience with vertical-shaft pulverizers at coal mines suggests that capacity increases of 10% to 35% and increases in fineness of 25% to 50% are achievable.

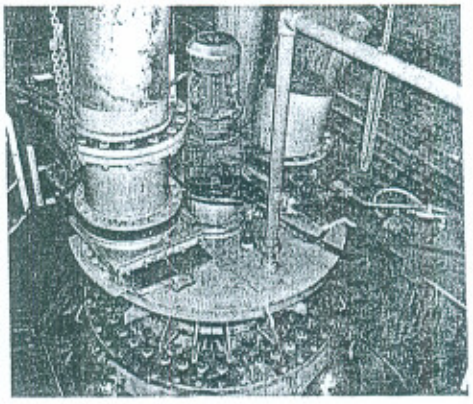
One Size Doesn't Fit All

A dynamic classifier is retrofitted to a vertical shaft pulverizer by installing a duplicate upper pulverizer casing that houses the classifier's fixed and rotating vanes, motor and drive connections. A typical dynamic classifier assembly has a centre coal feed pipe and several coal outlet pipes **(Figure-6)**. The rotor drive is mounted on the side of the casing and driven by a belt. If the coal feed is off-center, the drive can be directly coupled, as was the case at the J.B. Sims Power Plant in Michigan **(Figure-7)**.

6. Aftermarket leader. This is a typical LSKS dynamic classifier, with a central coal inlet pipe and four coal outlet pipes. *Courtesy: Loesche Energy Systems*

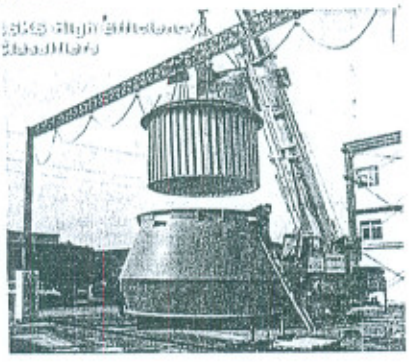


7. Nice installation. At the J.B. Sims Power Plant in Grand Haven, Mich., retrofitting each of three LSKS dynamic classifiers required mounting a direct drive for it in the center of the existing Model EL 56 pulverizer. *Courtesy: Loesche Energy Systems*



In most cases, dynamic classifiers can be installed as "slide-in" retrofits with little need to move existing equipment. **Figure-8** shows another type of dynamic classifier, with one inlet and outlet, favored by the cement industry.

8. Top of the mark. This large LSKS dynamic classifier with one inlet and one outlet is being assembled prior to delivery to a cement plant. *Courtesy: Loesche Energy Systems*



It should go without saying that gains in fineness, capacity, or both, depend on many factors, such as the type of coal, the brand of existing pulverizers, and the design of the overall fuel-handling system. Likewise, the costs of a retrofit are site-and unit-specific, not so much for "as found" equipment but as a result of fuel system or other unit modifications.

To get you in the ball park, consider the following basic cost analysis recently completed for one of our customers. Only the final results are shown:-

- Basis: 187-MW coal fired boiler with four pulverizers.
- Present vs. predicted UBC level: 30% vs 5%.
- Predicted NO_x reduction: 15%.

For this job, the break-even point for fuel savings alone is estimated at 2.4 years. The break-even on fuel savings plus NO_x credits is 1.6 years (which falls to 1.3 years if revenues from sales of fly ash with less UBC are factored in).

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