

# PRIORITY AREAS IN AUSTRALIAN GEOMECHANICS RESEARCH

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## ABSTRACT

This paper summarises the result of a review of priority areas in geomechanics in Australia, carried out by a sub-committee of the Australian Geomechanics Society. Three broad areas are defined:

1. Problematic Soils of Australia and the Pacific Rim
2. Mining Geomechanics
3. Environmental Geomechanics.

For each area, details are given of research objectives, current use of technology in Australia, potential benefits of the research, and the research and development potential. Some of the problems pervading geomechanics research are also outlined.

## INTRODUCTION

In 1990, the National Committee of the Australian Geomechanics Society (AGS) appointed a sub-committee to consider the question of priority areas in research in geomechanics. The objectives of this exercise were to provide some guidance both for applicants seeking research funding, and organisations or groups supplying this funding. Almost concurrently, the Institution of Engineers Australia embarked on a revision of the Engineering R & D Outlook Report produced in 1988-9. Consequently, the development of a reasoned list of research priorities by the AGS served a further purpose.

This paper summarises the results of the AGS sub-committee's deliberations. Three broad priority research areas have been defined:

1. problematic soils of Australia and the Pacific Rim
2. mining geomechanics
3. environmental geomechanics.

In each case, details are given of the problem and the research objectives, current use of the relevant technology in Australia, local trends in this technology, potential benefits of the research, and the research and development (R & D) potential.

Finally, some problems facing research in this country are discussed.

## 2. PROBLEMATIC SOILS OF AUSTRALIA AND THE PACIFIC RIM

### 2.1 Description and Objectives

There are number of problematic soil and rock types including expansive clays, collapsing soils, dispersive clays, calcareous sediments and soft rocks, in the countries comprising the western Pacific Rim. Many aspects of economic development involve significant geotechnical input and solution of engineering problems posed by these problematic soils, for example, damage to structures and roads caused by swelling and shrinking of expansive clays, erosion in earth dams due to deflocculation of dispersive soil, and low bearing capacity for offshore oil and gas platform foundations sited on calcareous sediments.

There is an urgent need to undertake research into:

- (i) the engineering behaviour of these problematic soils
- (ii) treatment to improve engineering properties of these soils
- (iii) effective methods of geotechnical and foundation design in these soils.

### 2.2 Current Uses of the Technology

In Australia, problematic soils are widely encountered in:

- (i) the construction industry (both domestic and industrial)
- (ii) transportation (roads, railway tracks)
- (iii) resource development via open-cut mines
- (iv) offshore oil and gas

### 2.3 Local Trends in Research

1. research in calcareous sediments, driven by problems with Bass Strait and NW Shelf platform.
2. research in expansive soils, driven by continuing problems with building foundations
3. research in soft rock technology, driven by the prevalence of these deposits in areas of economic significance.

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## 2.4 Potential Benefits of Research and Ability to Capture Benefits

Many facets of mining, civil and infrastructure development encountered difficulties with problematic soils. Delays and failures can cause substantial economic losses, estimated to be in excess of A\$250 million per annum. Technology and skills can be exported to other Pacific Rim countries with similar geotechnical problems. Potential damage, loss of life and environmental disaster (e.g from flooding caused by failures of dams constructed of dispersive soil) can be reduced substantially by appropriate research.

Australia has extensive research facilities within some of its Universities and the CSIRO Divisions of Soils and Geomechanics, and has a number of internationally respected research workers in the field. Linkages can be formed with the mining and resource industries, and also the construction industry, and through these, international markets for technology and skills can be developed.

## 2.5 Research and Development Potential

The research fields are fertile, in many instances still in a "primary" phase; current technology is almost 1/3 to 1/2 way up to "S curve". Required technological breakthroughs include:

1. better methods of identification and quantification of problematic soils.
2. suitable methods of mechanical and chemical treatment of these soils.
3. more reliable methods of geotechnical and foundation design incorporating modern geotechnical analysis techniques.

## 3. MINING GEOMECHANICS

### 3.1 Description and Objectives

Mining geomechanics involves the application of geotechnical engineering to the mining industry. This requires a wide range of technical expertise aimed at greatly improving the industry's international competitiveness and standing. Geotechnical engineering plays a crucial role in economic operations, safe working conditions and environmentally sound development, and is therefore a key factor in the above. As minerals and energy resources represent over 60% of Australia's total commodity exports, this should have a major influence on the country's economy.

Specific areas requiring R & D include the assessment of in-situ conditions; methods of modelling development; techniques for efficient construction and extraction (loosening, breaking and removal of material), methods of handling, trans-

portation and stockpiling of materials, including waste; stabilization of excavations left after extraction; environmental impact and control of developments.

### 3.2 Current Uses of the Technology

There are a large number of applications of mining geotechnics in Australia, including coal mining, basic metal mining, gold mining, general resource and energy mining, quarrying, road building and heavy civil construction industries (structures, tunnels, underground space and storage).

### 3.3 Local Trends in Research

- (i) Development of mechanised excavation; driven by need to reduce costs and increase productivity and production rates.
- (ii) Stabilization of stockpiles and waste dumps; driven by safety, environmental and cost-saving considerations.
- (iii) Stabilization of permanent and semi-permanent mining slopes; driven by safety, efficiency and economic considerations.

These all arise, at present, from problems experienced in existing industrial or mining operations for which better solutions are required for social approval of the continuing activity within Australia.

### 3.4 Potential Benefits of Research and Ability to Capture Benefits

As noted earlier, a high proportion of Australia's exports are mining oriented. Even minor improvements must have major influences on our economy. We are also very close to many developing countries which require these products. These same countries are also developing their own resources and may require ongoing technological advice, education and training services (in Australia or overseas), equipment and service backup. These comments apply to all forms of operation, and are particularly important with respect to environmental and safety considerations. We are in an ideal position because of proximity and experience with similar conditions. The potential benefits must be enormous, perhaps greater than any other industry.

Basically Australian mining technology is as good as any other country's, but, unlike some other nations (e.g USA), we seem to lack the ability to get this message across as much as we should. It would seem that there is insufficient marketing of these skills, at both national and international level. Another major problem is that while much of the initial development work takes place without too many problems, the important later and final stages often suffer from the lack of support at a local level.

### 3.5 Research and Development Potential

The potential for R & D in mining geomechanics within Australia is immense, principally because of our proximity to operations both here and in neighbouring countries and the small but very active group of people working in this area. Despite a relatively low national population, the technical output of this group has been recognised throughout the world. In general terms, we must be very close to lift-off on the "S" curve resulting in quite major developments for even relatively modest investment. The technological developments are many and varied. The risk must be very minor when considering the benefits and the investment required to bring the many aspects to market could be as variable as the range of aspects themselves. The product, i.e. the development of mining geomechanics to service our own and neighbouring countries' mining industry, could undoubtedly be produced in Australia.

## 4. ENVIRONMENTAL GEOMECHANICS

### 4.1 Description and Objectives

As is well known many environmental problems are associated with disposal of solid and liquid wastes from industrial and mining processes. Many of these problems are centred on the interaction of these wastes with the earth which is the field of environmental geomechanics.

Mine tailings technology can be taken as an example. These generally consist of fine-grained solids suspended in fluid which is often loaded with chemicals used in the mineral extraction processes. The storage and densification of the tailings and migration of the fluid and potential pollutants are areas requiring considerable research. Similar problems are experienced in many industrial operations, often in sensitive urban and near-urban environments.

Some areas that require immediate research are:

- Impact of chemicals on physical properties of clays.
- Contaminant flow and absorption in unsaturated soils.
- Contaminant wall design.
- Quantification of risks.
- Landfill design and behaviour.

It is suggested that suitable long-term objectives would include:

1. physical and hydraulic design of containment walls;
2. basic physico-chemical behaviour of soils, especially clays; and
3. the management, monitoring and assessment of subsurface pollution. The long-term objectives are generally driven by legislative and social concerns and the impact that these have on the economy of any particular operation.

### 4.2 Current Uses of the Technology

The technology is required in a wide range of primary and secondary industries, including:

1. Petrochemical
2. Manufacturing
3. Coal mining
4. Metalliferous mining
5. Transport
6. Construction.

### 4.3 Local Trends in Research

Among the research projects being undertaken are the following:

1. Pollution migration modelling by centrifuge and numerical methods.
2. Groundwater studies by field observation.
3. Tailings densification at laboratory and full scale.
4. Remote sensing of pollution.

### 4.4 Potential Benefits of Research and Ability to Capture Benefits

Virtually all areas of economic activity are now constrained, often to a large degree, by environmental considerations. These lead to our dominant export sector, mining, suffering reduced efficiency compared to overseas competitors. Many projects may well not proceed due to our inability to solve the environmental problems associated with development. There are similar problems with manufacturing and petrochemical industries, where environmental problems may effectively stop us from replacing imports with value-added local manufacture. Indeed the growth within Australia of the industries discussed above is almost certainly closely linked with solution of associated environmental problems.

The problems Australia faces now will be faced by many of our regional neighbours in due course and there is and will be a market for export of technological advice, education, training and equipment.

Overall the benefits are measured best by the fact that if we do not solve these problems then many areas of economic activity will be stifled.

As discussed earlier, research at present is totally market driven and thus the benefits are captured almost completely. The problem of course is that there is no long-term view and a future project will not, in general, fund current research. Research in environmental geomechanics will certainly be captured by industry, as even in a depressed economy there is a ready market in industry for postgraduate engineers with research degrees. In addition many Australian companies and consultants have the desire and ability to apply current and future research results in this area.

Freeing up mining and industrial activity while not compromising our environment will provide such large benefits that these will be captured by either industry or society. It is this sort of research that will enable us to compete internationally. The only limit to capturing benefits will be our society's inability to agree to technical solutions to environmental problems.

#### 4.5 Research and Development Potential

There appears to be substantial potential for the following reasons:

1. Currently relevant research fields are very fertile with most researchers being young academics or professionals.
2. Current technology must be about 15 to 25% of the way along the "S curve", thus providing relatively large returns for each unit of research input.
3. Current technology is about 50% of the way to its realisable potential.
4. This technology does not require any "break throughs" but continual and incremental development.
5. As the work is continual and incremental and realisation of benefits considerable, the risks are almost non-existent.
6. Once each element of research is complete, its application only requires appropriate industrial problems. Australia has many mining and industrial organisations and consultants able to effectively apply or implement the results of research in this field.

#### 5. PROBLEMS FACING AUSTRALIAN GEOTECHNICAL RESEARCH

The principal factor influencing Australia's ability to achieve the desired R & D capacity is lack of support (principally funding) by industry and government. There is also a major problem in attracting and keeping competent research personnel when other countries are offering so many more rewards, financially, in employment conditions in general, in opportunities, and a higher standing of engineers within the community. The potential is quite clearly there but the capacity seems limited by the inability of our political masters to see beyond the short-term gain. We require major and consistent investment for long-term development in the technology.

Other problems which may hinder research progress are:

1. the lack of a culture in inter-disciplinary research; all three major areas of research described herein require input from a group which goes well beyond the traditional geotechnical and geological members of the geomechanics community.
2. the general lack of will on the part of industry to support and commercialise research, and on the part of government to support international venturing comparable with that given by other governments to their nationals.
3. Often the difficulty in carrying out collaborative research among competent groups with common interests, primarily because of geographical distance, and the reluctance of funding bodies to provide significant travel expenses.
4. the low level of recognition of the importance of technical expertise and training as important national assets.

#### 6. CONCLUDING REMARKS

Three broad areas of geotechnical research have been identified as priority research areas: problematic soils of Australia and the Pacific Rim, mining geomechanics, and environmental geomechanics. Each area has substantial "payback" potential to Australian industry, and there are potentially large rewards for relatively modest outlays of research funding.

There are significant problems which tend to inhibit the development of geomechanics research, primarily in the lack of research funding support industry and government. Despite these problems, there are a number of positive factors in Australia, for example:

- (i) the presence of a pool of talented and competent professionals and researchers
- (ii) research groups with well-established links with major overseas research and industrial groups
- (iii) a somewhat unique set of geological, geotechnical and environmental conditions which have required the development of local solutions to local problems, where imported solutions have not been found to be effective.

It is to be hoped that such positive aspects will more than outweigh the negative factors, and that the Australian geomechanics community will pursue with vigour the research areas outlined herein.