

Dr. Ganuni Gunasekera MA - 252  
As requested per  
3/10

**REPORT OF A WORKSHOP ON ALTERNATIVES TO  
CORAL-BASED LIME FOR USE IN THE  
BUILDING INDUSTRY HELD ON  
28 OCTOBER 1997 AT THE  
NARESA AUDITORIUM**

**NATIONAL SCIENCE FOUNDATION**  
*47/5, Maitland Place*  
*Colombo 7.*

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## LIMESTONE RESOURCES

**Dr N.P. Wijayananda**

*Director, Geological Survey & Mines Bureau*

There are two sources of coral-based lime. They are coastal coral reefs and inland deposits of coral. We are concerned today with the mining and destruction of our coastal reefs as the mining of inland coral deposits is legal and controlled. However, such mining creates environmental problems in the form of pits that are not reclaimed once mining is completed. The demand for the supply of coral-based lime is greater than the supply. Reef coral is very slow-growing and cannot cope with demand as the pace of economic development increases. Hence, more economically viable resources should be identified in place of coral-based lime. We have to look for other suitable materials.

Limestone resources are sedimentary rocks containing calcium carbonate. Limestone forms a coastal belt running from Puttalam to the Jaffna Peninsula; the latter is entirely of limestone. Dolomite is the other resource that we have. It contains up to 22% MgO,  $[(Ca\ Mg\ (CO_3)_2]$ . Magnesite is  $MgCO_3$ . If the magnesium content of the dolomite is low, it can be burnt to make lime for buildings, and if high it can be used as fertilizer. The calcareous resources of Sri Lanka are shown in Tables 1, and 2.

**Table 1: Types of calcareous deposits found in Sri Lanka, their distribution and usage.**

Type	Distribution	Usage
Sedimentary Miocene Limestone	Puttalam to Jaffna	Used in the manufacture of cement
Coral reefs and inland coral deposits along the coast	Ambalangoda to Matara	For production of lime
Shell deposits	Tangalle to Bundala	Mainly as poultry feed because this is more lucrative. Less for the production of lime.
Calcite - (pure $CaCO_3$ )	Balangoda	Reserved for ceramic industry because of high quality
Deposits of crystalline dolomitic limestone (marble)	Matale, Dambulla, Badulla and Kandy Districts	As substitute for lime and as fertilizer

Table 2: Chemical Analyses of Calcareous Material

Constituents	Shell (Hungama) %	Coral (Akurala) %	Miocene (Puttalam) %	Dolomite %	Calcite %
SiO <sub>2</sub>	1.15	2.00	0.82	0.75	tr.
Al <sub>2</sub> O <sub>3</sub>	0.41	3.40	0.52	0.27	tr.
Fe <sub>2</sub> O <sub>3</sub>	0.33	0.50	0.08	0.05	--
CaO	54.89	51.50	54.20	31.05	55.23
MgO	0.02	--	0.70	21.78	--
Loss on Ignition (CO <sub>2</sub> )	43.15	42.70	43.68	46.10	43.83
Total	99.95	100.10	100.00	99.96	99.06

Source: Geological Survey Department

Economics is the main factor in using lime. It is too expensive to burn coral, transport it from southern areas to the up country. The furthest kilns burning coral are found in Warakapola. Dolomite lime is used in the up country.

Lime from Miocene limestone when used for colouring is not pure white. Existing resources are not accurately assessed. They have been calculated approximately.

#### MANUFACTURE OF DOLOMITE LIME AS AN ALTERNATIVE

**Dr M.G.M.U. Ismail**  
*Head, Materials Technology Division*  
*Industrial Technology Institute*

In Sri Lanka lime is mainly used for the building industry. But in Developed Countries, lime has found wide application in the chemical, construction, agricultural, ceramics and metallurgical industries. In the construction industry, lime is used as a soil stabilizer in the construction of highways. Dolomitic lime is used as a fertilizer as well.

For the building industry 75 000 tons of quicklime are produced per year. To obtain this quantity of quicklime, 150 000 tons of limestone have to be burnt, annually. Of the 75 000 tons of quicklime, the contribution from coral is 80% and dolomite only 20%. In addition to use in the building industry, 5000 tons of coral lime are used per year in the form of hydrated lime in water purification plants.

Why is lime used in mortar? A mixture of cement and sand cannot give the required plasticity for the mortar. The addition of lime gives plasticity and workability to the mortar. The other important characteristic of lime is that there is a saving in cement use by increasing the lime content in the mixture of sand and cement. By this means high water retentivity can be achieved by increased mixing of lime. This mixture can absorb stress in areas where earthquakes occur; it also increases bond strength and ease of retempering, reduces efflorescence, produces lighter coloured mortar and autogenous healing.

When one considers fineness, dolomitic lime is coarser than calcareous lime. Lime is also used as hydrated lime for water treatment. Dolomite with low magnesium content can also be used for this purpose. Hydrated dolomitic lime in the form of putty is used for white washing.

The following alternatives to coral-based lime are suggested:

1. Inland shell deposits - Available in limited quantities. Hungama and southwards. There were two factories some years ago to produce precipitated  $\text{CaCO}_3$ , and hydrated lime. They are not functioning now  
( $>98\% \text{CaCO}_3$ )
2. Calcite -  $\text{CaCO}_3$  - Available in limited quantities for use in the Ceramic Industry  
( $>99\% \text{CaCO}_3$ )
3. Miocene limestone - For cement manufacture  
( $> 95\% \text{CaCO}_3$ )
4. Dolomite - Exists in large quantities. Used as hydrated lime for the building industry and for fertilizer  
( $\text{CaCO}_3, \text{MgCO}_3$ )  
( $\text{CaCO}_3$  80-95%)

Hydrated dolomitic lime which is available in the market cannot be used for plastering as it is much coarser than the hydrated coral lime.

When the physical properties of mortar are considered, the setting time of both mortar using coral lime and dolomitic lime is similar, but soundness (the measure of the expansion) varies from 1.00 mm for cement paste to 0.5 mm for lime/cement paste. Hence, mixing with lime reduces expansion. Therefore it is important to use lime-based mortar for plastering.

The compressive strengths of mortar cubes made using cement / coral hydrated lime mixture is higher than the cement / dolomitic hydrated lime mixture. This is due to the fineness of coral hydrated lime compared to dolomitic hydrated lime. Similar strengths could be obtained by using dolomite hydrated lime of same fineness.

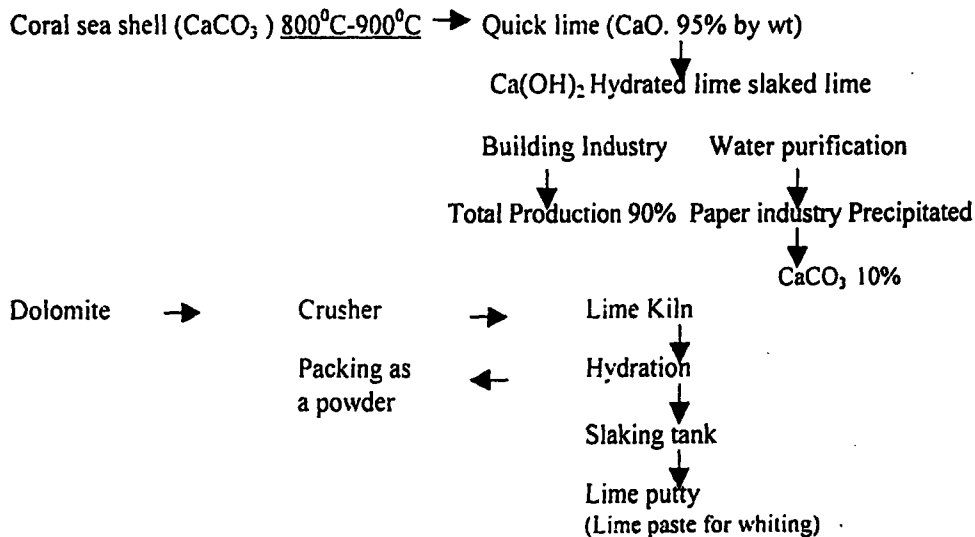
The ratio of the constituents of mortar is cement 1 : lime 1 : sand 5, by volume.

Comparison of properties of dolomite and coral lime.

- Burning -** As coral has only  $\text{CaCO}_3$ , it decomposes at one temperature whereas Dolomite, which contains both Ca and Mg carbonates, decomposes at different temperatures. Temperature control is required for production of quicklime which could be completely hydrated as coral quicklime.
- Slaking -** Slaking depends on baking characteristics of powder. Coral lime gives complete slaking. If dolomite is over burnt, slaking is very slow and results in unslaked  $\text{MgO}$ , which will change the properties and durability of mortar paste.

Workability and smoothness are the same if the particle size is similar. Strength, too, is similar if particle sizes are similar. The only problem with dolomite is the blistering of plaster if not fully hydrated.

**Process of manufacture**



The final yield as hydrated lime is very low in the case of dolomitic quicklime, compared to coral quicklime.

The Mineral impurities and compositions of dolomite vary from Matale to Digana. These will change the temperatures of decomposition.  $MgCO_3$  in dolomite decomposes at a lower temperature and sinters to give a compact structure when the temperature is raised till  $CaCO_3$  is decomposed. This prevents the penetration of water when hydrolysing, resulting in a non-hydrated fraction.

Problems to be solved with regard to dolomitic lime.

- (1) Over-burning of magnesium is a problem.
- (2) Difficulties in hydration need to be addressed.
- (3) Yield is low compared with coral lime, i.e., roughly about 50% of yield compared with coral lime.

This needs to be studied.

In conclusion, the quality of dolomitic hydrated lime available in the market is very poor. In order to get a better yield it is necessary to adopt better calcination methods and a viable hydration method. The correct particle size and control of temperatures are also necessary to obtain higher yields.

## CHEMICAL ALTERNATIVES TO LIME

**Mr K. Manchanayake**  
*General Manager*  
*Building Materials Corporation Limited*

The best way to reduce coral harvesting is by finding ways and means of reducing the demand for coral lime. Coral-based lime is extensively used in the construction industry as an essential ingredient in the plastering mix, i.e., cement, sand, lime. But there are chemical alternatives to this lime in the plastering mix.

In 1984 / 85 the Building Materials Corporation introduced one such chemical to the market. It was used by a few leading contractors e.g., U.N. Gunasekera and Nawaloka.

This liquid admixture contains salt of vinsol resin, which costs Rs. 85/- per litre today, and a litre of this chemical can replace 100 kg of lime in the plastering mix; this is 1/10 the price of the lime. This chemical is available at Finco Ltd, and it is called 'Fabmix plus'. It is advisable to bring this to the notice of all the vocational

training institutions in the country and so expose new craftsmen to the potential use of this product and encourage them to use this alternative.

## USE OF LIME IN THE CONSTRUCTION INDUSTRY

**Mr. P.W. Wickramasekera**  
*Director/Advisory Services*  
*Institute for Construction, Training and Development*

Applications of coral lime in the building industry are for plastering, white washing, putty and mortars.

Coral mining is prohibited by the Coast Conservation Act No 57 of 1981. For any mining of minerals a permit should be obtained from the Geological Survey and Mines Bureau, Dehiwala.

Prices of Lime (per ton) in 1997

Dolomite Lime	Rs 2500-3500	(Digana & Matale areas)
Coral Lime	Rs 5000-6000	(Colombo District)

In 1990 the cost of coral-based lime was Rs 2500 per ton. It has now risen to Rs. 6000. Hence there has been an increase of over 150% in the price of coral-based lime over the past seven years.

Input of lime to the construction industry (monetary value)

	Lime %	Cement %	Others %
Housing	1.28	8.81	89.91
Non-residential	1.51	7.84	90.65
Civil works	0.10	6.63	93.27
All buildings	1.35	8.50	90.15
All constructions	0.85	7.74	91.41

In 1997 Rs. 65 billion has been spent on the construction industry, of which Rs 0.85 was on lime.

The growth of the construction industry can be measured by the amount of cement consumption in Sri Lanka. In 1980 it was 7 000 000 metric tons but in 1996 it was 180 000 000 metric tons. The amount of lime used in the construction industry was about 135 000-145 000 tons per year. The demand for lime increases about 10 000 to 15 000 tons per year.

**Alternatives for coral lime for plastering**

- \* Lime from dolomitic limestone
- \* Lime from Miocene limestone
- \* Chemical air-entraining agents (mortar plasticisers)
- \* Masonry cement

**Alternatives for coral lime in white washing and putty**

- \* Lime from dolomitic limestone
- \* Lime from Miocene limestone
- \* Wall fillers and putty

**Dolomitic Lime**

- \* 40-50% cheaper than coral lime.
- \* Transportation is expensive to main cities.
- \* Quality-wise is sub-standard to coral lime.
  - \* off white in colour.
  - \* less plastic.
  - \* blistering may occur.
- \* Produced as a cottage industry.
- \* Resources are scattered but sufficiently large.
- \* Quality varies from source to source.
- \* Needs improved technology for efficient production.
- \* Need to study the feasibility of a large production plant against several small plants.

**Miocene Lime**

- \* A preferred alternative for lime production.
- \* May be cheaper than coral lime.
- \* Resources are sufficiently large.
- \* Need to study the possibility of using existing cement-manufacturing plants to produce lime
- \* Need to study the feasibility of a large production plant against several small plants

**Masonry cement**

This is produced by grinding a mixture of Portland cement clinker and gypsum with limestone and air-entraining plasticizer in suitable proportions to a fineness greater than that of ordinary Portland cement.

This produces a strong yet workable mortar when mixed with fine aggregate, and is considered better than lime mortar, lime cement mortar or cement mortar.

The use of masonry cement not only improves the quality of masonry mortar but also meets the need to increase the production of cement by better utilization of available resources in the country.

#### **Chemical Air-Entraining Agents (Mortar Plasticisers)**

- \* About 15-20% cheaper when the lime in 1:1:6 mixture is replaced with mortar Plasticisers.
- \* Imported material.
- \* Safe for use.

#### **Chemical Wall fillers**

- \* Very expensive
- \* Imported material
- \* Safe for use

#### **Conclusions**

- \* Immediate replacement for coral lime would be dolomitic lime.
- \* Presently dolomitic and Miocene lime are cheaper than coral lime.
- \* Mortar plasticisers are effective replacements for the lime components in plasters.
- \* Masonry cement is an effective replacement for the lime components in plasters, if introduced to market, with adequate publicity and prevention of misuse. Use a different name
- \* Pilot studies are required to use Miocene limestone for lime production.

#### **Recommendations**

- \* Market acceptance of dolomitic lime must be improved by improving availability and by promotion.
- \* Quality issues related to dolomitic lime should be dealt with scientifically.
- \* Production technology should be improved by special research efforts.
- \* Use of mortar plasticisers should be promoted.
- \* Masonry cement should be reintroduced to the market, with adequate means of identification as different from cement. New name should be used.
- \* Pilot studies are required to use Miocene limestone for lime production.

## ENVIRONMENT COSTS OF CORAL BASED LIME

**Mr. P. Steel**  
*Senior Manager*  
*Development Options (Private) Limited*

The damage caused to environment resources and to environment must be assigned values. Evaluating damage to environmental resources is part of Environmental Economics.

According to the Coast Conservation Dept. (CCD) data, 1500 people were directly engaged in coral mining, collecting and transporting in 1994, and their monthly income was Rs. 2000/- per person during a four-month season.

According to the same source, 20 000 tons of coral (80% inland and 20% sea) had been mined in 1994. This figure may be a little out dated when compared with the figures outlined by the other speakers. About 800 people are involved in inland coral-deposit mining.

Coral mining is one of the major causes for loss of coral reefs. Other causes which contribute to loss of coral reefs are siltation from river discharge, destructive fishing methods, boat anchorages etc. Even if coral mining is stopped tomorrow, there will be other causes which affect the environment.

### **Economic costs of the loss of the corals**

#### **\* Increased sea erosion**

According to the CCD coastal zone management plan, the erosion measured in the

Galle District is	0.3 - 0.4 metre /year and
Matara District is	0.9 - 1 metre/year

Erosion is severe along the south-western coast especially in the Galle and Matara Districts.

Cost of protection can be both for short-term protection by building of revetments, which works out to Rs. 30 000-40 000 per linear metre, and long-term protection with sand nourishment costing Rs 250-450 per square metre. It has been estimated that sand nourishment of 8 km at Hikkaduwa requires Rs 280 million, and 4 km of Galle North require Rs 85 million.

If coral mining is responsible, only 10% of the cost of damage is due to erosion, i.e., Rs 36 million. This underlines the significance of loss of coral cover when considering costs of loss due to erosion.

\* **Loss of fishery habitats**

Coral reefs support and protect ornamental fish. This is a large export industry. Further, they form feeding ground for a large variety of fish.

Export revenue in 1995 (assuming 50% ornamental fish was from marine sources) was valued at Rs. 300 million.

The average export price for ornamental fish exported to a European State was Rs. 1000 per fish.

The value of coral reefs in terms of providing the sustainable ornamental fishery for export of fish is Rs 200 million.

\* **Tourism and recreation**

Cost of an average dive is Rs 2500/- per hire. Cost of snorkel on the beach is Rs 50 per hire

There are two diving companies and five tour companies offering diving facilities. Income from 1000 dives per year is Rs 25 million.

In conclusion, the environmental costs given below are very rough estimates.

**Erosion : Rs. 38 million in two key sites.**

**Value of ornamental fishery: Rs. 200 million**

**Value of diving opportunity: Rs. 25 million**

But they indicate

- \* Environmental costs by losing corals are likely to be large.
- \* These costs are reflected in various ways. There is a cost factor for conflicts at Hikkaduwa between coral miners, ornamental fishermen and divers. These costs impinge on the life of people.
- \* Environmental costs can be used to justify government spending and provision of subsidy to develop alternatives. If dolomite is to be improved as an alternative, a subsidy for transportation can be given, recognizing

environmental costs due to damage of coral reefs. Loss of ecological value has a significance on the economical value. It is justifiable for the government providing transport cost, or any other subsidy for transportation of dolomite.

- \* Inland coral mining is also not harmless. It affects the water table, encourages breeding of mosquitoes and loss of land due to pits left open after mining.

### DISCUSSION

In the course of the workshop, the problem of coral mining was considered from a number of different aspects. The participants were brought together to present their views on "How solutions can be found" and "What processes can be adopted?". A number of actions were proposed for funding, research and development, and for implementation. We have arrived at some consensus on who should take responsibility for some of these actions.

There was general agreement that if the demand for lime is reduced by introducing alternatives, mining can be stopped. Current practice of reef-coral mining must be stopped, without delay.

Considering dolomitic lime the main problem that was identified is particle size. The other problem is the magnesium content. If these two problems can be solved, dolomitic lime will become a viable alternative. Steps must be taken to address these two problems. The problem of transport costs is solvable. It was pointed out that the State Engineering Corporation had a plant in Matale, but they were unable to use correct temperature levels to achieve burning off of magnesium. Masons did not accept the product because of impurities. The grinding process has to achieve a certain degree of fineness to give the product plasticity and strength. Masons are reluctant to use dolomitic lime now in the market as it does not give them the essential properties of plasticity and strength. Dolomitic marble contains 10% impurities as silicates.

- (1) **One of the priorities is to develop a technology** which can be used easily by small, as well as large operators. Once a technology is developed, guidelines should be given to the industrialists and they should be encouraged to take up production of good quality dolomitic lime. CISIR or any other appropriate organization should develop the required technology within two years and carry it through the laboratory and pilot project phases, and transfer the technology to the manufacturers.

When the above process is complete, active promotion of dolomitic lime is required. At that stage, all State Sector Building projects should be directed to use dolomitic lime. In this way the demand for coral based lime can be reduced, and coral mining can be banned completely.

Dr Ismail observed that the following should be considered as essential for success:-

Packing:-Space for the correct size of the dolomitic lime and for CO<sub>2</sub> and fire  
 Select the size of the kiln  
 Time factor  
 Temperature  
 Control of correct particle size before hydration

Dolomitic lime from Digana is different from that of Matale. There is a variation in the proportions of silicate impurities present, i.e., mica, pyroxene, forsterite, apatite. Hence there are differences in the processing temperature. Decomposition temperature of dolomite is found to vary from 800°C at Digana to 890°C at Matale.

Hence, the immediate need is to find a methodology for the production of lime independent of such factors as amount of impurities, particle size, grinding etc.

At present, the cost of burning dolomitic lime is high, and this has to be minimized. Additionally, the method of burning should be environment-friendly. For instance, IDB is operating a kiln and coconut trunks are used as fuel wood. If this is to continue it will lead to another disaster. "Kothela himbutu", a medicinal plant, is used by the State Engineering Corporation, and according to the SEC, this plant gives more efficient burning and the product is of higher quality. However, Dr Ismail stated that the scientific basis of burning is not understood.

Dr Wijayananda stated that the technology used in the dolomitic lime industry at present, is outdated. Three factories were closed down as there were complaints and protests on environmental grounds. Blasting affects the environment. Therefore, location of the industry should be moved away from crowded areas. The technology, too, should be updated.

Dr Bogahawatte (NBRO) said that the use of lime is widespread. According to him, the key factors in processing the lime are –

\* Method of calcination.

- \* Hydration.
- \* Raw-material selection,
- \* Process control

The process is somewhat different from that used in burning coral for lime. An overall effort should be directed at :

- \* Educating the people in the lime-making industry
- \* Developing a lime-burning kiln as a cottage industry. Set up a pilot plant by CISIR or relevant agency with improved burning and with improved hydration. The pilot plant could be located in the central part of the country. Government could adopt it later for large-scale production and the process could be implemented even in the other parts of the country, as well.
- \* Kilns should be re-designed and a method of burning should be developed so as to ensure burning to adequate levels.

- (2) As a short-term measure, he said that pozzolonic material should be imported. Masonry cement should be produced. The conventional way of producing masonry cement was by intergrinding cement clinker with limestone and an air-entraining agent. But the modern approaches are to use a pozzolonic material (waste material) to produce masonry cement.

Imported pozzolonic material will cost less.

Dr Priyan Dias said that the practice of using masonry cement to adulterate Portland cement, which happened in the past, must be prevented. The original attempt at using masonry cement failed because of this. Masonry cement could be re-introduced with proper safeguards.

- (3) Chemical additives

Lime is used for white washing, plastering and putty. It is necessary to know what in what processes lime can be substituted for by chemical additives. Workability and cost factors are important considerations.

Problems in the use of masonry cement are mainly sociological. Using bags of a different colour from that of cement bags, and naming it as "masonry lime mixture" rather than "cement", or using smaller bags were suggested by Prof. Abeywickrama. Cement Manufacturers could produce masonry cement with a pigment added.

The organizations which are to be involved in examining the question of masonry cement are.

CISIR - Dr M.G.M.N. Ismail  
IDB -  
NBRO - Dr V.T.L. Bogahawatta  
BMC - Mr K. Manchanayake

These organizations would convene group discussions through NARESA.

A consensus view should emerge paying attention also to environmental costs.

The Construction Industry uses 60-65% lime for production, for construction purposes including plastering, putty and white washing. If the quality of bricks can be improved, lime use can be limited to plastering only.

It was agreed that economic aspects play a more important role than technical problems in this matter. Different groups had been brought together and there was bound to be conflicting views and some entrenched ideas. The information base may not always be accurate.

The main issues considered were the use of dolomite, masonry cement, Miocene limestone, better quality bricks, chemical additives, and panelling for walls. Each of these should be examined from technical, environmental, and economic view points.

#### 1. Dolomitic Marble

- 1.1 The technology in use is more than two decades old and needs review. CISIR is already engaged in a project related to this matter. The project should be expanded with the goal of developing an appropriate technology. Once that is achieved, it should be popularized with the industry and the end users.
- 1.2 Survey of dolomitic marble deposits : A rapid survey system must be developed to determine the quality of dolomitic marble deposits at various locations and the extents of such deposits should be determined.

CISIR should proceed from the laboratory phase to pilot testing in the field and recommend the technology and methodology that should be used.

- 1.3 Can the dolomitic marble now available be used?
- 1.4 Should the industry be large or small? How large are the deposits and where are they located?
- 1.5 What organizations should be involved in developing dolomitic marble for lime production. CISIR (lead agency), IDB, NBRO, GSMB. Representatives from these agencies should decide on a programme of action. It should be goal oriented, and time limited, with a budget.

Economic considerations should be built into all the above questions. It is necessary that accurate, authoritative information be provided to the government for use as the basis for policy and decision making. Scientists should be able to present a consensus view, highlighting benefits, drawbacks, environmental costs and economic costs.

## 2. **Masonry cement**

The problem here is mainly sociological. The uninformed "end user" should be told what it can be used for and what it should not be used for. The cement industry should be requested to recommence production. Sharp practices should be prevented, using pigments, changing names and bagging methods. Masonry cement could be subsidized, until it gains general public acceptance.

## 3. **Miocene lime**

The first step is to determine its relevant characteristics and how best this can be used.

NBRO (lead agency) + CISIR were identified.

## 4. **Better bricks**

Use of Wire cut bricks - BMC was requested to look into the economics of using these vis-a-vis lime and cement use.

**(4) Chemicals**

Report on the use of the chemicals.

Admixtures for different usages, i.e., super plasters, retarders and accelerators, plasticizers, improve the properties of plasters. CISIR was requested to get the chemicals tested and see whether lime can be replaced by them. One should be careful to see that our countries are not dumping sites for chemicals which are prohibited in countries of origin. The history of the chemicals should be known. Chemicals which are accepted by the countries of origin can be used. "Febmix Plus" one of the admixtures originated by Feb in UK, conforms to BS and ASTM standards. The representative from Finco Limited said that free samples can be given for testing.

It was suggested that guidelines for "end users" should be prepared by ICTAD.

Indigenous material can be used as cladding until alternatives are introduced. Practicality of using lime only for surface wash during the interim period was discussed. A directive should go to all the government building contractors that these material should be used accordingly. When this is popularized, dealers would also start popularizing the product and the market will grow.

Dr Arulpragasam said the coral reef has a value which had not been accounted for in the presentation by Mr Steel. The Coral reef is one of the most productive ecosystems in the tropical waters of the world. It supports not only ornamental fish but is also a feeding and breeding ground for many other organisms. Total value far exceeds than that presented.

In conclusion Dr Arulpragasam welcomed further ideas and information on the subject from the participants present.

The Organizations represented:

SLSI, NBRO, Puttalam Cement Ltd., University of Moratuwa, IDB, CISIR, CCD, Geological Survey and Mines Bureau, BMC, Finco Ltd., ICTAD, Department of Buildings, Kandy Fertilizers and Digana Dolomitic Industries.