Re-inforcing Cement Concrete Steel

by A N M Mahfuzar Rahman and M A Sattar

IN Bangladesh more than 250,000 tons of re-inforcing cement concrete (RCC) steels, commonly known as Mild Steel Rods (M S Rods) are consumed annually. These M S Rods are used in the construction of buildings, bridges, roads etc as a re-inforcing materials in cement concrete. Thus it is essential to have specific characteristics of different grades of M S Rods used depending on applications and structural design. Besides reinforcement in concrete works, M S Rods are extensively used for fabrication works like grills, guys, furniture, fencing, miscellaneous engineering works etc.

Raw Materials

M S Rods are produce by hot-re-rolling of steel billets and steel scraps in 200 re-rolling mills, of the country located at various places. The main source of steel billet in Bangladesh is Chittagong Steel Mills Ltd which supplies around 100,000 tons of billet of different grades per annum. Besides, about three dozen small steel plants comprising electric arc and induction furnaces of capacities raining from a few hundred kilogrammes to six tons per batch having annual capacity of around 1,00 — 10,000 tons each are in operation. One of the plants has modern facilities comprising continuous casting and oxygen generation. The estimated total billet production capacity of these plants is about 300,000 tons per annum. A considerable quantity of billet is imported depending on market situation. Besides billets, steel scraps are also used as raw materials for producing M S Rods.

There are various sources of steel scraps such as home or revert scrap or return scrap, industrial or prompt scrap and obsolete scrap. Home or revert scrap or return scrap is generated by steel mills during the process of steel making and rolling. Industrial or prompt scrap is generated by metal working industries. Obsolete scrap is generated by the use of iron and steel products which become available for recycling once their usefulness is past. Discarded rail track, equipment, demolished structures and old ships are source of these obsolete scraps. M S Rods produced from ship-breaking scraps occupy around 50% of the market share of the total M S Rods consumed in the country.

Chemical Compositions

Steel billets re sold on the basis of chemical composition comprising mostly the content of carbon, mananas, phosphorus and sulphur. M S Rods manufacturers indicate or choose the chemical composition while purchasing billets based on the desired mechanical properties of end products in the form of M S Rods. The engineers designbuildings and other structures on the basis of these mechanical properties. Besides mechanical properties, carbon content limit is specified by some national or international standard where welding characteristic is desired.

International standards of M S Rods are formulated by Geneva based International Standard Organisation (ISO) and updated regularly. All the developed countries and many of the developing countries have got national standard in respect of M S Rods. In Bangladesh, designers are mostly familiar with British standard (BS), Japanese Industrial Standard (JIS), American Society for Testing and Materials (ASTM) Standard while the designers are yet to be familiar with Bangladesh Standard (BDSI) though Bangladesh Standards and Testing Institution (BSTI) adopted Pakistani Standard long ago.

British Standard for hot-rolled bars, for the reinforcement of concrete specifics chemical composition is, 025% Carbon maximum, 0.06% Sulphur and Phosphorus maximum each. ASTM steel bars for concrete reinforcement specifies — only the Phosphorus of 0.05% maximum. JIS specifies bars for concrete reinforcement with a maximum of 0.05% Sulphur and 0.05% Phosphorus for grades having yield point 30 kg per square millimetre minimum while for other grades of higher yield point up to 0.32% Carbon maximum, 1.80% Manganese maximum, 0.05% Sulphur and 0.05% Phosphorus maximum, each. W German Standard restricts the limit of silicon up to 0.6o% Max only.

Mechanical Properties

The design criteria of RCC structures in respect of M S Rods diameter and spacing are based on mechanical properties. British standard specifies 25 kg per square millimetre yield point for mild steel and 41 kg per square millimetre for high yield steel rods while the tensile strength shall be at least 15% greater than the actual yield point. ASTM specifies three grades of M S Rods of yield point 40,000, 60,000 and 75,000 pounds per square inch minimum (PSI) and ultimate tensile strength of 70,000 90,000 and 100,000 pounds per square inch minimum respectively. JIS specifies five grades of yield point 24,30,35,40 and 50 kg per sq.millimetre minimum having ultimate tensile strength of 39-53, 49-63, 50 minimum, 57 minimum and 63 kg per square millimetre minimum respectively. W German standard for reinforcing steel specifies yield points of 22 and 42 kgf with tensile strengths of 34 and 50 kgf per square mm minimum respectively.

Besides, percentage elongation of different grades of M S Rods are specified in all the standards and this percentage elongation is specified at 5-12 per cent minimum in 200 mm gauge length in case of ASTM M S Bars for reinforcement concrete depending on diameter and grade. In case of JIS, M S Rod for concrete reinforcement, percentage elongation on 50 mm gauge length varies from a minimum of 14% to a minimum of 24% depending on the grade of M S Rods.

Bend Tests are also conducted to ascertain the bendability required during the actual use of M S Rods. Test samples are subjected to bending angles of 90 or 180 degree depending on standards.

Fatigue tests are also conducted to ascertain the fatigue properties of steel. A steel structure may fail at a lower load when subjected to alternate tension and compression load compared to ultimated test load. Thus it is imperative to consider this factor while designing bridges and other similar structures.

Testing Machine

Normally, Universal Testing Machine is used to ascertain the mechanical properties and this testing machine is to be calibrated for accuracy and sensitivity at regular intervals through standard calibration devices like proving Ring, Dynamometer etc. These standard calibration devices are, again, to be checked and calibrated at approved National Physical Laboratories or similar recognised institutions. In the absence of a National Physical Laboratory in Bangladesh, it is imperative for all Institutions and Testing Laboratories engaged in ascertaining mechanical properties of M S Rods, to arranged calibration of their proving rings or dynamometers from Nations Physical Laboratory, New Delhi or elsewhere. In the even the Bangladesh Standards and Testing Institution (BSTI), the central body for standardization, arrange calibration of a set of Proving Ring, Dynamometer or similar other devices from recognised institutions, all the Testing Machines in the country can be recalibrated with these calibrating devices of BSTI. It may be worth-while to mention that Universal Testing Machine of Chittagong Steel Mills Ltd is calibrated regularly by the Dynamometer calibrated at Nation Physical Laboratory, New Delhi at regular interval and this is a requirement for testing and certification of steel materials for ship building purposes according to Lloyds of London.

Types of M S Rods

M S Rods are normally available in the form of Plain, Deformed, Cold Twisted Deformed and prestressed. A type of concrete reinforcing threaded bar called Sumineji bars has been recently innovated in Japan by Sumitomo Metals.

In Bangladesh most of the M S Rods used for reinforced concrete are plain rods while projects for construction works involving foreign consultants, deformed M S Bars are used. Cold Twisted deformed bars, known Tor Steel or Tor Bar are rarely used though commercial production of this type of bars started a few years back in a few industries of the country.

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It is worthwhile to mention that plain M S Rods are replaced by Deformed Bars in developed countries as these Deformed Bars have higher bond strength with cement compared to plain bars. In case of deformed cold twisted bars, the M S Rod requirement will be at least 20% less compared to plain and deformed bars rolled from the same steel, since the mechanical properties are much higher. In the cold working process, torsion increases both the tensile and compressive characteristics of steel.

The Newly developed Sumineji Bar is a high strength, fully threaded concrete reinforcing bar which is given its threaded surface by means of hotrolling. The great advantage is that the bars can be connected readily by using couplers that fit the bars threading. The spaces between the threads of the bars and those of the coupler are normally filled with epoxy resins.

Chittagong Steel Mills produce various grades of steel billets and M S Rods rolled from these billets conform to standard specification of ASTM, BS, BDSI and JIS. Selling price of billet varies with the grade of steel. Most of the private steel makers do not possess adequate quality control facilities.

Prestressed Concrete Steel

Steel bars for prestressed concrete are manufactured from hot rolling of steel billets followed by stretching or drawing of rolled products in the cold condition. According to JIS, chemical composition restricts the limits of impurities like phosphorus).030% max while the mechanical properties specify yield point, tensile strength, elongation etc. The yield point ranges from 80 kg per square mm to 130 kg per square mm and the tensile strength varies from 95 kg per square mm to 145 kg per square mm depending on grades of prestressed concrete steel bars.

Steel Rolling

The Mechanical properties of M S Rods vary depending on the size of M S Rods produced. Higher mechanical properties are obtained in case of flower diameter M S Rods compared to higher diameter MS Rod produced from the same quality of steel billets in the same re-rolling mill under the same hot rolling conditions M S Rods produced from same billet having different finishing temperature will have different mechanical properties. Thus M S Rods of the same size produced from the same billet will have different mechanical properties. Normally M S Rods are allowed to cool in the Rolling Mill compound after hot rolling and this natural cooling can be accelerated by artificial cooling through spraying of a controlled quantity of water.

Selection of the Test Samples

To ascertain the design criteria in respect of M S Rod size and spacing mechanical test are to be conducted from a re-presentative lot and rod diameters are to be checked thoroughly. ASTM standard specifies that samples of MS Rod of a particular size produced in one continuous shift of 8-hour operation from every batch of billet is to be tested. British standard specifies to test samples from every lot of atleast 25 MT, 35 MT or 45 MT for nominal sizes under 10 mm, 10-16 mm or over 16 mm respectively and similar is the provision according to JIS. But regarding M S Rods produced from steel scraps, JIS specifies that samples from every lot of three tons should be tested.

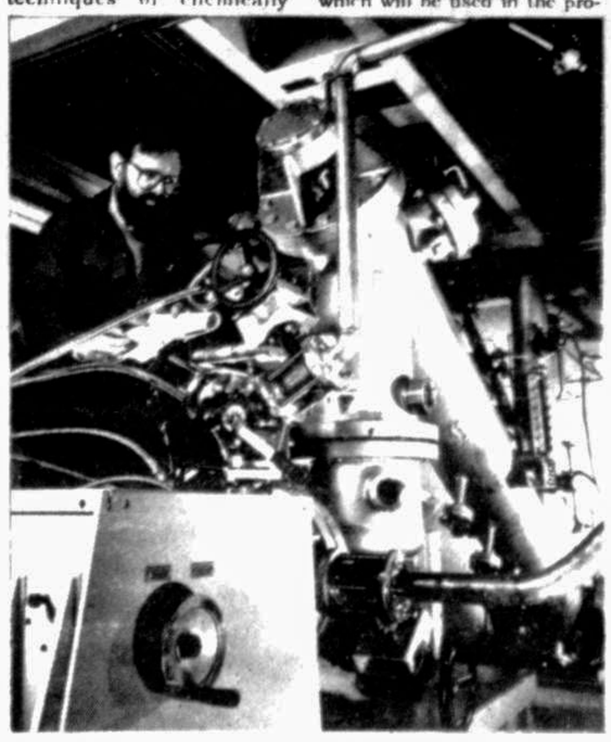
M S Rods produced from billet, ship-breaking scrap or other scraps can be used for reinforced concrete works provided these M S Rods meet the design criteria, alternatively, design is to be based on test data alone and not on theoretical characteristics of steel. It must be mentioned that failure of a re-inforced concrete structure may occur not only due to sub-standard M S Rods but also due to poor quality of cement, adulterated cement, poor workmanship, inappropriate curing, sand-cement mixing ratio, poor quality of aggregate materials or improper design. Calibration of Testing Machines at regular interval by re-calibrated or new proving Rings or Dynamometer etc is of utmost importance for ascertaining the correct and appropriate design criteria.

Natural Composites Can Replace Plastics

PLANT fibres such as those from flax, wood and cotton could soon be used as replacements for conventional reinforced plastics and lead to the creation of a new high value crop for farmers.

These new environmentally "friendly" composite materials are likely to emerge as a result of a research project into techniques of chemically modifying plant fibres. As well as lightness and low cost, their advantages would include low energy content and relative ease of disposal.

Here Dr James Bolton, who heads the project at the BioComposites Centre at the University College of North Wales in Bangor, is shown making adjustments to a unique pilot scale refiner which will be used in the process. The refiner operates at double the working pressures found on industrial installations.



Plant fibres such as those from flax, wood and cotton have strength characteristics comparable with those of glass and carbon fibre, but being inherently water-reactive they absorb water and swell in the presence of moisture.

Dr Bolton and colleagues have developed a patented process which enables such fibres to be treated to prevent this, and to be readily bonded and moulded under pressure to form a wide range of products.

This project is likely to lead to a new generation of stable, high performance biocomposites for use, initially, in the replacement of conventional reinforced plastic interior panels and fittings in the automotive and acrospace industries. Future developments may include products for all weather use.

While early research has involved only small batches of materials, the new centre has a scaled-up pilot plant for continuous production which will make biocomposites under conditions close to those in commercial manufacturing.

One advantage of the project is that the fibres will represent a readily renewable resource offering farmers an alternative high value crop, enabling much low-value agricultural produce to be upgraded, and providing scope for the rise of a new type of rural industry. — IPS

Microlaser Project: Breaking New Ground

WITH the recent development of a solid-state microlaser by MBB, German researchers have reached a turning point in microsystems technology. The main goal of microsystems technology (MST) is to integrate microelectronic, micromechanical and micro-optical functions in complex, highly miniaturised systems on a single silicon chip.

The first two steps — integrating microelectronic and micromechanical functions— have been realised thanks to production methods borrowed from semiconductor technology. Integrating microoptical functions, however, is still in its infancy.

MBB in Germany has now reached a turning point in integrating the three technologies on a single chip with the design of a solid-state laser. The long term objective of MBB's corporate engineering division is to implement a microsystems technology laser in which mechanical, thermal, optical and electronic systems interact on a minute scale.

The development of the microlaser will involves several stages. In the first stage, which MBB has already reached, semiconductor laser diodes are used in place of discharge lamps as the exacter for a solid-state laser.

In the second stage, which has also been initiated, packaging and assembling engineering techniques from the field of hybrid electronics will be applied to significantly reduce the size of the laser. In the planned third stage, the manufacturing methods developed in microelectronics are to be used to integrate a laser on a silicon chip.

A laser beam is created by repeatedly reflecting light through the amplifying medium between two parallel mirrors. The beam forms along the resonator's optical axis. Since one of the mirrors is partially transparent, part of the radiation leaves the device as a beam of coherent light.

Laser is an acronym for light amplification by stimulated emission of radiation. Today, the variety of materials which may be used as lasing media is very extensive.

Laser light can be generated not only with various gases, solids and semiconductors, but also with certain liquid dyes and even with free electrons modulated by periodic magnetic field (the free-electron laser).

The means of excitation varies from one medium to another. In addition to light and electrical current, chemical reactions can also stimulate laser emission. Fundamentally, however, the process is always the same: light is amplified by stimulated emission.

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Every laser emits highly ordered energy, with wavelengths in all parts of the visible range, from 0.1 micrometre to 1 mm. The spectrum ranges from the emission lines of the inert-gas-halogenide lasers in the ultraviolet to those of molecular gas lasers in the far infrared.

Laser beams differ from the radiation emitted by other artificial and natural light source in their high radiance, i.e their light emission per unit surface area and solid angle.

Compared to the greatest radiance of the sun's surface within the visible range, the radiance of a small helium-neon measuring laser is five orders of magnitude greater.

Thanks to their small diameter and small angle of divergence, laser beams can be focussed on a very small spot.

This characteristic is what makes laser suitable for a wide variety of applications in materials processing, medicine and data storage and retrieval.

The narrow spectral width of the emission is a prerequisite for laser applications in broadband communications, holography and interferometric metrology.

Most gas and solid-state lasers are excited by means of gas discharges and are consequently inefficient, voluminous, sensitive to slight maladjustments and limited in their service life.

This is the reason for the limited use of laser in aerospace applications, althou-gh their special beam prope-rties would make them very suitable for a number of such applications in sensor techn-ology, communication and remotesensing.

Only semiconductor laser (laser diodes) offer the essential advantages of compactness, efficiency and ruggedness, and are widely used in telecommunications, CD scanning, laser printers and laser scanners.

For many applications, however the large angle of divergence and broad emission spectrum of the laser diodes is a significant disadvantage, rendering them unsuitable for precision work in electronics or for power transmission via optical fibers in surgery.

Furthermore, their bored emission spectrum limits their use in interferometric metrology and data transmission.

A future, novel type of high-quality laser source is to provide not only higher beam quality than that of laser diodes, but also a broader selection of laser wavelengths.

The present laser generations ModiLas and HybridLas developed by MBB's Central Laboratories and the future microlaser use a combination of semi-conductor and solid-state laser to achieve the important improvement in physical properties and technical features described above.

Despite the disadvantages described earlier, laser diodes, as narrow-band, efficient sources of light with a low-voltage power supply and a long service life, lend themselves will find use as exciters for various solid-state lasers.

The major advantage of this combined laser system consists in the increase in spectral radiance.

Solid-state laser have the special capacity to produce very shortpulses with high peak power. They do this by storing energy over long intervals of time at the stimulated level of the laser medium.

This technology, which is being used for the first time to construct a solid-state laser, is suitable for installation in ground vehicles, aircraft or satellites.

With its smaller structure, the microlaser will be less sensitive to shocks and vibrations. On the other hand it will require more efficient cooling and faster and more precise temperature control.

—PTI Science Service

India Spins Cash from Space Research

INDIA is the first Asian country to turn space research into cash. The Indian Space Research Organisation (ISRO) launched its technology transfer scheme way back in 1975. Now research in the sky is earning valuable dollars.

As one scientist puts it, "Once developed as products, these technologies now serve as import substitutes in various sectors of the economy."

They cover some important profit-making areas such as telecommunications, computer systems, mechanical systems, electro-mechanical instruments, electro-chemical systems, electronics, optics, TV hardware, pyro-ignition systems, polymers, chemicals and special materials.

According to space analysts, this was first started as a tentative exercise, with some initial resistance from industry. Now it caters to the rapidly expanding space applications market in satellite communication.

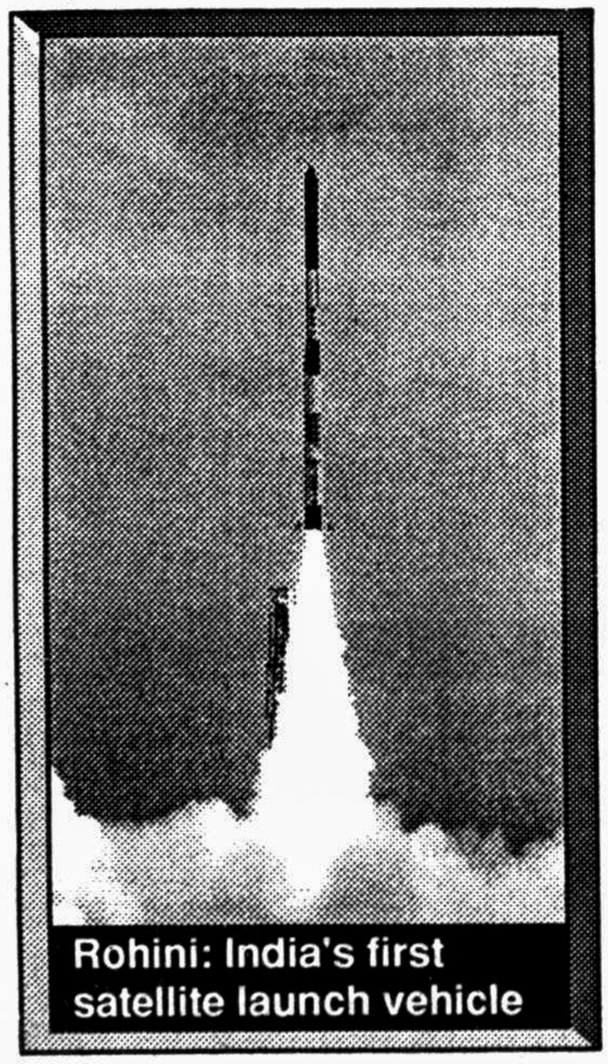
TV and radio networking, meteorological observations, remote sensing, natural resources survey and environmental monitoring and management.

Among the 181 recipients of technology transfer, the 94 to receive technological consultancy and those contributing to the country's space efforts are many big corporate names as also a good number of relatively small ones, spanning the large, medium and small-scale sectors.

Now space officials are planning to set up a corporate front for ISRO. This is designed to cut down government delays and bureaucratic hassles.

According to Mr Pramod Kale, "We can hasten the pace of technology transfer and cashing in on our research if we have a firm doing it."

An ISRO engineer, Dr Siddharth Trivedi, has set up a firm called Maharishi Electronics. He is among the few technocrat-entrepreneurs who opted to go on his own and set up an independent business. Other engineers and technocrats are being encouraged by ISRO.



Rohini: India's first satellite launch vehicle

Dr Trivedi's product, a computer hardware called frame-grabber, is priced at 88,000 rupees (US $3,143). It has been made economically viable by constant design upgrading. The latest word on this model is that its price has been brought down to 55,000 rupees (US $1,965) apiece.

Dr Trivedi's has already found several important customers such as the Bangalore-based Indian Telephone Industry (ITI), the Ahmedabad Cancer Research Institute and the news agency, Press Trust of India.

According to Mr Pramod Kale, Director, Space Applications Centre (SAC), another space research centre based in Ahmedabad, "Products developed by ISRO for its own use are now finding their slots in Indian industry. Business firms are contracting to develop the product after we have transferred the required technology."

During the SITE (Satellite Instruction Television Experiment) days, various components were developed by ISRO. But there were 24,000 such components.

"So we transferred the technology to ECIL, Hyderabad. The thrust, therefore, is on technology transfer, continuous validation and effective utilisation," explains Kale.

The ISRO is also involved in technology consultancy. Over 94 consultancy projects have been undertaken by ISRO, over a dozen alone in the past year.

One recipient of ISRO's technology has been market leader Tata Telecom Ltd, Ahmedabad, which has resulted in the local production of 90 per cent of printed circuit boards (PCBs), imported from Japan.

Recalls Mr Vinay Gupta, Tata's Executive Director for Operations, "The PCBs made by Indian vendors were rejected by Oki, Japan, our collaborator, and the process of sending them to Japan was proving to be cumbersome. Towards the third quarter of 1988, a few months after commencing commercial production, we approached the SAC."

It is high time government organisations approached Indian industry for manufacturing components for space research. It is a paradox that they approach foreign companies as if local ones are security risks

SAC carried out product validation tests with Tata Telecom's four Indian PCB vendors — Micropak, Rao Insulating, Indal and GNFC — and effected the required improvements in the next two years.

"The dynamic technological consultancy that SAC provided helped he local vendors to meet the standards set for import substitution. Now we are saving foreign exchange worth 13 million rupees (US $464,285) a year," says Mr Gupta.

Another field where Tata Telecom has been able to cut corners and save up to 8 million rupees (US $285,715) a year is in the field of power supply . AC-to-DC convertors, which were earlier imported by the company.

Tata Telecom has signed a technology transfer agreement with ISRO to manufacture "transcoders," a digital coding and decoding system which enables telephone cables to carry double their existing capacity. ISRO will be paid 300,000 rupees (US$10,700) for developing the transcoders which will go a long way in removing telephone traffic congestion.

"SAC specifications are as good as, if not better than the specifications offered by any multinational company. We are lucky to have such an institution of excellence catering to the needs of the Indian industry, right in our midst," says Mr Gupta.

ISRO has also evolved a scheme for the active involvement of Indian industries in the national space programme. The responsibility for the development and fabrication of a wide variety of hardware that goes into ISRO's launch vehicles and satellites now vests with Indian industry.

"SAC has already selected five
Tata Telecom men for high precision, space-grade electronic assembly," says Mr Gupta. "It is high time various government organisations such as ISRO approached Indian industry for manufacturing various components. I just cannot fathom the paradox of these organisations approaching foreign companies, as if we are security risks."

— Depthnews Asia