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The Kimbers Lane footbridge on the Maidenhead by-pass (U. K.), a reinforced continuous structure.

Shoppenhangers Lane bridge on the Berkshire section of the Maidenhead by-pass (U. K.). The bridge beams are precast concrete and the deck is transversely post-tensioned.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

AUGUST 1961

RUPEES TWENTY NINE CRORE LOAN BY THE INTERNATIONAL DEVELOPMENT ASSOCIATION FOR ROAD DEVELOPMENT IN INDIA

AT the close of the Second Five-Year Plan our National Highway System (14,900 miles in length) was deficient mainly in the following respects:

(a) 80 major bridges remained to be built.

(b) 400 miles of missing links remained to be constructed.

(c) 1,000 miles had only one lane (12 ft wide) water bound macadam surface carriageway.

(d) 12,300 miles had only one lane (12 ft wide) black top or cement concrete carriageway.

The likely expenditure for the construction of 50 major bridges, 400 miles of missing links, black topping 1,000 miles of macadam surface, converting 12,300 miles of single lane B.T. or concrete surface roads to two lane carriageway and completing carry over works from the second plan was estimated to cost Rs 200 crores. Anticipating the deficiencies indicated above and keeping in view the likely increased future requirements of road transport, the Chief Engineers in their report on Road Development Plan for India (1961—81) recommended a provision of Rs 590 crores (which included Rs 200 crores for the development of the National Highways) for the development of roads during the Third Five-Year plan period.

Against above mentioned Rs 590 crores, Planning Commission provided Rs 325 crores for expenditure during Third Five-Year Plan period as per break up given below:

(i)	(a) National Highways Rs 48.5 crores (b) Roads in Sikkim Rs 1.5 crores	Rs	50 crores
(ii)	Roads of Economic and Interstate Importance	Rs	30 ,,
(iii)	Roads in Union Territories	Rs	26 ,,
(iv)	Roads in State Sectors	Rs	219 ,,
		Rs	325 crores

It would be seen from the above that only Rs 48.5 crores were provided for the development of National Highways for the Third Five-Year Plan against the requirements of Rs 200 crores. It is significant to note that this figure of Rs 48.5 crores also includes a sum of Rs 30 crores required to complete works carried over from the Second Five-Year Plan.

This is very disappointing, almost all new development works of the National Highways will have to be deleted from the plan to remain within the imposed ceiling of Rs 48.5 crores.

The long range maleffects of the above shall be that, even by the end of the Third Five-Year Plan, it will not be possible to ply a truck semi-trailer combination with 11 ton Pay Load neither from North to South of the country nor from East to West of the country except along a few isolated sections. This shall not be conducive to the necessary progress of Road Transport, and shall adversely affect the economy of our country.

At this difficult period for the Road Transport, the International Development Association extended a helping hand by providing an interest free credit of Rs 29 crores to the Government of India. This credit is available in any of the freely convertible currencies.

The I.D.A. has also agreed to set apart 300,000 dollars to meet expenditure on specialists for a comprehensive traffic survey in respect of roads in Bombay city and suburban areas.

The credit is to be treated outside the Third Five-Year Plan provisions and has to be utilised within the first three years of the Third Five-Year Plan.

Works covered by the projects assisted by the I.D.A. credit include development of 660 miles of roads, construction of 19 major bridges (some of which were omitted from the Third Five-Year Plan). The most important works to be carried out are given below:

(A) **Bridges**

Over Sone, Kosi at Kursola, Burhi Gandak; Mahananda at Dingraghat in Bihar State, Rupnarain and Kangsabati in West Bengal State; Mahanadi, Birupa, Brahmani, Kharaswan, Baitarni, Salandi, Nuniajhari, Pudabalang in Orissa State; Bassein Creek, Tansa, Vaitarna Vandri & Kommon Creek in Bombay State.

(B) **Roads**

Chichara-Subernarekha, Ranchi-Jamshedpur, Jamshedpur-Baharagora Section, Barauni-Phulberia, Barauni-Muzaffarpur in Bihar State. Joypurbeel-Bihar-Border, Byepass North of Calcutta upto Baidyabaty, Byepass Baidyabaty-Suptagram in West Bengal State, Cuttack-Bihar Border, road in Bihar State and Eastern Expressway (4 lane divided highway) in Maharashtra State.

These works shall be carried out in fully controlled and scientific manner with proper machinery for compaction of soils, and quantitative and qualitative controls of other construction items.

In order to utilise the provision made in the Third Five-Year Plan and also the I.D.A. credit of 29 crores in the first three years of the Plan, the expenditure in each of the first three years for development works of National Highways will be Rs 21 crores $\left(\frac{48.5 - 11}{5} + \frac{29 + 11}{3}\right)$ against the expenditure of Rs 8 crores for the last year.

In order to utilise Rs 21 crores per year on National Highways alone will mean considerable increase in tempo of work alround, shall involve increasing and strengthening of staff at the Centre, States, Research Organizations and will need gearing up of all material, and construction agencies to attain the required targets. To achieve this, the works shall have to be treated as a top priority works, and everything including accounts, financial controls, administrative formalities, etc., shall have to be streamlined and all concerned assisted and helped to achieve the tempo and the targets.

No doubt our engineers, scientists, machinery and construction agencies will rise to the occasion and will attain the tempo, and continue momentum of Rs 20 to Rs 21 crores expenditure per year on the development of National Highways in addition to other road development works in various states in India.

The organizations when built up and accelerated to the required tempo, after 3 years, unless more work is found for the organisation, shall have to be disbanded and geared down to the yearly expenditure of 8 crores on the National Highways.

It is, necessary for our Planers and administrators to find out ways and means so that the attained momentum and speed of the work is continued.

AN APPEAL

I AM making this direct appeal to all our colleagues and co-workers who serve the Government of India, in whatever capacity they may be functioning.

After fourteen years of Independence, fourteen years of hard work and travail, of considerable success and occasional failure, we have arrived at a critical phase in our national existence. Indeed this critical phase applies to the international scene also, and no man can say what the future may bring to this afflicted world.

But our immediate concern is inevitably our own country and the hundreds of millions of people who inhabit it. Even our service to the world can best be achieved through our serving our own people.

We have started on the Third Five-Year Plan. This is a mighty effort, based on the strong foundations laid in the First and Second Five-Year Plans, and aiming still higher. We are determined to succeed in this great adventure. We have faith in it because we have faith in our people, and it is the hard work and co-operative spirit of our people that will bring success and the advancement of our people to greater prosperity and equality of opportunity. The Third Plan will, we hope, take us out of the rut of poverty that has brought so much unhappiness and degradation to our millions.

To make good Plans is not easy, but far more difficult is to implement them. That implementation demands the joint effort of all our people. More particularly it demands the effort of the vast governmental administrative machinery. I am, therefore, appealing to this vast machinery of Government, spread out all over India, which carries the burden of Government and on whose activities depends the success of everything that we may undertake.

I appeal to all of them for integrity in the public services. This is not merely an ideal to be thought of or to be aimed at, but something which has to be practically achieved. It is intimately connected with the individual good of all of us. Let our public services be a model of integrity and efficiency, of co-operation and courtesy.

In particular, I would appeal to each one of us to work continuously and deliberately for the promotion of national unity and emotional integration of all our people. Thousands of years of history have conditioned our people and made our country what it is—an abiding unity and, at the same time, great diversity. People of many religions live in this country, many great languages flourish among our people. And yet, in spite of this variety, there has been a deeper unity which has held us together. Each one of us must realise that the only future for India and her people is one of tolerance and co-operation which have been the basis of our culture from ages past.

We have laid down in our Constitution that India is a secular State. That does not mean irreligion. It means equal respect for all faiths and equal opportunities for those who profess any faith. We have, therefore, always to keep in mind this vital aspect of our culture which is also of the highest importance in the India of today. Those who put up barriers between one Indian and another and who promote disruptive tendencies do not serve the cause of India or her culture. They weaken us at home and discredit us abroad. Therefore, it is of the utmost importance that we should work for this emotional integration of India.

This applies to linguistic differences also. It is our proud privilege to have great languages, intimately connected with each other. Let us serve them all and not consider any language which is not our own mother tongue as something alien. All these languages have grown up through the ages and are of the flesh and blood of India. If any one is injured that injury is of India.

I appeal, therefore, for this conscious effort on the part of all of us for the emotional integration of all our people. I want this translated into the day-to-day activities of ours, official or non-official, so that we may build up the India of our dreams.

NEW DELHI,
July 5, 1961.

JAWAHARLAL NEHRU

CIVIL ENGINEERING TRENDS IN EUROPE TODAY

F. CHARLES GREENFIELD, M.A. SCE

Handforth, England.

AS winner of the Culmann Travelling Fellowship, 1958—1959, offered by England's Institution of Civil Engineers, Mr. Greenfield spent a year in Europe studying design and construction in concrete and steel. A paper giving his observations in this interesting field was printed in the Proceedings of the Institution (Vol. 16, pp. N 11-N 23, July 1960) and forms the basis for this condensation. American engineers will be interested in an Englishman's views on Continental European practice.

With every European country moving towards the American standard of living it would seem that many mechanization trends in civil engineering will follow lines similar to those in the United States. Since Europe is not so rich in steel as is America, it is likely that precast concrete, in spite of its limitations, will one day become the dominant structural material.

Developments in structural steel-work, often in keen competition with precast concrete, are following similar lines, that is, every possible operation is being done off the site, in the largest possible sections, and in the shortest possible time. Clearly, the automatic welding machine will replace the welder and the riveter wherever practicable.

The progress that will inevitably occur in factory techniques—improving output and lowering costs—must be weighed against the performance of the man on the site, which cannot be expected to keep pace with the rise in wages he will expect from the new era. Further, the quality of the factory product is already of such a high standard everywhere in Europe that the demand for individual workmanship, characteristic of former times, is greatly reduced.

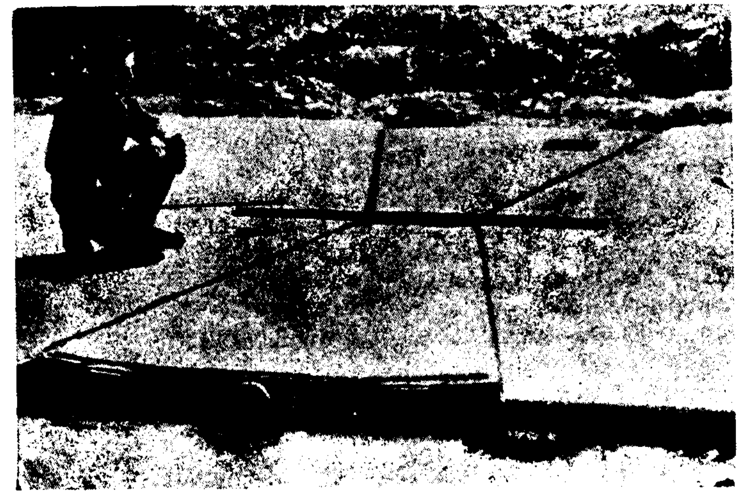
Transportation

The tremendous construction programmes in Europe today are activated by an unprecedented rise in living standards for all. Widespread car ownership accounts for many of the civil engineer's problems. Many countries are viewing their transportation systems as a whole. Thus, in conjunction with the new urban road system of Berlin, considerable extentions are being made to the underground railway. In Milan, too, the construction of an underground railway is being provided as one of the best means of solving street traffic problems.

The treatment of internal transport as a single national problem is nowhere more evident than in the Low countries, where the bold outlook appears to stem from the densest population in the world combined with a position as the gateway to Europe. Holland's new electric railway system is probably the finest in Europe. Belgium has a ten year plan, providing for the complete modernization of roads, canals and railways.

Postwar bridge construction

Faced with a gigantic postwar bridge-building programme, to be carried out in the shortest possible time and with the minimum of every commodity, German engineers have performed miracles. New techniques had to be evolved which often required considerably more effort in design calculations. The Severin Bridge, Cologne is an example of success in this task. The wide-spread application of automatic welding, three-dimensional cables, low-alloy steels, high-strength bolted joints, box girders in place of plate girders, and orthotropic plate design for the decks, reduced the weight of steel required to about half that considered necessary a quarter of a century earlier. Prefabrication of entire sections reduced the time factor. The use of one tower only pleased harbour authorities, preserved the view downstream, and provided a counterpoint to the great cathedral. River traffic was not seriously impeded, since construction was performed on the cantilever



The Swiss have used wedge prestressing successfully on experimental road. The French used an inflated jack with good results. Courtesy of B.B.R.V. Zurich

At Ludwigshafen, Germany, single columns support a roadway 95 ft wide. The structure shows what can be done with bare concrete. Courtesy Dyckerhoff & Widmann, K.G., Munich

principle and temporary river supports were kept to a minimum.

The cantilever principle has also been applied to the construction of prestressed concrete bridges. In the German *Dywidag* system, both the concrete and the forms are cantilevered. The elimination of conventional centering makes the method particularly economical for viaducts over deep ravines. For construction over important rivers, such as the Rhine, the extra cost (if any) is well repaid, since there is little inconvenience to navigation. The completed bridges over the Rhine at Worms, and the Moselle at Koblenz, are well proportioned, unostentatious, and blend well with the landscape.

The same method is being employed at present in the Nordbogen Bridge, Berlin, the Mangfall Viaduct, near Munich (this time with prestressed concrete lattice girders), and also in Scandinavia. The French and the Swiss, employing the B.B.R.V. system of prestressed concrete, have also been extremely successful in the railway viaduct at La Voulte-sur-Rhone, shown in an accompanying photograph. Here only the newly placed concrete was cantilevered (in conjunction with temporary prestressed-concrete strut) the sliding forms being supported by temporary steel girders. In many cases where, until recently, steel was the automatic choice, the use of cantilevering with prestressed concrete now provides strong competition for spans upto at least 400 ft.

The 5-mile Maracaibo Viaduct in Venezuela probably represents, for shear size at least, the peak in concrete bridge construction to date, and is perhaps the most notable example of the infiltration of concrete into fields previously the prerogative of steel. Under construction at present by the German firm of Julius Berger, A. G., to the designs of Professor Morandi of Rome, the Colossal 760-ft centre spans, with towers rising 320 ft above water level, will provide bridge engineers with something to think about for years to come. Everything possible is precast.

So far steel is the dominant material for railway bridges, and some particularly interesting welded designs have recently been utilized in Germany. There are also a number of recent examples to be found in concrete, including a three-span spandrel arch bridge and a skew double-box-culvert type for the new Ghent Ringvaart. However, none seems to be quite so spectacular as the earlier Voulte-sur-Rhone Viaduct (seen in an accompanying photograph), which is famous for its beautifully clean-cut lines.

An interesting new development in Belgium is the prestressed suspension bridge, a design also to be used for the new

This railroad bridge at La Voulte-sur-Rhone was constructed by cantilevering the concrete in conjunction with prestressed struts, the sliding forms being supported on temporary steel girders. Courtesy S.N.C.F. and Enterprises Boussiren

In general it may be said that for road bridges in Europe today, prestressed concrete is now the outstanding material. For small one-or two-span bridges, pretensioned beams upto about 85 ft are becoming increasingly popular, although as yet Germany seems to be the great exception. For spans up to about 400 ft, post-tensioned concrete bridges and approaches (usually with continuous beams and two-way prestressed decks) can be seen with almost monotonous regularity. For long-span bridges, even though steel may still be the answer, prestressed concrete now plays a large part in the approach spans and is sometimes used for the deck slabs of suspension bridges. A particularly good example is the Rodenkirchen Bridge at Cologne.

Ghent Ringvaart. The principle involves jacking the towers after laying the cables and the concrete deck to provide a predetermined load on the cables, the tension being measured as the jacking proceeds. In effect, the bridge is a large continuous prestressed concrete beam with a wholly external tendon. So far the maximum span employed is only 330 ft, but in considering the feasibility of much longer spans the inconvenience of falsework should be borne in mind. It should also be remembered that the Ghent bridges possess the rather unique advantage that the canal for which they were intended had not yet been excavated when they were built.

The new Tancarville suspension bridge at

Le Havre possesses a number of interesting features. No doubt with future maintenance in mind, the towers were built of concrete. The thrust on the approach viaduct side is taken by a huge hinged concrete abutment, the other side being anchored into the mountain.

Reinforced-rubber abutment bearing pads are everywhere gaining popularity. In comparison with steel details they are, of course, simple and cheap and are often substituted for hinge and rocker.

Joints of polyester glue have been used on a small steel bridge at Marl-Huls, Germany, built about 5 years ago. Perhaps not possessing quite the same faith as the manufacturers, the authorities insisted on the provision of bolts also, placed in oversize holes, so that failure of the glue would reveal itself by undue deflection of the bridge. So far the glue has stood the test. Experimental concrete beams have also been glued successfully by the same manufacturers.

High dams for power

Construction of dams at considerable altitudes in remote regions, such as the Grande Dixence and the Mauvoisin in Switzerland and the Vaiont in Italy, present the civil engineer with innumerable problems, and also test his skill, courage and imagination

29

The Alwegbahn monorail in Germany may play a major role in solving city traffic problems. A monorail at Wuppertal has been in trouble-free operation for 60 years

In north Italy segments of a concrete arch, designed by Prof. Riccardo Morandi, were cast vertically and then lowered into position

to the utmost. The three dams just mentioned approach the Eiffel Tower in height and their construction involves considerable risk to all concerned. Grande Dixence involves the placing of 8,000,000 cu. yd. of concrete.

Recent continental developments in dam design seem to have been concerned more with cellular construction, the pure arch, and the gravity arch. Apart from Scotland's Allt-na-Lairige Dam, the few examples of prestressed concrete dams in Europe seem to be prestressed only within the structure itself. Thus the prestressing is concerned only with the reduction of horizontal tensile stresses in the arch, rather than with the balancing of overturning moments, such as would be provided by vertical pretressing anchorage tendons.

In several countries the trend is to build a hydro power-station actually within the mountain. Surprisingly, this does not seem to involve appreciable extra cost. Advantages appear to be mainly camouflage and protection from bombing and missiles, and also the saving of valuable space in the valleys. The Germans and Swiss sometimes build the power station served by a particular dam actually inside the next dam further downstream.

For the construction of mountain-side "feeder" culverts to their impounding reservoirs, the Swiss often employ rubber duct tubes, which are bedded on and surrounded by concrete. After the concrete has set, the duct tube is deflated and used again. The culvert so formed can negotiate bends quite impossible for conventional pipes, which in many cases could not be transported and handled in such difficult terrain. Although the duct tube is expensive, the resulting culvert is of course much cheaper than a tunnel through the rock. Originating in France, duct tubes are now used extensively on the Continent for storm drains, electrical ducts, and many other purposes:

Already used for a variety of works varying from small-house extensions to huge power stations, the Menard pressure meter (from Paris) is an ingenious tool for determining soil strengths at depths upto about 200 ft. The apparatus is remarkably simple. A borehole about 2½ in. in diameter is augered to the required depth and a rubber-cylinder lowered into it. Measured water and air pressure are applied to the different compartments of the cylinder (the water in the centre, with air above and below) and the resistance of the ground is related to the pressure applied. It is understood that this pressure meter functions in any type of soil, regardless of the level of the water table.

Multipurpose structures

When building elevated engineering works, it is now a popular Continental practice to provide a secondary function for the benefit and amusement of the general public. This usually takes the form of a restaurant and lookout platforms. In many cases the tourist attraction is considerable and the structure pays for itself within a few years. A television tower at Dortmund, Germany, is set in the midst of a beautiful recreational park, which contrasts vividly with the industrial town. It is typical of the Teutonic mind that the restaurant is arranged to revolve (from 2 to 6 rph) so that everyone can have a fair share of the sun and a view of the landscape over 400 ft below. Water towers frequently have high-level restaurants built into them.

Mountainside culverts in Switzerland are built using deflatable duct-tubes

On the construction side, the latest practice in Scandinavia is to build the tank of a water tower at ground level, and subsequently jack it up to the required height.

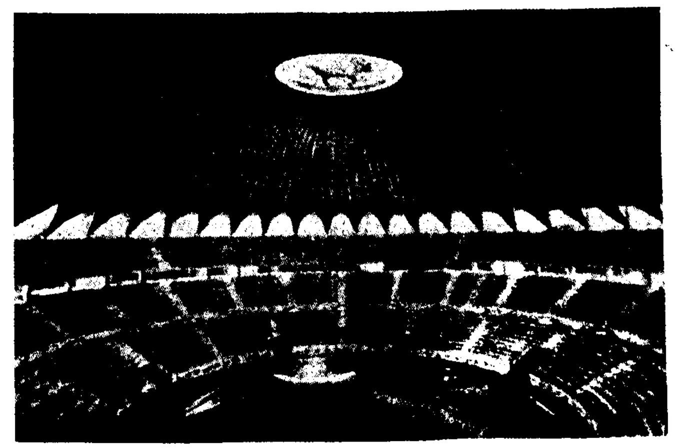
Sometimes only the floor and "starter" wall are built in this manner, the wall proper and the roof being constructed in final position. A 300 ft television lookout tower overlooking Rotterdam Harbour was built with slip-forms, and the steel restaurant was hoisted up afterwards.

The engineer and esthetics

On the Continent today there are many fine examples of engineering expressed in concrete and steel; there are also many beautiful examples of modern architecture (perhaps mainly inside work). But it is the writer's opinion that, with some truly notable exceptions, there are few buildings in which the two are found together, each doing full justice to the other. But can such a standard be obtained if economy is not to be forgotten? It is the writer's belief that it can.

The exposure of plain unadulterated concrete, both externally and internally, has now become quite commonplace on the Continent and in a number of instances when applied in suitable proportions, the results have been remarkably successful. In some cases the boldness of its intrusion are quite staggerring—foyers and boxes in lavish opera houses, roof beams and columns in magnificent congress halls. It provides unlimited scope for the architect's imagination; it delights the engineer to see his work at last revealed to all; and it is very inexpensive to the client. But of course boldness has sometimes been carried to extremes, and the results can easily amount to austerity, and after a certain lapse of time, to a depressing shabbiness.

In his use of exposed concrete, both in situ and precast, as an engineering-architectural material, Pier Luigi Nervi, in Italy,



The Palazzo dello Sport in Rome is a creation of Pier Luigi Nervi. It seats 16,500. Detail is at the lower balcony

must surely be considered outstanding. Such creative and imaginative work, revealing the hand of the craftsman combined with the very best that mass production can offer, has provided a new concept in building construction and has proudly taken its place beside the architectural treasures of the past. The Palazzo dello Sport, which seats 16,500 people, cost 980,000 dollars excluding fittings, and the Plazzetto dello Sport cost only 4 0,000 dollars complete. See accompanying photographs.

Such works of art are the creation of an engineer-architect working with engineering-architectural material and assisted by a staff of engineers and architects. Since the relative merits of the two systems, but it may be worth while to consider some of the main characteristics of continental practice.

On the Continent it is common practice for a client to invite tenders for design and construction. This enables him to consider many alternatives before committing himself to a considerable expenditure. It may often happen that at least one design contains a revolutionary principle which is particularly suitable for the contractor's resources, saves considerable expense, shortens construction time, involves negligible maintenance cost, and looks very much more attractive than an alternative conventional method. Such designs as the best in both fields are so rarely found together today, a lesson can be learned from these buildings. Certainly there has never been a greater need for the architect and the engineer to work in harmony than there is today.

The smaller Palazzetto dello Sport in Rome, also by Pier Luigi Nervi, with Annibale Vitellozzi as architect, has an unusual arrangement of supporting arches

Engineering and contracting

It is well known that engineers in the United Kingdom conduct their profession very differently from their continental confreres. Throughout Western Europe and Scandinavia basic practice does not seem to vary greatly between countries. It can only be assumed that the island position of Britain accounts for its unique system. The writer would not presume to judge the rela-

German and French cantilevered bridge construction, the new Palais des Expositions, Paris, and the "poems in concrete" of Pier Luigi Nervi, are examples of the very best Continental practice.

It is impossible to remain unimpressed by the closeness of the ties that exist on the Continent between the university and industry. Indeed, it is a mystery how so many engineers find time to combine their duties at a university with their engineering practice. Invitations for a vacant chair are often extended to an eminent practicing engineer who need not suffer financially since he will have full opportunity to act in a private capacity. Under this system the experience of the finest

engineers is made available not just to a few privileged assistants, but to thousands of prospective engineers (the new lecture theatre at the Aachen Technische Hochschule seats 1, 00 students), who are taught to view theory and practice in true perspective.

Conversely nowhere in Europe is there less appreciation of the civil engineer's work than in the United Kingdom. Indeed, Britain has reached a stage when the term "engineer" is quite meaningless, whereas in Italy an engineer is addressed by this title and is held in the highest respect by the general public. Nowhere else in Europe is there confusion in the layman's mind as to the distinction between a professional engineer and a technician or tradesman.

Conclusions

Many Continental engineers—to the delight of their architectural associates—now design their building columns purely for vertical loads, in order to reduce column sizes. Wind loading is taken by elevator shafts, stair wells and end walls via the floors. But today, as always, the bridge remains the best structure for expressing the art of civil engineering. Perhaps no type of construction can do so more successfully than the suspension bridge, but the properties of prestressed concrete have provided the Europe of today with very many fine bridges unrivaled in the past in slenderness of proportions and simplicity of outline. It seems evident that the student in search of engineering combined to perfection with modern architecture would do better today to look at the bridges rather than the buildings of Europe.

It is of interest to note that no matter how small its area or meagre its natural resources, each of the countries referred to has expressed itself most brilliantly in at least one aspect of civil engineering. Particular fields of progress have often been dictated by differing national needs and natural resources, and one country can well learn from another in the light of such variations.

Many of the colossal schemes now under construction on the Continent may never pay for themselves. The magnificent new Dutch railways, the Delta works, the Zuiderzee works, the complete modernization of the Belgian canals, the Grande canal d'Alsace, the Grande Dixence Dam of Switzerland will take years to build and will cost a fortune—yet there is a magnificent attitude of pride in them shared by engineer and layman alike. This goes to prove that the wealth of a country lies in its people rather than its resources.

('*Civil Engineering*', *April, 1961*)

DEFINITIONS OF HIGHWAY ENGINEERING TERMS.

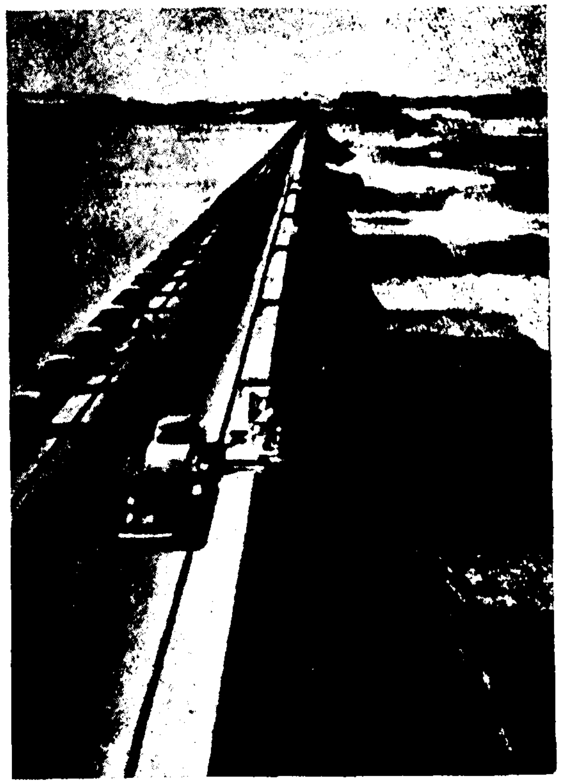
SKID-BRAKE PAN: An iron shoe or a wooden block or other device to enable animal-drawn carts to travel on steep gradients without the risk of sliding back or forward.

SKIDDING: The motion of a vehicle with its wheels locked on a road surface.

TRANSPORT IN U.A.R.

THE eight-year period since 1952 makes a panorama of great achievements; they reveal the strong will to implement a policy aimed at the overall modernisation of the transport system—railway, road and water transport. The postal services and telecommunications have their shares too.

Reconstruction is the symbol of the UAR which is determined to make the future as great as the past.



Railways

A modernisation plan has been set up by the Government to revolutionise the railway system of which the main components are: (1) Necessary replacement of the rolling stock and track renewals which required considerable expenditure totalling 60 million pounds. (2) Increasing the gross earning of the Railways and simultaneously cutting down the working expenses to meet the need for a well-balanced budget. (3) Reorganisation of the whole system to meet the need for a greater efficiency of the services offered to the public. (4) Better working methods to meet the current traffic requirements and equally those of the future. (5) Setting up of the First Five-Year Plan (1952-57) and the Second Five-Year Plan (1957-62) for rehabilitation which will help to meet the greatly increased requirements of the development programmes now underway. (6) Co-ordination between railway transport and other related forms of transport such as air, water and road transports.

Highways

Highway planning now has a very close relationship with the overall planning of the economic development of the whole country. This is clearly illustrated by the fact that better roads mean better standard of living.

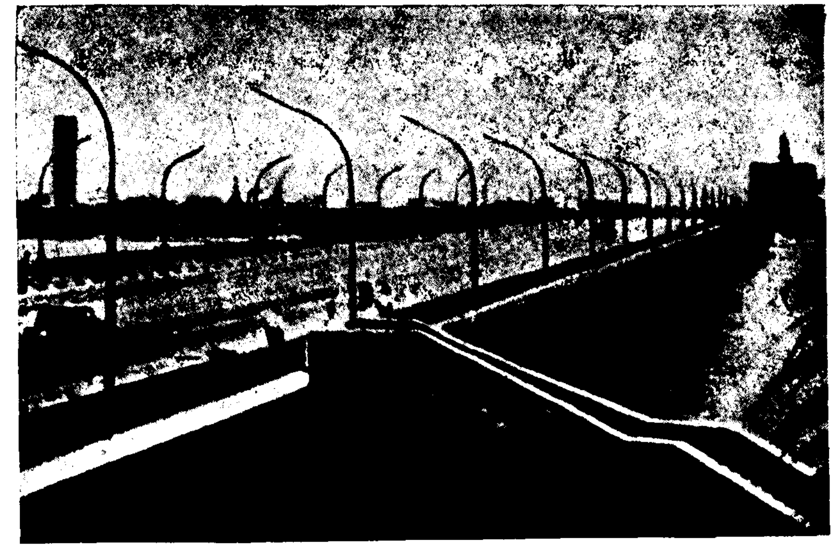
Progress in Road Construction

More than 2,500 kms. of roads have been constructed between 1952 and 1959, that is an average of 350 kms. per year. A big programme has been set up to build and pave a widespread network of roads throughout the country—including urban highways and inter urban highways as well.

The plan also includes the building of roads leading to mining areas to help encourage the exploitation of natural resources. Tourist roads were given special attention to promote tourism and provide speedy access to the centuries-old remains of the mighty forefathers. A network of roads linking up the villages with main highways is now under way.

Road Research Work

Modern technology in the field of road building is a prerequisite to sound planning. So, it was of capital importance to establish a research laboratory devoted particularly to road work and research. Equipped with



The University Bridge of Cairo. It is the most modern bridge in the Middle East

The "Metro" in the suburbs of Alexandria

most modern test equipment, the highway laboratory is the first of its kind in the Middle East.

Many tests in paving were successfully carried out in the different parts of the country to seek the most economical methods in road building. Local material, such as pit run gravel, crushed limestone and sand have undergone special experiments to define the suitability of each to paving work. Standard specifications for use in road and bridge building were recently released by the Department as a result of the studies undertaken in the highway research laboratory.

Training Centre

A one-million pound training centre was recently established to help raise the technical know how of road and bridge engineers and supervisors as well. Special courses on road and bridge construction and

" Al-Zamalek " bridge in Cairo

ıintenance requirements are the main bjects on the curriculum.

Scholarships and fellowships are awarded the centre to study in the U.S. and ırope to help catch up with the modern hniques of road and bridge building.

Over 100 engineers and assistant enıeers have undertaken their training ırses in the last two years.

land Water Transport

As old as the first man who lived in the le Valley, inland water transport has ın and is a vital means of transport of people of Egypt.

Navigable waterways, excluding the Suez nal, total 3,395 kms. The Nile extends 52 kms. from Wadi Halfa at the Sudan rder to the Mediterranean Sea. Watery routes *via* navigable canals and lakes al 1,665 kms. in lower Egypt and 1,729 ıs. in Upper Egypt.

The Government has spared no efforts to improve the existing waterway routes and construct a new network of canals to link up the various important industrial districts. Therefore, a Ten-Year Plan has been set up (1954–1964) by the Government to raise the standard of services rendered by the waterways and further the construction of new navigable routes. Expenditure expected total L.E. 11 millions, of which already L.E. 5 million were spent in the 5-year period ended 1959.

Inland water transport is privately owned and run by 28 companies with a capacity of over 100,000 tons. Total capital investment of these companies is over L.E. 2·5 million. Not to mention the 25,000 of sail boat crew who are engaged in this transport system. Total tonnage carried by water has totalled a record of 4 million tons per year.

(From 'State Transport Review', Annual, 1960)

DRIVING TRICKS THAT CAN SAVE YOUR LIFE

In a split second you'll crash—unless you react properly. Test yourself on these 14 basic emergencies selected by experts.

ON A PENNSYLVANIA HIGHWAY one afternoon last winter, I was driving up a steep hill at 55 miles an hour. Speeding downhill in the opposite lane, a green car suddenly hit an icy spot and started skidding straight toward me. From a corner of my eye I glimpsed another car behind the green one. For a fleeting moment my hands and feet were paralysed. Then, tapping my brakes, I instinctively turned sharply right, off the road and into a shallow ditch.

The green car spun uncontrollably into a tree ten feet behind my car and crashed in a tangle of metal and torn flesh. The driver was killed.

Had I jammed on my brakes and stayed on the road, I would have been directly in his path. If I would swerved left, there would probably have been a head-on collision with the second car. My split-second instinctive decision saved my life.

That nerve-shaking close call made me wonder how many critical emergencies I could drive away from with my car—and all my bones—intact. " To stay alive on today's car-smashing highways," says Dr. Herbert J. Stack, consultant at the Centre for Safety Education at New York University, " you should be prepared to act in sudden problem situations without delay. A good defensive driver anticipates trouble. He has to steel himself to use the manœuvre he has learned is right. Jamming on brakes, for example, may save your life—or it could be fatal. Depends on the situation."

Sam G Athey, safety supervisor for a national bus network, says, " When you're driving, assume that everyone else is irresponsible, drunk, sleepy or crazy."

While such caution may seem extreme, sooner or later even the most careful motorist is bound to be trapped in a driving emergency. Are you ready for yours? How good a defensive driver are you?

For the following real emergency problems, the solutions are based on a consensus of seasoned bus and racing drivers, safety training instructors and the American Automobile Association. While you may never have to cope with some, you should know how to react to all of them. Any of them can happen to you as they did to someone.

So put yourself at the wheel of the critical car and test your PDQ. (Prepared Driving Quotient).

1. As you round a curve and travel down a two-lane road, a big truck is stuck across both lanes, blocking your path. You're going too fast to stop instantly. How can you stay alive?

Recommended for the average driver: Use your foot brake to slow down gradually as you swerve off the road, picking the softest spot to hit—wire or wooden fence, an embankment, whatever will absorb impact with the least violence to you. Unfortunately most drivers never think of running off the road; they do everything to stay on it.

" Always keep an eye out for an escape route," advises Duane Carter, Indianapolis Speedway driver. " On most highways, there's a field, a road shoulder or just another traffic lane. If you have no such escape route, cut your speed and drive with extra care."

2. With cars parked along both curbs. You're going down a city street. Two lanes are open. Approaching you in the left lane is car " A ". Behind it, car " B " starts to pass around and is making a beeline for you. You're trapped, with apparently no place to go.

" That's a tough one," says Dr. Stack. " It's usually best to do anything to avoid a head-on collision. But if you hit a parked car, the oncoming vehicle may strike you broad-side, where you're sitting. Since an accident is inevitable, take it on your front bumper."

The best you can do is sound your horn, jam on your brake, switch off the ignition and brace your feet. Reducing your own speed will give the other driver a few more seconds to stop or slow down, and thus lessen the force of the impact. Turning off your ignition reduces possible risk of fire.

3. A car passing you cuts too closely in front of you, forcing you to swerve. Your right front wheel drops off the pavement to a soft shoulder several inches below the level of the pavement. Don't try to yank your car back on the road or it may turn over. And don't slam on your brakes or you may be ditched. Ease up on the gas, keeping a light touch to maintain control. Steer so that front and rear right wheels are about three feet off the pavement but parallel with it. When you're in control and rolling evenly, turn back—not sharply —to the pavement.

To avoid getting into such a jam, the good defensive driver always slows down when someone passes. Give the passer plenty of room.

4. Navigating in the right-hand lane of a four lane expressway, you approach an entrance lane. A car ("A") is moving to enter the stream of traffic and it appears you're about to crash into each other. In the left lane, a station wagon is about 30 feet behind you. A third car is at your rear. What's your best manœuvre?

"You have three possible choices," advises Dr. William G. Anderson of Columbia's Safety Research and Education Project. "If there's enough space in the middle lane, shoot out your hand to signal and swerve left, ahead of the station wagon and around entering car "A". The second choice, if the car behind you is not too close, is to apply your brake, hoping the following car will see the situation and slow down. If you're boxed in by the station wagon and the car behind you, blow your horn and go full speed ahead to beat out the entering car. Never swerve right and try to get behind car "A". Chances are the "A" driver will slow or stop and you would crash into his rear".

To avoid such a trap, when you see the car entering the access lane, either slow down to let him enter ahead or speed up so he can come in behind you.

5. On a busy turnpike, with a line of cars behind you, your gas pedal sticks and your car shoots ahead.

You'd probably jam your brake, frightened by the roar of the engine. Don't turn the ignition key and throw your transmission into neutral. Slow down gradually until you can pull of the road. If you brake too fast, you'll lose momentum and stop—abruptly—with all those cars behind you. Shifting into neutral will probably let your car roll long enough to reach a safe area.

6. Riding on a throughway, you spot what seems to be a drunken or "mad" driver. He weaves from lane to lane, drives too fast in the rain or snow, fails to signal. You try to pass him and he switches into your lane.

Brake and let him go ahead. "Avoid a 'nut' driver like poison," warns Dr. Stack. "Keep out of his way. Don't get angry and dispute the right of way. If he's on the lane beside you, slow down and let him get ahead. Above all, don't try to lose him by speeding".

If you suspect a wavering or wandering driver has dozed off, blast him with your horn or flash your headlights to wake him. Stay behind him—don't risk pulling up alongside his car.

7. Just as you reach a traffic light, it turns red and you stop. You hear a screech of brakes and your rear-view mirror shows you that a truck behind you can't stop in time and is about to crash into your rear. You've got a second to do something.

Instantly release your foot brake and flop over on the side, if there is no other passenger. Or slump down in your seat, keeping your foot just over the brake. Taking your foot off the brake will help lessen the shock because your car will have a little give. Ducking down will avoid a painful or dangerous "whiplash" injury to your neck, caused when the seated body is hurled forward by a blow from the rear while unsupported head is snapped forcefully backward. As soon as you feel impact, apply your brake to keep out of the cross-traffic.

8. Without warning, on a well-travelled parkway, you hit a fog bank so heavy that you barely see a foot ahead of you or at your side. You're driving blind. What are your alternatives? Snap on your low-beam or parking lights and try crawling along, holding to a speed that you're sure you can

Transport-Communications Monthly Review
August 1961

handle and will keep you from being struck from behind. If that's too nerve-racking keep right and stop. Have your passenger get out of the right side of the car (or, if you're alone, do it yourself) and scout the right edge of the road to see if it's safe to pull off the pavement until the fog lifts.

9. In heavy traffic at high speed, you have a blowout in your right front tire.

Fight the impulse to brake! Grip the steering wheel with both hands with all your strength to keep it from tearing loose. Gently feed gas in short spurts: it may help you regain control by lifting the weight off the dragging tire.

Your car will start lurching toward the right. Avoid jerking it to the left or the car may turn over. Steer in a straight line. When you have the car under control, start touching the foot brake lightly, to slow the car down.

Keep going on the flat tire until you reach a turn-off. This may ruin your tire but it will save your life and your car. Anything that stops suddenly on a busy road is apt to get clobbered.

If you hit your brake hard after the blow-out, the forward part of your car will drop, the wheel's rim could bite the macadam and throw you far enough to the side of the road to slip over. Blowouts under line the importance of keeping both hands firmly on the wheel so that you can steer safely in emergencies.

10. On a two-lane highway you're in a long line of cars and swing out to pass on the left. But another car suddenly appears over a hill and comes directly at you. You're not sure you have enough passing distance ahead.

Of course, you've broken the cardinal rule of the road not to pass on a hill or a curve where visibility is limited. Slam on your brakes, put on your right indicator, let the car beside you move ahead and try to squeeze back into line to avoid both a head-on collision and a sideswipe. Pray that other cars in the right lane will be noticing your plight and hold back for you.

11. As you descend a steep hill, with a row of cars ahead, your brake pedal suddenly drops lifelessly to the floor-board. How can you safely stop your runaway car?

Pull the emergency hand brake with all your strength, give the foot brake a series of short, swift pumps to build up pressure past a passible leak in the hydraulic system. If possible, shift into a lower gear to reduce speed. Edge toward the side of the road and look for the escape route mentioned in emergency.

12. Driving on a pitch-black night, your headlights go out.

This is a petrifying experience, but don't panic. Gradually slow down. Switch to your parking lights, spot-light or fog-light they may still work and enable you to be guided by the white road line. If one of your lights functions, and you have an emergency flash-light in your glove compartment, aim it out the window. When you can make out the road and your surroundings, pull to the side of the road.

13. You hit a curve too fast at a sharp angle, realize you have only a thread of control and become panicky as you see a cliff on the right.

Start braking slowly in spurts and take the curve flatter, crossing over to the left side (provided there is no other car in the left lane). Shift down to a lower gear if you can. If you suddenly slam on your brakes, with the wheels turned, you could roll over.

14. At night, on an unfamiliar road, an oncoming driver blinds you by a "glare fog" of headlights. All road details blur. What can you do?

You've made the mistake of looking directly into headlights instead of angling your gaze toward the right. You will be partially blind for about seven seconds. Keep blinking your headlights in the hope that the approaching driver will depress his. Slow down, steer cautiously and stay the road as you can. Grip your steering wheel and pray.

Of course, you may encounter other emergencies. To keep from ending up as a highway accident statistic, you've got to develop the right basic responses so that you re-act automatically in the crucial few seconds before a possible crash.

To avoid meeting such emergency situations, learn the art of defensive driving. It may save your life.

(From 'Coronet', April, 1961)

PRE-QUALIFICATION OF TENDERERS

IT is the Department's practice to accept the lowest of tenders offered for road or bridge work, provided the lowest tenderer can produce satisfactory evidence of capacity. In practice it is sometimes difficult to judge the value of evidence submitted, and a tenderer is likely to be given the benefit of any doubt which may exist.

This practice has led in a number of instances to contractors being given work which has later proved to be beyond either their financial or technical capacity, often finally involving them and the Department in loss or indifferent results.

In the United States it is a common practice to assess the capacity of prospective tenderers in advance, and only to accept tenders from those who are of proved capacity for work of about the size and nature under consideration. For example, a contractor may be "pre-qualified" to tender for bridges up to 50,000 pounds in value, up to 100,000, pounds up to 200,000, pounds and so on, depending on his proved capacity. If a contractor demonstrates his capacity to carry out successfully work valued at say 100,000, pounds he may then be "pre-qualified" to carry out future works up to a larger sum. A beginner would be pre-qualified for a low figure, and the figure would rise as he proved himself.

The Department has recently undertaken discussions with the Federation of Civil Engineering Contractors with a view to the adoption of the "pre-qualification" procedure in respect, in the first place, of bridge contracts.

(From 'Main Roads', December, 1960)

A NOTE ON THE EFFECT OF MODULUS OF SUBGRADE REACTION ON THE THICKNESS OF A CONCRETE PAVEMENT

By

S. KOTESWARA RAO, B.E., M.TECH.*

SYNOPSIS

This article shows the effect of the modulus on the required thickness of a concrete pavement, and illustrates whether precise measurement of the modulus by the specified test is necessary or whether its value can be assumed by other means for design purposes.

WHEN a concrete road slab is loaded over an area in any manner, the subgrade beneath it offers reaction in such a way that the reactive pressure at any point under the slab is proportional to the vertical deflection of the slab at that point, i.e., if p is the reactive pressure, and δ is the vertical deflection at a point, p is proportional to δ or $p = k\,\delta$ where k is the constant of proportionality. This constant is termed the modulus of subgrade reaction, and is generally symbolized as 'k'. All rational formulae for the design of concrete pavements take this modulus into account. The question of the necessity or otherwise of the accurate determination of the modulus is of practical importance to the engineer because of the labour involved in its determination.

Modulus of subgrade reaction is determined by plate-bearing test carried out by loading a 30-inch diameter circular rigid plate on a prepared subgrade to a value of 10 lb per square inch (7,070 lb) and recording the deformation in inches with this load. The load is applied almost instantaneously, viz., in 10 seconds and is held until practically complete deformation has taken place. If δ is the total uniform deformation in inches under the plate, during the application of the load, the modulus of subgrade reaction $k = 10/\delta$ lb/sq. in./inch deflection. The equipment needed for a plate test is cumbersome, involves a heavy loading device such as loaded trucks or an anchored steel frame, a set of mild steel plates of different diameters ranging from 12 inches to 30 inches, a hydraulic jack to transfer the loads on to the plates, dial gauges to record the deformation of soil, and an independent rigid steel or aluminium frame to suspend the dial gauges. Because of the heavy equipment involved it is seldom feasible to conduct the test. Further in a road of considerable length the engineer is sure to encounter subgrades of varying quality which necessitates conducting the plate test at various points involving lot of expenditure and time. In view of the above difficulty it is worth while to examine to what extent of accuracy the k-value should be determined in order not to affect the designed thickness of a pavement seriously.

To illustrate this point, design curves using different values of k are prepared and shown in Figure 1. The design is carried out by the generally favoured Pickett's corner load formula

$$\sigma_c = \frac{4 \cdot 2p}{hr}\left(1 - \frac{\sqrt{\frac{a}{l}}}{0 \cdot 925 + 0 \cdot 22\frac{a}{l}}\right)$$

in which

σ_c = Allowable tensile stress in concrete in lb/sq. in.

p = Maximum wheel load in lb.

* Indian Institute of Technology, Kharagpur.

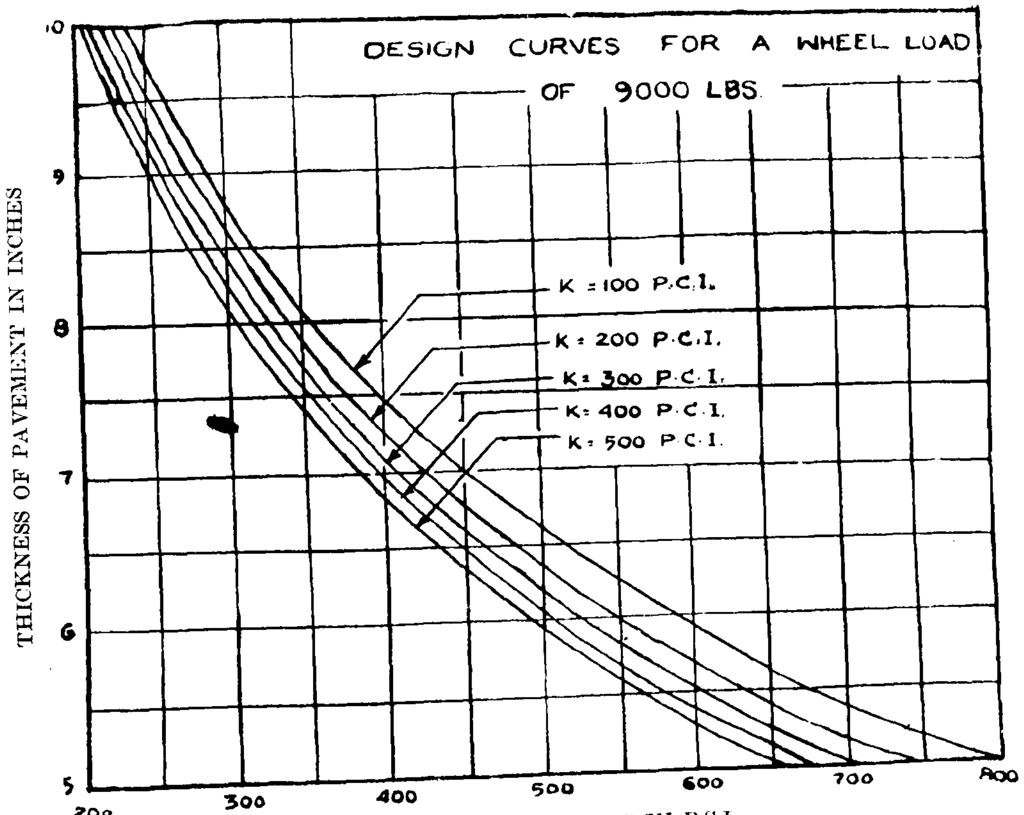


Figure 1

h = Thickness of the pavement in inches.

a = Radius in inches of tyre contact area which is assumed to be circular in shape.

l = Radius of relative stiffness (in inches) which is defined by the equation

$$l = \sqrt[4]{\frac{Eh^3}{12\,(1-\mu^2)\,k}} \quad \text{where}$$

E = Modulus of elasticity of concrete in lbs /sq. in.

μ = Poisson's ratio for concrete ; and

k = Modulus of subgrade reaction in lb/cubic inch.

The values used in Figure 1 are

p = 9,000 lb ; $E = 4 \times 10^6$ lb/sq. in. ; $\mu = 0.15$ and

a = 5·35 inches (assuming a tyre contact pressure of 100 p.s.i.)

The curves are drawn for 5 values of k between 100 p.c.i. and 500 p.c.i. Engineers are familiar that a soil whose k-value is 100 p.c.i. is considered a very poor subgrade whereas a soil with a k-value of 500 p.c.i. is considered an excellent subgrade. This means that the k-values adopted in Figure 1 represent subgrades ranging from very poor to excellent.

An examination of Figure 1 reveals that determination of the subgrade modulus to the nearest 100 units is sufficiently accurate for design purposes. An error of 100 units in the k-value would not have varied the designed thickness by more than quarter of an inch. However for heavier wheel loads the effect of k will be little more pronounced. For example considering the same quality of concrete as in the previous cases and

allowing a working stress of 350 p.s.i., a corner load of 60,000 lb. acting on a single wheel would require 24 inches thick pavement for a subgrade with a k-value of 100 p.c.i. ; and 23 inches thick pavement for a subgrade with a k-value of 500 p.c.i (the tensile stress produced in both cases being 330 p.s.i.). For the case of 9,000 lb wheel load, for the same working stress, the corresponding thicknesses would have been 8 05 inches and 7.40 inches showing a difference of only 0.65 of an inch as against one inch in the former case. However Roads Administration (U.S.A.) soils classification or the Casagrande soils classification[1]. The k-value may more suitably be adopted from the P.C.A. (Portland Cement Association) curve connecting California Bearing Ratios of Soils with their k-values. The curve is given in Figure 2 for ready reference. If the C.B.R. value of a soil is known its k-value can be readily read from this curve. The C.B.R. test is a standard test on soils requiring very simple equipment and it should not be difficult to obtain the C.B.R. values of soils. The method of

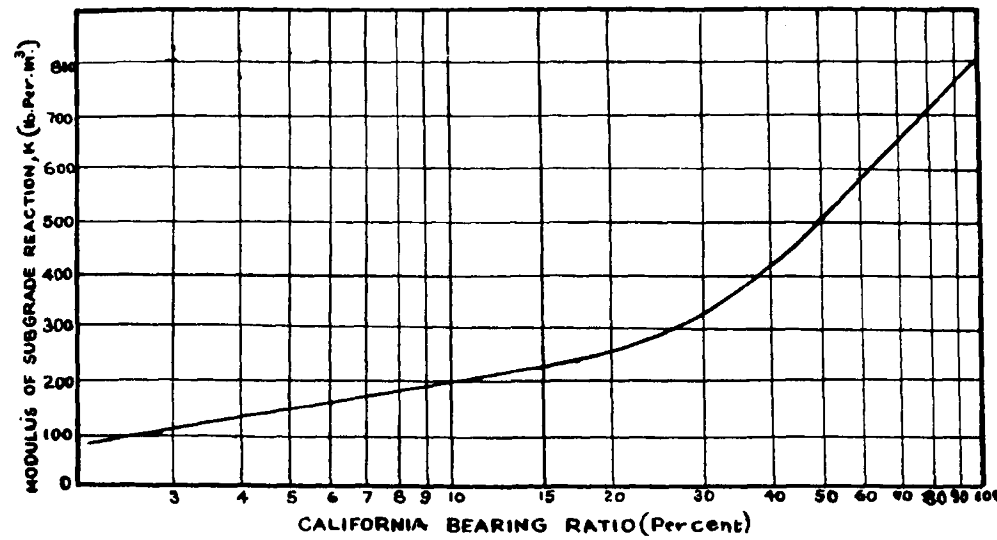


Figure 2

wheel loads greater than 9,000 lb are seldom anticipated on highways and in this case the insignificant change in the required thickness of a concrete pavement due to a considerable variation in the k-value is evident. Hence it is suggested that when it is not feasible to conduct a plate-bearing test, the value of k can be assumed from available publications which show the approximate range of k-values for soil groups classified by either the Public adoption of k-values from C.B.R. values is very helpful to the engineer for preliminary design purposes. Frequently in the investigation stage of a road project the engineer has to decide upon the economical form of construction which involves a choice between a flexible and a rigid pavement. A flexible pavement can be readily designed from the C.B.R. values and a curve of the P.C.A. type is equally handy in the design of a rigid pavement.

[1] Classification and identification of soils by Arthur Casagrande. Proceedings A.S.C.E., June, 1947, Page 783.

SOIL CEMENT FOR CITY STREETS

In the summer of 1960, the City of Saskatoon, Sask. carried out a soil cement experiment on a 1,500 foot section of street. The resultant economies would suggest that this method may be used much more extensively in that city.

THE conventional method of street construction wherein 8 to 16 inches of earth is removed and then replaced with compacted, graded base material and topped with a minimum of $1\frac{1}{2}$ inches of hot-mix asphalt provides an ideal solution to an all-weather, dust-free road. However, since costs are increasing beyond a comfortable figure, the City of Saskatoon found it necessary to investigate and determine whether there were other methods which would be as satisfactory and yet provide the much-needed economies.

After much deliberation and consultation with other road building authorities, it was decided that soil cement construction offered about the most economical solution, and that an experimental study should be done before proceeding on any full scale programme.

A 1,500-foot strip of street that carries medium to heavy traffic was selected for the pilot study, and the work was carried out in the summer of 1960.

Laboratory Tests

Before any work was done various laboratory tests were run to determine the following points :

1. Natural water content.
2. Grain size.
3. Liquid and plastic limits.
4. Compaction tests on natural material and on material to which was added 6%, 8%, 10%, 12%. and 14% of cement by weight (based on dry soil weight).
5. Compression strength tests on sample moulds made from the material with the cement content as listed under point 4.

TABLE 1

Analysis of compaction and compression tests

Cement content % by weight	Optimum water content %	Maximum Lb per cubic foot	3-day compressive strength average PSI	7-day compressive strength (2-tests)	28-day compressive strength (3-tests)
No Cement	8.6	125.0	—	—	—
6	10.1	124.2	192	182	236
8	9.6	123.8	168	212	320
10	8.8	126.1	268	355	550
12	8.4	125.9	305	427	646
14	8.2	124.3	379	434	642

The laboratory tests carried out revealed that the following existed :

1. Natural water content was 6.3%.
2. Liquid limit was 35, plastic limit was 20, which provided a plastic index of 15. This revealed a soil in the low to medium plastic range.
3. The sulphate salt content based upon dry weight was 0.43%.
4. Sieve analysis showed that the material contained 25% gravel, 55% sand and 20% silt and clay.

Table 1, provides an analysis of the compaction tests and the compression tests carried out in the laboratory.

It will be seen from these results that the sulphate content was fairly high. Regardless of this it was decided to use 10% of Portland Cement. Our engineers established

For this experiment, cement was distributed manually, but in large scale operations a specially designed cement spreader is used for this purpose

Pulvi-mixer thoroughly mixed the soil and cement to a depth of 6 inches under wet conditions

that a minimum compressive strength of 300 p.s.i. would be required and Table 1 shows that the results were well above the established criterion.

Having completed the various test analyses, and having had employees of this Department check with the methods of construction used in the City of Edmonton, we proceeded with the programme.

Sequence of Operations

The roadway was first shaped with a patrol grader and, where necessary, gravel was added in order to bring the street up to the proper grade. The entire surface was then scarified to a depth of 6 inches and pulverized with an American Marietta Pulvimixer. Since the project was very small it was not possible to use a bulk cement spreader and, therefore, bagged cement was purchased and spotted in a grid pattern to give the required cement content. And, since this was an experiment, the staged length development was limited to 300 feet of street.

The cement sacks were then broken and the entire surface was mixed with the Seaman-Andwall Pulvimixer to a depth of 6 to 8 inches. The first mix was carried out under dry conditions, and the last two under wet conditions. Water was added in order to provide about three gallons per square yard, the water being run from a tank truck through the Seaman-Andwall mixer. The quantity of water required was started out on a trial-and-error basis, with the result that the water content on the first section was too high. Some of the test results of this paper will reveal the disadvantages of having too great a water content.

After mixing, the road surface was compacted first by an Essick Vibratory pull type compactor, and then by a Ferguson self-propelled wobbly wheel roller.

Density checks were taken after the first and second passes of the vibratory compactor, and the following results are expressed as a per cent of Standard Proctor :

Section 1

(Unintentional Excess Water Used)

First Pass	89.9%
Second Pass	101.8%

Section 2

First Pass	101.8%
Second Pass	113.6%

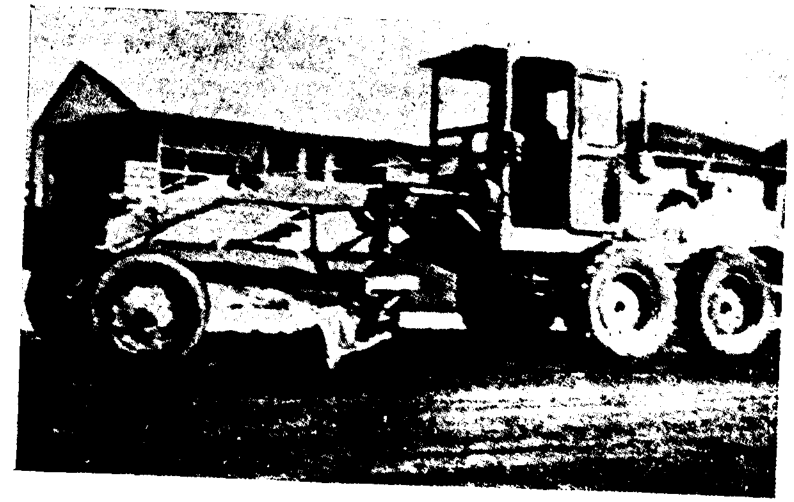
Density of sections 3, 4 and 5 of the experiment were taken after compaction was completed and were as follows :

Section 3	113.5%
Section 4	113.2%
Section 5	111.2%

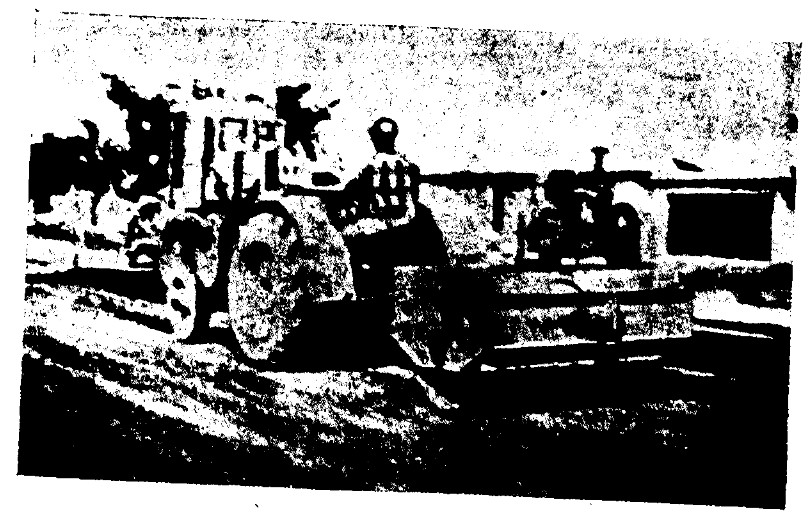
TABLE 2

Analysis of field mixes

Test Number	Dry Density lb per Cubic Foot	Water Content %	7-day Compressive Strength
1.	128.9	8.8	440 p. s. i.
2.	126 1	9.6	400 p. s. i.
3.	135.2	5.0	630 p. s. i.
4.	133.3	8.1	740 p. s. i.
5.	132.4	8.0	400 p. s. i.
6.	121 8	11.1	73 p. s. i.



Mixing is followed by grading to smooth surface prior to compaction



Finished product is compacted with an Essick vibratory roller

To prevent penetration of water into the surface and a subsequent spalling, each section was sealed with approximately 0.25 gallons per square yard of MCO as soon as compaction was completed. The street was then closed to traffic for seven days and a sand-seal coat, comprising 0.25 gallons of RS2 and 25 lb. of sand per square yard, was applied.

Checking Results

In order to check the actual field results with the laboratory tests, several field mixes were taken, made into molds and tested. The results were as follows :

Test No. 6 of the above table was on that section of work which had too great a water content, illustrating very clearly the undesirable results of adding too much water to the mix.

Table 2 also reveals that the field tests have a highei 7-day compression strength than the laboratory tests. This may be

(Continued on page 33)

PROOF ROLLING OF SUBGRADES

NEW DEVELOPMENT IN U.S. HIGHWAY PRACTICE

ONE of the most significant developments in the current road building art in the United States is that of requiring test rolling of the earth subgrade prior to acceptance as a support for the pavement. Several State Highway Departments have inaugurated this practice. It has added little to the cost while greatly improving the completeness of quality control as compared to field-laboratory testing of samples alone.

As a basis for finding remaining weak spots, the North Carolina contractors on federal-aid highway projects are required to test-roll every square foot before receiving approval and final payment for their work. This testing is done after all of the usual construction specifications pertaining to embankment and subgrade construction have been fully complied with. These requirements of course include usual rolling of material placed in layers.

Following a period of trial as a special provision or a supplementary contract item, proof rolling was embodied in North Carolina's new standard specification book (April, 1959). Section 36 spells out the proof rolling in considerable detail, saying specifically that this item " shall consist of furnishing and operating at the Engineer's direction heavy pneumatic-tired compaction equipment for compaction and testing for stability and uniformity of compaction of the subgrade, sub-base, and soil or aggregate base course or other areas which the Engineer may direct ".

This specification is not intended to limit the use of heavy rubber-tired compactors just to proof rolling, but it does require that such a roller be available for this purpose. In actual practice on major arterial projects, particularly Interstate jobs, the North Carolina Engineers have insisted on proof rolling at least the complete subgrade before acceptance.

An example is the project here pictured, that of Thompson-Arthur Paving Co. of Greensboro, covering a segment of Interstate 1-85 north of Durham. As a result of proof rolling the complete template grade along one of the dual roadways in this 11.5-mile job, change orders were issued requiring over 200,000 dollars expenditure for subgrade drainge. The need for this drainage had not been anticipated, and wouldn't have shown up immediately under ordinary compaction procedures.

The weaknesses looked for in proof rolling may stem from any of several causes. The material may be found insufficiently compacted. Areas of poor material may show up. Or wet, springy spots may indicate need for better drainage. In any event, the inspectors look primarily for evidence of excessive resilience or rutting. Considerable depression with surface cracking immediately around the tires means trouble to the inspectors.

A point of particular interest in the North Carolina procedure is the inspection vigilance. One and preferably two inspectors walk alongside or immediately behind the compactor, with their eyes on the tires and tire paths.

Proof rolling is done only when a qualified inspector is present, and complete records of the rolling are kept and the conditions indicated. This inspector, assigned by the Resident Engineer, has the power to approve or disapprove the subgrade, supervise correction, etc.

The test rolling equipment is specified to consist of four heavy rubber-tired wheels mounted in a single axle line on a rigid frame. The four evenly spaced wheels must be independently mounted so as to carry approximately even loads when operated over uneven ground. The maximum spacing between wheel centres is 30 in. This leaves about 12 in. clear space between tires, so that successive staggered passages create a slight overlap of surface coverage.

Test rolling a completed subgrade on a route 1-85 project in North Carolina. Note the two inspectors walking along with eyes on the tire paths. The plastic tarpaulins were placed to help maintain a constant moisture content (and weight) for the sand ballast.

A suitable body is required for ballasting to provide gross loads between 25 and 50 tons as the Engineer directs. The specifications leave it open for the contracter to substitute some other type of rolling vehicle of equal or better effectiveness, with written permission of the State's Chief Engineer.

Tire pressure is an important detail in the testing. Pressure ranges are specified between 60 and 150 psi, and 90 to 95 per cent of the tire volume is to be filled with liquid. The contractor must furnish the engineer with charts showing the contact areas and contact pressure for the full range of inflation pressures, and for the full range of loadings for the particular tires used.

Ballast for the compactor is also subject to specification control, iron pigs, sand bags or other units are specified that can be readily checked for weight accuracy by the engineer. Ballast must be on hand for weighting up to the full 50 tons maximum if considered desirable.

For sub-base or base courses, rubber-tired tractors are required. For subgrade testing, a crawler tractor is permitted. Ability of the compactor and tractor to make a 180-degree turn on a 27-ft wide grade is one other detail considered essential and so specified.

The subgrade and (if involved) the base course must be prepared and compacted in accordance with the specifications including density. Then follows the further compaction with the test roller.

The first step is to give the subgrade section two or more complete " coverages " with the compactor. This term is defined as meaning that stage in the rolling when the entire width of the grade has been passed over by a roller tire. The roller's speed is between $2\frac{1}{2}$ and 5 m.p.h. and effort is made to maintain the same speed as well as tire pressures throughout a given test operation, to eliminate variables in judging the subgrade's condition.

After the second coverage is made, if the engineer sees signs of developing weaknesses, a third coverage is ordered. Should suspicious conditions warrant it, test borings are made and the samples studied for moisture content and other conditions. Or, pits may be dug with a backhoe to facilitate more complete inspection to find the reasons for non-uniform stability.

The specifications require that the contractor correct unstable areas by any of the following means:

1. If the quality of the soil is found acceptable and the instability of the subgrade is due to high moisture content, the soil may be ordered aerated, recompacted when drier, and again test rolled. No payment is made for drying the soil.

2. If the soil is found to consist of material high in organic matter, mica or other objectionable material whose instability is not due to moisture content alone, the material must be removed and replaced with satisfactory material. Following recompaction, test rolling is again done for final acceptance. The material removed is classified and paid for as Unclassified Excavation, and the replacement material paid for as Borrow.

A shoulder drain being installed along a section of finished grade on the North Carolina project here described.

Base courses are proof rolled in essentially the same manner and with the same provisions for correction.

Payment for proof rolling is made by roller-hours. No payment is made for idle equipment due to repairs, servicing, loading or unloading ballast, changing tire pressure, bad weather, wet subgrade, or standing by, just hours of actual rolling.

The unit bid price for such rolling for the Thompson-Arthur project was 50 dollars per hour. The price has ranged from 15 dollars to 50 dollars on recent North Carolina projects. It is not known exactly how much this new requirement may have upped the bid price for grading and base construction. The difference if any has reportedly not been great, and the procedure has the whole-hearted approval of the North Carolina State Engineers and the understanding and co-operation of contractors.

The test rolling has been more than just a construction tool. It has added to the knowledge of the engineers in soils and road design. The drainage required for the Thompson-Arthur project, for example, represents a revised approach. These drains consist of 6-in. helical corrugated metal pipe, perforated at the under-quarter points. The drains are set in herringbone or transverse position in the subgrade. The chief " new " details are two: one is that the need for the drains was discovered during construction, rather than after the road had begun to carry traffic and to develop untimely defects. The other is that such drains are now often set deeper than was formerly considered necessary. On the Thompson-Arthur job the depth is 5 to 7 ft below bottom of pavement, compared with 3 to 5 ft usually specified for subgrade drains in the past. The heavy compactor, with high tire pressures simulating the severe conditions of a modern arterial highway, produced a pumping action here that necessitated deep drains for effective correction.

This better understanding of drainage needs is now expected to lead to extensive use of drains in connection with widening and resurfacing existing roads in North Carolina.

(From " World Construction ", November, 1960)

(Continued from page 29)

due to the fact that, before work was started on this road, gravel was added in order to bring it up to the desired height. Also the water content may have been more select than that which was done in the laboratory.

Eventually, on some of the residential streets in our city, we will be able to utilize the native materials for the provision of a stable, all-weather, dust-free street. If economies can be experienced, and if job conditions are as favourable as the experimental project reveals, then there is a strong likelihood that the City of Saskatoon will proceed with a great deal of this type of construction.

The job costs for this experiment, of course, are higher than for a large project—for example, bagged cement is much more expensive than bulk cement; also costs can be reduced appreciably through improved methods of spreading.

This experiment cost the City of Saskatoon 1.30 dollars per square yard, as compared with an adjacent paved street which cost 2.50 dollars per square yard to construct. Using bulk cement with a cement spreader, the city feels that the cost of soil cement stabilization could be reduced to 1.05 dollars per square yard.

Guidance and advice on this project were provided by Inland Cement Company, B.B. Torchinsky and Associates Ltd., Consulting Engineers, and the City of Edmonton Engineering Department.

(From " Roads and Engineering Construction ", January, 1961)

A five-year-old boy, outshopping with his mother, got lost in a crowded department store. " Well, young man," "said the floor manager, " What does your mother look like ? "

The youngster answered through his tears, " She's the lady with a lot of packages and no money ".

NEW STANDARDS OF WIDTH OF HIGHWAYS IN AUSTRALIA

DURING the year, higher standards of width were adopted for pavement and shoulders on State Highways. These will be applied when old lengths of pavement are reconstructed or widened. For some time it had been apparent that older standards were insufficient to meet the needs of fast and heavy traffic, but previously the Department did not feel that funds available would permit a change. Although funds are still far from adequate, the need for greater widths is increasing and cannot be longer resisted.

A pavement width of 24 feet has been adopted for the Hume Highway, Federal Highway, Pacific Highway, Prince's Highway, between Sydney and Nowra, and the New England Highway between Hexham and Tamworth. A width of 22 feet has been adopted for all other State Highway pavements, but this will generally be reduced to 20 feet if traffic is less than 150 vehicles a day, although the 22 feet width will be adhered to if the pavement is of loam or the shoulders are of black soil.

Where pavements are 24 feet wide—shoulders will be made 10 feet wide, excluding width of table drain. Where pavements are 22 feet wide, shoulders will be six feet wide on fillings and four feet wide in earth cuttings, excluding table drain.

In all cases in rock cuttings, a concrete table drain will be built two feet from the edge of the pavement, which will be extended to the kerb of the drain. In such cases, therefore, the shoulder will be two feet wide only.

(From "Main Roads", December, 1960)

HERE AND THERE

1. "TALKING" ROAD WARNS OF HAZARDOUS CURVE

By

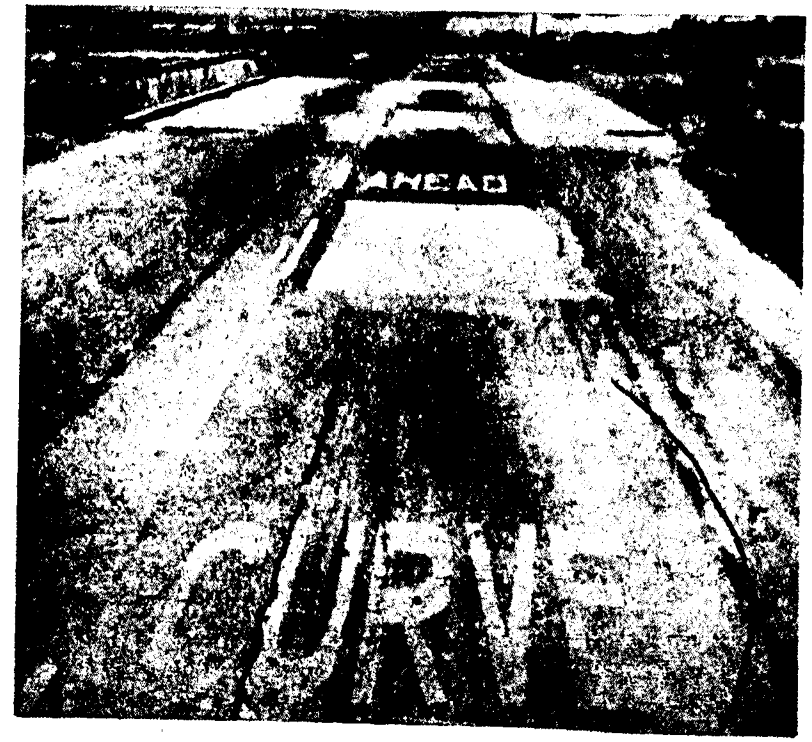
KENNETH R. MACDONALD

● A HIGHWAY that tells drivers to "slow down" is now being tried out in Richmond, Calif. The Contra Costa County Public-Works Department and a private firm are jointly engaged in testing a rock and plastic "rumble strip" system that sends sound and vibration warnings through the frame of an automobile as it passes over patches of the material placed ahead of danger spots in the road.

The experiment is expected to indicate whether motorists will slow down for hard-to-see traffic hazards if they get a warning signal. The location chosen for the test is a 1-mile section of a county road that abruptly makes a 90-deg. turn just over a low hill.

An average of seven major accidents a year was the record at the location chosen. Motorists failed to decrease their speed in time to make the turn. Skid marks indicate many narrow escapes.

The experimental rumble strip consists of a high impact polyester resin that binds the sound-producing rock chips in a tough skid-resistant layer that is expected to stand up for 5 years or more under hard usage.



A view of the rock-and-plastic rumble strips constructed in Contra Costa County, Calif., to warn and slow down vehicles approaching the sharp curve in background.

In constructing the strips, county road crews coated an area 10 × 25 ft in size with penetration-grade asphalt over asphaltic or Portland-cement-concrete surface without any pre-treatment. This was followed by crushed rock, distributed by a mechanical spreader over the asphalt film. This layer was rolled with rubber-tired rollers, after which the resin was sprayed over the entire strip and then blotted with coarse sand.

The strips were laid down at intervals as predetermined by studies of minimum and maximum speeds on the particular stretch of road involved. Driver-reaction times and other related factors were supplied by radar traffic studies.

The resin was mixed in two containers. The first contained the resin and a cobalt naphthenate promoter and the second contained the resin and a methylethylketane-peroxide catalyst. Twin spray guns were used to apply the resin at a predetermined rate and pattern. Ingredients of the two containers remain separate until they emerge from the spray heads.

(From "Better Roads", April, 1961)

2. AUSTRALIAN ROAD RESEARCH BOARD

● REFERENCE was made in the last Annual Report to the decision of the National Association of Australian State Road Authorities to proceed to establish an Australian Road Research Board to coordinate, encourage and arrange for research work into such problems as cheaper and better road surfaces, traffic flows, road safety, planning to meet future needs, and the economics of road transport.

At a meeting of the Association held in Sydney late in 1959, the constitution of the Board was finally drafted, following on which the proposal was submitted by each of the State Road Authorities to its Government for approval. All six State Governments approved it. At a further meeting of the Association in Sydney in March, 1960, it was formally resolved to establish the Australian Road Research Board, and the Board then held its first meeting, the members of the Board being as follows :—

Commissioner for Main Roads, New South Wales ;

Chairman of the Country Roads Board, Victoria ;

Commissioner of Main Roads, Queensland ;

Commissioner of Highways, South Australia ;

Commissioner of Main Roads, Western Australia ;

Director of Public Works, Tasmania ;

and Director-General, Common Wealth Department of Works.

In May, 1960, the Board appointed Mr. D. F. Glynn to the position of Director, which will be the chief executive position on the Board's staff.

It is intended that the Board will hold periodical conferences or symposiums for the presentation and discussion of papers on road research, publish the results of road research, and make grants for carrying out road research to Road Authorities, Universities, the Commonwealth Scientific and Industrial Research Organisation, and similar bodies.

The Board proposes to set up an Australian Road Research Advisory Council comprised mainly of research specialists to advise it on the organisation of research projects.

The finances of the Board will be provided by contributions from the various State Road Authorities, each contributing to annual budgets for approved road research works proportionally to the percentage payments to the State adopted by the Commonwealth Government in the Commonwealth Aid Roads Act operating at the time.

The headquarters of the Board are provisionally to be in Melbourne, pending consideration of ultimate establishment at Canberra.

(From "Main Roads", December, 1960)

3. SURVEY OF NEEDS

● IN the United States of America, many of the individual States have carried out detailed surveys of needs in order that the extent and priority of these may be known, and financial provision made to meet them, over a suitable period. Recently, the Department of Main Roads has carried out such a survey of road needs for the next ten years in New South Wales. It was done in a more detailed fashion than any previous assessment of road needs in this State, and has followed the lines of such surveys in the United States of America. The survey comprised the following stages :—

(1) deciding the road standards which should be aimed at for roads carrying traffic of various volumes ;

(2) a detailed survey of the standards already achieved on country State Highways, and on metropolitan Main Roads, and the extent to which improvements are needed reasonably to meet traffic needs within the next ten years ;

(3) a similar detailed survey of the needs on other country Main Roads in typical shires throughout the State ;

(4) study of the life to be expected from present road surfaces, having regard especially to experience over past years ;

(5) traffic surveys to ascertain in each case the volume of traffic at present using the road, and estimates of its probable growth in the next ten years ;

(6) an estimate of the funds, needed to bring the roads within ten years to the standard needed to meet estimated traffic needs at the end of that period ;

(7) an estimate of the amount needed for maintaining the Main Roads during the ten-year period ;

(8) an estimate of the revenue likely to be available to the Department of Main Roads during the next ten years if present tax rates are continued unchanged ;

(9) the extra sum required to enable the ascertained needs to be met during the ten years, assuming that money does not continue to loose value ;

(10) the amount required assuming the present trend of loss of purchasing power continues ;

(11) examination of the question as to whether the money, if provided, could be spent within the ten-year period.

It was concluded that, subject to funds being available, all the works seen to be needed on Main Roads could be accomplished within the ten-year period except for some of the needed expressway construction in the metropolitan area, where it was considered unrealistic to expect that the land could be cleared of building, and plans and specifications prepared for construction, sufficiently quickly to enable the carrying out of all the programme judged to be needed within the next ten years.

(From "Main Roads", December, 1960)

4. HIS ROYAL HIGHNESS PRINCE PHILIP SPEAKS ON THE GAP BETWEEN RESEARCH RESULTS AND THEIR INDUSTRIAL APPLICATION

● PRINCE Philip in his speech at the Annual Conference of the Department of Scientific and Industrial Research, London stated: "In the abstract it is obvious that improvements should be applied at once. But it is not altogether surprising that when things are going well the manufacturer does not want to change and when things are going badly he cannot afford to change!" He has, too, a knack of drawing a moral, though often he conceals the fact behind the facade of a quip. "I have found that I can get almost immediate attention when going round a works if I just happen to mention that I have seen a much better machine or process or idea in some other factory. Following on from that I am frequently struck by what seems to me to be an extraordinary lack of knowledge of what is going on in other works of the same industry in this country and particularly abroad. There is a certain amount of interest in America but very little indeed in Europe. It would seem therefore that if Research Associations could encourage manufacturers to go and look at each other's works and at similar works abroad it might stimulate a greater interest in the rapid application of research results." When we heard them those words struck strong responsive chords in us; for we have held the view for years–and expressed it too that there is too much secrecy in this country. It seems to use that it is the backward firms who dare not let competitors see their works; and that it is the progressive ones, confident of their ability to improve upon existing designs and processes, which are least secretive and most ready to learn from others. True also of many firms in this country and untrue only of few were Prince Philip's words about the lack of knowledge of what is going on in Europe. Sadly we think it may be especially true of mechanical engineers and we wish the Institution of Mechanical Engineers would take its members abroad for Summer Meetings—especially to the Continent—more often.

(From "The Engineer", May 5, 1961)

Composer Gioacching Rossini was once told by his doctor, "Your trouble stems from wine, women and song."

Rossini thought this over a moment, then said, "I can get along without the songs, since I compose my own."

"Which of the other two are you prepared to give up?" asked the doctor.

"That", replied Rossini, "depends entirely on the vintage."

TENDERS ACCEPTED

Particulars of Tenders accepted by the Kerala State.

Name of State	Name of work.	Name of accepted tenderer.	Amount of work.	REMARKS
Kerala.	(1) Constructing 2 bridges at miles 49/6 and 50/1 of Vattamkulam-Ponnani Road in Palghat District.	Sri V. K. Kuriakko Puthenkurissi.	Rs 2,68,504	These two bridges are proposed to be constructed at miles 49/6 and 50/1 of Vattamkulam - Ponnani Road in the Palghat District. The bridge consists of a single span of 66′ 0″ and 42′ 0″ respectively (centre to centre of piers). The superstructure of each bridge consists of 3 cantilever beams at 8′ 3″ centre to centre.
	(2) Reconstructing the Kootilangadi bridge at mile 411/6 of Madras-Calicut Road.	M/s. Veera & Raghava, Engineering Contractors, Madras.	8,31,627	The bridge is proposed at 660 ft. upstream of the old bridge at mile 411/6 of Madras-Calicut Road. The bridge consists of 5 equal span of 60′ 0″ clear T. beams, and deck slabs are provided for I.R.C. standard loading for 60′ span and road width of 22′. The deck slab rests on T. beams 69″ x 18″.
	(3) Reconstructing the bridge at mile 28/1 of Mannarghat Chinnathadagam Road.	Sri C. J. George, contractor, Kanhiramattom P. O., Ernakulam.	2,53,016	This bridge is proposed to be constructed at mile 28/1 of Mannarghat - Chinnathadagam Road. The bridge has 3 spans of 64 ft. The superstructure consists of 3 Tee beams with deck slab.

LIST OF PUBLICATIONS ADDED TO THE ROADS WING LIBRARY

(Continued from July, 1961 T.C.M.R.)

1. **Proceedings of the Twenty-first Annual Highway Engineering Conference, March 8-9, 1960.** (*Bulletin of the University of Utah, Vol. 51, August 30, 1960, No. 12, Bulletin No. 105*). Published by College of Engineering, Department of Civil Engineering. University of Utah.

2. **Aluminium Bridges by Bhaswu Rai** presented at the 5th Annual Meeting of Indian National Group of IABSE held at Bhopal on the 6th January, 1961.

3. **Aluminium Bridges by Gleaswala** presented at the 5th Annual Meeting of Indian National Group of IABSE held at Bhopal on the 6th January, 1961).

4. **Classified Catalogue Code, Edition 4, 1958.** Published by Library Association, London.

5. **National Register of Scientific and Technical Personnel (Indians Abroad) Series S.T. No. 9—Scientists and Technologists, September, 1960.** Published by Council of Scientific and Industrial Research, New Delhi.

6. **Engineers—September, 1960: National Register of Scientific and Technical Personnel (Indians Abroad) Series E. No. 9.** Published by Council of Scientific and Industrial Research, New Delhi.

7. **National Register of Scientific and Technical Personnel—Consolidated Directory of Indians Trained Abroad—Engineers, Vol. I, January, 1960.**

8. **(Research Note on Mud Plastering for Rural Houses) Report on Tests on Cheap, Waterproof and non-Erodable for Mud Walls, December, 1960.** Published by Highway Research Station, Highway Department, Madras-25.

9. **Financial and Cognate Powers Delegated to Ministries and Heads of Departments, 3rd Edition, February, 1960.** Published by O & M Division, Cabinet Secretariat.

10. **Manual of Highway Engineering**: P. A. KRISHNASWAMY.

11. **All-India Civil List (corrected upto 1st January, 1960), November, 1960.** Published by Associated Advertisers and Printers, Bombay-7.

12. **IS: 1624—1960: Code of Practice for Field Testing of Building Lime and Lime Mortar.** Published by Indian Standards Institution, New Delhi.

13. **IS: 1607—1960: Methods for Dry Seiving.** Published by I.S.I., New Delhi.

14. **I. S. 1654—1960: Code of Practice for Design and Construction of Woods Stairs.** Published by I.S.I., New Delhi.

15. **Geology for Engineers by Trefethen (Third Edition).** Published by D. Van Nostrand Company, New York.

16. **Fundamentals of Transportation Engineering by Roberts G. HENNES.** Published by McGraw Hill Book Company, New York.

17. **Second Congress of the Federation Internationale Amsbrdom Internationale.**

18. **International Water Back fur due strassive Verbeh Restrechnik Vocubulario Internale Ingineeria de Trafico International Traffic Engineering Vocabulary Vocabulaure International dela.**

19. **American Society of Civil Engineers, 1960—Annual Report.** Published by American Society of Civil Engineers.

20. **Central Board of Irrigation and Power, India—Annual Report (Technical), 1957, Publication No. 66.** Published by Central Board of Irrigation and Power.

21. **Index Irrigation and Power Journal of the Central Board of Irrigation and Power, Vol. 16, 1959, Nos. 1—4.** Published by Central Board of Irrigation and Power.

22. **Irrigation and Power Research in India Research Pamphlet, 1960.** Published by Central Board of Irrigation and Power.

23. **Hamare Nabh Deep.** Published by Ministry of Transport and Communications.

24. **Strassenbau A-Z. IV/1960, 35. Nachiefer Wing.**

25. **IS: 1343—1960: Indian Standard Code of Practice for Prestressed Concrete.** Published by I.S.I., New Delhi.

26. **Yojna ke Vibhinn pehlu.** Published by Ministry of Information and Broadcasting, India.

27. **Tisri Panchvarshey Yojna—Prarambhik.** Published by Ministry of Information and Broadcasting, India.

28. **Dieselisation and Diesel Oil Taxation.** (*Report of the Council of Applied Economic Research, Prahanin Street, New Delhi*). Published by Deep Chand and Kishan Lal, Bangalore.

29. **Simple Method for the Determination of M.G.O. in Dolomitic Lines.** Published by D.S.I.R., U.K.

30. **The Technical Merits of Rubber and Additive to Road Binders.** The present position published by National Rubber Producers Research Association, England.

31. **Manual of Stream Gauging.** Published by Central Water and Power Research Station.

32. **Five-year report on Durable "All Weather" Roads at low cost with Rubberised Asphalt Emulsion.** Published by Nationl Rubber Development Board, Kuala Lampur, Fedaration of Malaya.

33. **Universal Decimal Classification 7/8 Roads.** (English translation typed copy.)

34. **Digest of a Study conducted at the Hindustan Cables (P) Ltd., Rupnarainpur in relation to: (a) Inventory Control and Purchase Policy, (b) Plant Maintenance and (c) Scheduling of Production.** Published by the Committee on Plan Projects (Industrial and Mining Teams, New Delhi).

35. **Specifications of Roads and Bridges in Nation Forests and Parks.** Published by Federal Roads Agency, Public Roads Administration, Washington.

36. **British Reinforced Concrete Reinforcements, 10th Edition.** Published by British Reinforced Concrete Engineering Co., Ltd.

37. **(Eastern Economist pamphlet) Public Section.** Published by Eastern Economist Ltd., New Delhi.

PERSONAL AND MISCELLANEOUS

1. We record with deep regret the death of Sh. D. M. Asarpota on the 15th February, 1961 after a long Illness. He was a member of the Indian Roads Congress.

2. We record with deep regret the death of Prof. D. Subba Rao, who was the Dean of the Faculty of Technology and Engineering, Baroda on the 12th October, 1959. He was a member of the Indian Roads Congress.

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