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LEARNING AND SKILL

[From 'Concrete & Constructional Engineering' London, May 1950]

THE Editorial Note in our January number, in which we urged that a higher standard of general education than is at present common was desirable before a young man started to concentrate on special training for his profession, brought a number of replies. Without exception these deprecated our suggestion that a course in the liberal arts should precede technical training, on the grounds of the extra expense and the longer time that would be spent at college. Since then the subject has been debated at some length in Parliament and elsewhere, and our view has been supported by many eminent men.

Perhaps Lord Chorley, in the House of Lords, pointed out most clearly one of the main problems when he said: "There is a very important distinction between the technologist and the technician, and I rather fear that there is a tendency to confuse the two. A technologist is a man who engages in the scientific study of the practice of industrial arts, and in the practical application of scientific principles and discoveries to the arts and to industry. In other words, he is a man who is concerned with the fundamental scientific principles on which technology rests. He is the commissioned officer of the industrial army, and it is from among these commissioned officers that more and more of the field officers of industry and its leadership generally are being drawn. The technician, on the other hand, is a person who carries out in a responsible manner approved techniques which are either common knowledge or specially prescribed by the management of the business. In other words, the technician is the non-commissioned officer of the industrial army." Or, as we expressed it, on the one hand there are scientists and engineers, and on the other hand laboratory assistants, designer-draughtsmen, computers of stresses, and others doing routine work in laboratories or in engineers' offices or practising as consulting engineers in the class of everyday work that needs no special degree of vision or special sense of engineering.

With a few fortunate exceptions, the education of all would-be scientists and engineers is the same, that is a general education up to the stage of matriculation in their early 'teens followed by intensive study of special subjects. The result may be a degree in science and sufficient knowledge to enable a man to get employment, but it is not education in the true sense of the word. Most of our correspondents expressed the view that this is all that is necessary, and so it is if the aim is to produce only "non-commissioned officers," men who are technicians only, of whom 'The Times' recently wrote, "It is a constant complaint from industry that many of them are unable to draft clearly a simple report of work for which they are responsible." But it will not produce - except by chance - men with a true scientific outlook.

The view that we have often expressed was recently emphasised by Dr. Percy Dunsheath, C.B.E., D.Sc., M.A., a director of an important industrial company. "It is essential," he wrote, "to get clear the difference between technical training and the education of technologists. The requirements for the education of the technologist and the requirements of industry are exactly the same - education in the fundamentals of science to a high standard, for technology is not, as is commonly supposed, concerned merely with the "know-how" of industry but with the application of scientific principles and the scientific method to solve current problems and to build up new branches of industry. But equally important is the question of general education. Industry is looking more and more for technologists in positions of leadership and of high administrative responsibility. In order that they may acquire the vision and the side grasp of affairs which such positions call for they need a background of more general culture, such as economics, languages, history, and philosophy. This has long been recognised in the foreign institutes, and of recent years by some of our own technological faculties.

Dr. Dunsheath suggests that this kind of education is best undertaken by the universities, while the technical training is best carried out by the technical colleges. A report issued by the Advisory Committee on Scientific Policy stated that "scientists" were being produced almost at the rate of 5,000 a year, and the only justification for the claim was that nearly 5,000 people were awarded a degree in science in the previous year. Some of these men may be potential scientists, but the number is very few because they have not the wider and more liberal education which is necessary in a scientist; they will be skilled in the routine work of one branch of science and be useful members of society, just as are men who are trained and become skilled workers in any other walk of life.

The narrow outlook that results from technical training without a liberal education is frequently to be noted in the engineering profession. We see, for example, in the Journal of the Engineers' Guild a claim that a man with a degree in engineering or who is a member of one of the premier engineering societies is "a properly and adequately qualified engineer and scientist." How often is this true? How many such men are competent to initiate and carry through a major work of engineering? By far the majority of them will for the rest of their lives be working as routine designers, either on their own account or in the employ of others, because their knowledge and ability do not fit them for more responsible work.

In the present system there is insufficient provision for giving extra help to men whose work shows that they have more than the average amount of natural ability. If he has not an exceptional degree of natural ability, no amount of education or training will make a man a brilliant scientist or engineer. Exceptional natural ability will, but rarely, produce exceptional scientists at an early age; for example, Marconi had but little school training when he transmitted wireless messages in his early twenties. In most cases a liberal education will be of untold help to men with natural ability. At present this is nearly always limited by the means of the parents and the need to start earning at the earliest possible age.

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A "NO"—MAN

* * *

The Minister of Transport, time after time, when asked in Parliament to remedy some outstanding danger spots, bluntly refuses to spend a penny. He has certainly earned for himself the contra epithet to "Yes-man." One wonders why a Minister of Transport (Roads Department) is necessary if his duty consists of nothing more than saying "No" to every proposed project, no matter how good, how necessary, how desirable, in the interests of safety and commerce.

(Extracted from 'Highways and Bridges'—July 19, 1950).

ROAD RESEARCH IN BOMBAY

THE inaugural meeting of the Road Research Sub-committee of the Board of Communications, Bombay, was held at Vallabh Vidyanagar, Anand, on the 3rd April 1950 under the Chiarmanship of Shri N. P. Gurjar, I. S. E., Chief Engineer, Public Works Department, Bombay (since retired), and was attended by Shri Bhailal D. Patel, Shri S.S. Naik, Prof. A. DeSouza, Shri L. W. Kale, members and Shri B. K. Choksi, Secretary. Shri N.C. Bulsara and Shri P.R. Jeevarajani were also present by invitation.

Called upon by the Chairman to start the discussion, Shri Patel referred to the practice of making high banks for road formation and said that in these days of fast motor traffic, it was unsafe to have high embankments as the bullocks were liable to shy and pull the cart with them down the embankment. He thought that a height of, say, 6 in. to 12 in., just enough to provide a dry subgrade, was all that was required and that the formation should, more or less, follow the general lie of the country and too much insistence need not be laid on long continuous stretches at a constant gradient.

Shri Kale referred to I.R.C. Paper No. 117 on "Water Bound Macadam"* and said that a 3 ft. height of bank was necessary to provide the required dispersal of load on to the natural ground. Shri Bulsara pointed out that Shri Patel's suggestion was already covered by the existing orders of the Bombay P.W.D.

Shri Patel then referred to the design of the base course. It was agreed by the members that motor vehicles of 17,500 lb. weight had come to stay and that roads should be designed for this load. Heavier vehicles than these should not, however, be permitted for general use until the road surfaces were properly built.

The Committee agreed that research on stabilized base courses was required. For this purpose, it would be necessary to carry out laboratory tests and field tests. For the former there should be four centres, each associated with an engineering college, one in each of the three regions of the State, viz., Gujarat, Maharashtra, and Karnatak, and one in Bombay attached to the V. J. Technical Institute for the special study of the soils of the Konkan area where rainfall was heavy and the moisture contents of the soils were comparatively high. The field tests would be carried out by the P.W.D. in the areas concerned.

Shri Patel said that the Engineering College at the Vallabh Vidyanagar would be very willing to carry out the laboratory tests if Government provided funds for setting up a laboratory.

The speaker then referred to the importance of traffic surveys both for existing as well as proposed roads. Such surveys were being carried out to a limited extent at present, viz., once a year on roads of military importance only. The Chairman was of the opinion that traffic survey for a proposed road alone was likely to lead to wrong conclusions and was therefore undesirable. The Committee decided that the data should be collected on a larger number of roads and more frequently than once a year. The speaker had collected some data in connection with roads on which Bombay State Transport was operating and he was requested to place that information before the Committee.

Coming to the question of wearing surface, the speaker was in favour of concrete because of its longer life and because cement, unlike asphalt, was an indigenous material. Before making any definite recommendations it was considered necessary to carry out experiments. Experimental lengths of new roads with the following type of wearing surface were proposed to be constructed in Gujarat, in sections 2 furlongs long and 12 feet wide.

	Cost of Experiment.
(i) Cement concrete slab, 4 in. thick, laid direct on the subgrade without any base course	Rs. 14,300
(ii) ,, but thickness of slab 5 in.	Rs. 17,000

* "Water Bound Macadam" by G. M. McKelvie and K. S. Raghavachary published in I.R.C. Journal Vol. XI

		Cost of base course.
		Rs.
(iii)	,, laid over a base course of brickbats or kankar 3 in. to 4 in. thick. Thickness of slab 4 in	2,000
(iv)	Same as (iii) but thickness of slab 5 in.	2,000
(v)	Water bound macadam 4½ in. thick over brick-on-edge base course.	15,000
(vi)	4 in. creteways (single track) with the intermediate portion and sides filled with 4 in. kankar, brick-bat, moorum or other suitable local material.	7,500
(vii)	Surface painting with asphalt over water bound macadam, single coat using 105-J Grade Socony or Spramex-E 30 to 35 lb. per 100 sq. ft. and 6 cu. ft of "kapchi," [stone grit about ⅝ in. size].	2,400
(viii)	,, double coat. First coat of 30/40 asphalt 20 lb. per 100 sq. ft. with 4 cu. ft. of "kapchi" and Second coat of 80 100 asphalt, 20 lb. per 100 sq. ft, with 4 cu. ft. of "kapchi."	3,700

These experiments were proposed to be tried first in the Gujerat area as the soil conditions in the other regions of the State (except in black cotton soil areas) are more favourable in that hard moorum and metal are easily available in adjacent places, whereas in Gujerat metal has to be transported over long distances by rail from a few quarries.

The experiment of creteways would be tried in other regions also, particularly in black cotton soil areas.

Improvements to Existing Roads

Experimental two furlong lengths of 4 in. thick concrete slab laid direct over the existing water bound macadam surface were proposed to be laid in all the four regions as well as in the black cotton soil areas.

Cheap Roads

The following two types of experimental sections were proposed:

		Cost: Rs.
(i)	Soil-cement road, thickness 6 in., length one mile, width 12 feet	20,000
(ii)	Soil-salt road, length 2 furlongs, width 12 feet	2,000

The total cost of the experiments is expected to be about Rs. 1,20,000.

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MADRAS LEADS

The incidence of provincial taxes in Madras is nearly 20 times as hevvy on certain categories of vehicles as the incidence in Bengal on the corresponding classes.

(*Extracted from 'I.R.F. Bulletin No. 9'—London, May ,1950*).

COMPARATIVE ROAD AND RAIL COSTS

(*Extracted from 'Motor Transport'—May* 27, 1950)

COMPARATIVE road and rail costs are the major issue of inland transport, and the report of Mr. C. M. Merrick's findings on the subject (*Motor Transport*, March 25) is both interesting and instructive.

The figures which he gives of the fall in road costs between 1928 and 1948 are very similar to figures presented by Mr. K. F. Glover in a lecture given before the Study Section of the Royal Statistical Society. Mr. Glover analysed various operating costs of road vehicles and produced the following table to show how they had declined since 1922.

	1½-ton lorry (300 miles per week)		4-ton lorry (600 miles per week)	
	Cost in pence per mile	Percentage based on 1922	Cost in pence per mile	Percentage based on 1922
1922	9·06	100	10·78	100
1926	7·73	85	8·77	81
1931	6·54	72	8·76	81
1934	5·98	66	7·27	67
1937	5·94	65	5·45	51
1948	9·54	105	7·41	69

Thus, from 1922 to 1937 the costs of the 4-ton vehicle were practically halved, and those of a 1½—ton vehicle reduced by more than a third. Mr. Glover pointed out that, statistically, the series would have to end after 1939, on account of the general rise in prices and the fall in real value of the pound sterling during the war years. The figures given for 1948 were, therefore, not strictly comparable, as there were no means of knowing how much of the rise in money prices was due to the fall in the value of money.

Against these tremendous reductions in road vehicle costs, Mr. Glover could not find much evidence of costs' diminution on the railways during this period. He found that the number of steam locomotives fell by 17 per cent from 1928 to 1937, but by 1948 it was only 14 per cent below 1928.

Engine miles per heavy repair improved by 12 per cent between 1928 and 1938, and per light repair by 13 per cent: in 1948 they were only slightly worse than in 1938. Railway staffs fell in 1938 by 10 per cent from the 1928 levels, but by 1948 they were about 8 per cent above the 1928 figure.

Road charges go down

Mr. Glover proceeded to compile a further table to show the extent to which these changes in cost relationships had gone. For road transport he took the cost of a 4-ton lorry running 600 miles per week, divided by four to reduce it to "cost per ton-mile of capacity." In broad terms, he explained, these costs represented the rates paid for road haulage, for road rates must substantially conform to road costs in view of the existence of C licence competition. For rail, he reduced the total receipts for general merchandise into receipts per ton-mile. Thus, in both cases the figures approximatly represented the price charged to buyers per ton-mile. By expressing the road costs as a percentage of the rail costs, he was able to show the extent to which road transport had relatively improved its position as against rail. His table was as follows:

	Charge to consumers per ton-mile (pence)		Percentage of road to rail charges
	By Road	By Rail	
1931	3·19	2·22	99
1934	1·82	2·04	89
1937	1·53	1.95	78
1948	1·93	2·94	66

The last column is the important one; and in this case the value of these figures is not vitiated by the change in price levels over the war years.

In the 18 years from 1931 to 1948, road transport has reduced its costs compared

with rail by nearly two-fifths. It is also interesting to note the effect of the wartime increase in the level of prices on the railway figures: railway charges to consumers went up by more than 50 per cent. It would appear that road transport whose increase was only about 33½ per cent has been able to offset the rise to some extent by means of increased operating efficiency.

* * *

Future Expectations

What of the downward trend of road transport costs? Most people will agree that we have not yet reached the end of this trend, and that, despite the unfortunate increases resulting from the Budget, further costs in road transport are certain. Mechanical and engineering improvements are continually coming forward, and there are bright prospects of better engines, such as gas turbines. The use of aluminium and light-weight materials to reduce unladen weight should assist both to increase carrying capacities and to reduce running costs. An increase in the speed limit of heavy goods vehicles from 20 to 30 m.p.h. would have its effect, as also would road improvements, many of them overdue.

It is reasonable to suppose that the present trends will continue, namely that road costs will continue to fall, while rail costs remain fairly stationary.

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Quiz Corner

ROAD ACCIDENTS QUIZ

DO YOU KNOW?

1. The number of persons involved in road accidents in British India in 1946–47 was approximately
   (a) 5,000 (b) 15,000 (c) 25,000
2. The number of persons killed in road accidents in the same year was nearly
   (a) 2,000 (b) 5,000 (c) 10,000
3. The ratio of the number of persons killed to the number injured was
   (a) 1 : 7 (b) 2 : 7 (c) 4 : 7
4. The number of casualities in the Governors' Provinces to the rest of British India was as
   (a) 10 : 1 (b) 30 : 1 (c) 90 : 1

Answers:

1(b); 2(a); 3(a); 4(b);

HISTORY OF FEDERAL AID FOR HIGHWAYS IN THE U. S. A.

(Extract from "California Highways & Public Works" Jan—Feb, 1950)

(Continued from our November Issue)

Express Highways

THE 1943 Act directed the Commissioner of Public Roads to make a survey of the need for a system of express highways throughout the United States. The result of this survey is published in a report submitted to the President and Congress entitled "Inter-regional Highways" and is the fore-runner of the future discussed Interstate Highway System.

This Act also broadened previous federal aid legislation regarding war-damaged roads and bridges to make federal financial assistance applicable to roads and highways damaged by the action of contractors of the Army and Navy engaged in work in connection with the prosecution of the war for the national defence.

Post-War Appropriation

Prior to the cessation of hostilities and as a basis for post-war construction the Federal Aid Highway Act of 1944 became law on December 20, 1944.

This Act authorised a $1,500,000,000 appropriation for a three-year post-war period to be made available to the states at the rate of $500,000,000 a year as soon as the President and Congress determined that the war emergency had been relieved to an extent that would justify proceeding with highway construction. (By concurrent resolution passed by the House of Representatives on September 27, 1945, and by the Senate on October 2, 1945, the first post-war fiscal year was established as ending June 30, 1946.)

Of the $500,000,000 yearly appropriation, $225,000,000 was to be utilized for improvements on the Federal Aid Highway System, $150,000,000 for secondary or feeder roads, and $125,000,000 for projects on the Federal Aid Highway System in urban areas. An urban area was defined as an area including and adjacent to a municipality or other urban place of 5,000 or more inhabitants according to the latest available census.

Urban Areas Established

The boundaries of urban areas were to be fixed by the state highway departments subject to the approval of the Public Roads Administration.....

The Federal Funds authorized for these three classes of Roads were apportioned to the states in the following manner: For improvements on the Federal Aid Highway System the formula established by the Federal Aid Road Act of 1916 was utilized, giving equal weight to the area, total population, and mileage of post roads in the State. The appropriation for secondary or feeder roads was apportioned to the states on the basis of one-third in the ratio to which the area of each state bears to the total area of all states, one-third in the ratio which the rural population in each state bears to the total rural population of all states as shown by the federal census of 1940, and one-third in the ratio which the mileage of rural delivery and star routes in each state bears to the total mileage of rural delivery and star routes in all the states.

In the apportionment of funds for improvements of the Federal Aid System in urban areas the factor of population of urban places of 5,000 or more was used exclusively.

Right of War Money

This Act permitted the utilization of federal Funds to assist in defraying a state's expense in connection with the acquisition of rights of way up to one-third of such cost. The Act also provided that up to 10 per cent of the sums apportioned to the states could be used to defray the entire expense in connection with the elimination of hazards of railroad-highway crossings. On such railroad-highway projects the act recognized that certain benefits would accrue to the railroads affected and as a consequence provided that such rail-roads should contribute not to exceed

10 per cent of the total cost of the railroad-highway crossing elimination projects when such benefits were so established.

Interstate Highways

Perhaps one of the most farsighted provisions of the Act was the creation of a national system of interstate highways not exceeding 40,000 miles in total extent. This system of interstate highways was designed to connect by roads as direct as practicable the principal metropolitan areas, cities, and industrial centres to serve the national defense and to connect at suitable border points with routes of continental importance in the Dominion of Canada and the Republic of Mexico.

Airport Requirements

The rapid development and expansion of airports and their possible effect on the adjacent highways required joint action and study by the airport authorities and highway and local road officials. The 1944 Act provides for such joint study by including a provision requiring that no Federal Funds apportioned by any of the Federal Aid Highway Acts may be utilized for the relocation or reconstruction of any highway giving access to an airport until the state highway department and the Public Roads Administration have concurred with the officials in charge of the airport That the location of the airport or its proposed deevlopment and the consequent reconstruction or relocation of the highway are in the public interest.

Uniform Signs

The need for standardizing informational, regulatory, and warning signs, curb and pavement or other markings, and traffic signals among the various states of the Union has been apparent and the Federal Highway Act of 1944 provides that on any highway or street thereafter constructed with Federal aid, the location, form, and charactor of such signs, markings, or traffic signals shall be subject to the approval of the State Highway Department with the concurrence of the Public Roads Administration.....

Act of 1948

To continue the work authorized by the Federal Aid Highway Act of 1944 and to provide federal assistance in financing the growing demands for more adequate highways, Congress passed the Federal Aid Highway Act of 1948 on June 29, 1948.

This Act authorized the appropriation of $ 450,000,000, a year for a two-year period.....

On July 1, 1949, the Public Roads Administration was transferred from the Federal Works Agency to the General Services Administration and on August 20, 1949, became the Bureau of Public Roads under the U. S. Department of Commerce.

Most Recent Step

The Federal Aid Highway Act of 1948 is the most recently step in over 30 years of federal assistance in the planning, financing and construction of our highways.....

Since the Federal Aid Highways Act of 1948 provides federal aid only to the fiscal year ending June 30, 1951, appropriate action is being taken by the American Association of State Highway Officials and numerous other organizations to bring before the Congress of the United States their request for a continuing appropriation of federal funds for highway improvement.

Statement of Policy

Acting on recommendations of the Committee on Legislation and Administrative Policy and the Executive Committee, the chief administrative officers of the American Association of State Highway Officials on November 21, 1949, approved the following national statement of policy concerning future federal aid :

1. Four authorizations of federal aid funds on an annual basis.

System	Proposed Dollars	(1948 Act) Dollars
Interstate	210,000,000	nil
Primary	270,000,000	(202,500,000)
Secondary	180,000,000	(135,000,000)
Urban	150,000,000	(112,500,000)
Total	810,000,000	(450,000,000)

2. That the federal aid primary, secondary and urban allocations be distributed among the states in accordance with the regular formulas and matching basis as provided in the Federal Aid Highway Acts of 1944 and 1948; that not more than 25 per cent of the amount apportioned to each state for the primary and secondary systems may be switched from one system to the other provided the state highway department makes such request and it is approved by the Commissioner of Public Roads as being in the public interest.

3. That the interstate funds be apportioned on the basis of population of the states and that no state receive less than three-quarters of 1 per cent, that the matching ratio be 75 per cent federal funds and 25 per cent state funds.

4. That these interstate funds may be utilized at the option of any given state, to apply on the principle of general obligation bonds on toll-free facilities that may be used by such state for the purpose of expediting the improvement of the interstate system of roads.

5. That the provision in the Federal Aid Highway Act requiring the withholding of federal aid from any state failing to properly maintain a federal aid project be amended so that in the case of secondary and urban projects where a county or city has accepted responsibility for maintenance, future federal aid funds will be withheld from the county or city failing to maintain rather than from the state as a whole.

6. That a section be added to the proposed Federal Aid Highway Act authorizing an amount not to exceed $ 10,000,000 to be utilized by the Bureau of Public Roads, under specific emergency conditions, for the purpose of co-operating with the state highway departments in highway disaster relief on an area basis when an emergency has been declared by a Governor of a state and concurred in by the Commissioner of Public Roads, without limitation as to systems, and on a 50-50 matching basis.

7. That a special appropriation of $ 100,000,000 be authorized for the purpose of advancing funds to the state highway departments for the acquisition of rights of way to be repaid over an extended period of years.

8. That the present one-third limitation on federal aid for right of way purposes be increased to 50 per cent.

Population Increase Benefits

Since population plays such an important role in the federal aid apportionment formulas, a state with a high rate of increase would materially benefit in any new appropriation predicted on 1950 census figures.

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PROPHECY !

[*From the Scientific American of July 1899*]

" The improvement in city conditions by the general adoption of the motor car can hardly be over estimated. Streets—clean, dustless and odorless—with light rubber-tyred vehicles moving swiftly and noiselessly over their smooth expanse would eliminate a greater part of the nervousness, distraction and strain of modern metropolitan life."

From ' The Reader's Digest '—May, 1950.

HOW TO WRITE A SYNOPSIS

HINTS TO AUTHORS

(Extracted from "The Journal of the Institution of Engineers," July-August 1950 Australia)

ARISING out of a recommendation of the Royal Society Scientific Conference (held July, 1948), the Abstracting Services Consultative Committee of the Royal Society has prepared the "Guide for the Preparation of Synopses" printed below.

It has submitted this guide for the consideration of authors and editors of technical papers, as it was felt that the present widely-differing standards regarding synopses left much to be desired.

Well-prepared synopses not only save the time of busy scientific and technical men who may not wish to read whole papers, but also greatly facilitate prompt coverage by the "abstracting" journals.

Guide for the Preparation of Synopses.

1. Purpose:

It is desirable that each paper be accompanied by a synopsis, preferably appearing at the beginning. This synopsis is not part of the paper; it is intended to convey briefly the content of the paper, to draw attention to all new information and to the main conclusions. It should be factual.

2. Style of Writing:

The synopsis should be written concisely and in normal rather than abbreviated English. It is preferable to use the third person. Where possible use standard rather than proprietary terms, and avoid unnecessary contracting.

It should be presumed that the reader has some knowledge of the subject but has not read the paper. The synopsis should therefore be intelligible in itself without reference to the paper, for example, it should not cite sections or illustrations by their numerical references in the text.

3. Content:

The title of the paper is usually read as part of the synopsis. The opening sentence should be framed accordingly, and repetition of the title avoided. If the title is insufficiently comprehensive, the opening should indicate the subjects covered. Usually the beginning of a synopsis should state the objective of the investigation.

It is sometimes valuable to indicate the treatment of the subject by such words as: brief, exhaustive, theoretical, etc.

The synopsis should indicate newly observed facts, conclusions of an experiment or argument and, if possible, the essential parts of any new theory, treatment, apparatus, technique, etc.

It should contain the names of any new compound, mineral, species, etc., and any new numerical data, such as physical constants; if this is not possible it should draw attention to them. It is important to refer to new items and observations, even though some are incidental to the main purpose of the paper; such information may otherwise be hidden though it is often very useful.

When giving experimental results, the synopsis should indicate the methods used for new methods the basic principle, range of operation, and degree of accuracy should be given.

4. Detail of Layout:

It is impossible to recommend a standard length for a synopsis. It should, however, be concise and should not normally exceed 200 words.

If it is necessary to refer to earlier work in the summary the reference should always be given in the same manner as in the text. Otherwise references should be left out.

When a synopsis is completed, the author is urged to revise it carefully, removing redundant words, clarifying obscurities and rectifying errors in copying from the paper. Particular attention should be paid by him to scientific and proper names, numerical data and chemical and mathematical formulae.

HIGHWAY ENGINEERING IN FRANCE

(Extracted from 'Highways, Bridges & Aerodromes'-March 23,1949).

An article on "France's Road System" describing the design standards adopted in that country for the layout of roads was published in our issue for July, 1949.

The present article gives details of construction and surfacing of pavements. The results of research on surface dressings are also described.

ALMOST the whole of the French roads are constructed of macadam or ballast and surface-dressed.

Modern types of pavement, such as thick carpets using bitumen or tar, concrete or natural asphalt and all the different special types, are reserved for certain section of the most important highways, for the outskirts of large towns and for the streets and avenues of the big cities.

Macadam Construction

The macadam is built up upon a bed of good quality 2/6 cm. (¾ in. to 2½ in.) stone, laid on a foundation and bound by some earthy material.

The foundation consists generally of large, hand-pitched stones, laid directly on the soil to a depth of 10 to 25 cm. (4 to 10 in)

The foundation rests upon a well-prepared subgrade. Sometimes the foundation is replaced by a second macadam, consisting of slightly inferior quality stone, which is rolled.

The thickness of the pavement, including the foundation, varies from 25 to 40 cm. (10 in. to 16 in.) of which 15 to 25 cm. (6 in. to 10 in.) is the foundation, and 10 to 15 cm. (4 in. to 6 in.) the metalling. In certain exceptional cases, when the pavement rests upon very firm and dry ground, the total thickness can be as little as 15 cm. (6 in.)

On the whole, the macadam is carried out according to the technique at the end of the 19th century.

Very generally speaking, the metalling receives surface dressing made up of : (a) A first or impregnating coat ; (b) A second or wearing course.

Until recently, impregnation was done with a fluid tar but sometimes with a viscous tar. Emulsions are sometimes used for the impregnating binder.

The binders are applied at the rate of 1½ to 2 kg.* per square metre (30 to 40 lb. per 100 sq ft.) Blinding is effected by means of stone material of small sizes.

A new technique, using fluid cutbacks of B. R. T. A. viscosity, less than 50 at 25 degrees Centigrade, appears to be giving promising results. Trials made in France in 1947 and 1948 give promise of a wide field of application of these products.

Viscosity Problems

The binders generally used are Tar, and Bitumen-emulsions. Cutbacks are of viscosity B.R.T.A. 50 100 and 150 200.

Pure bitumen of 180 200 penetration is not used. Only one Department in France has remained faithful to this product, which, incidentally, gives excellent results.

Tar-bitumen mixtures, which had a certain fashion in the years 1930 and 1931, have noticeably fallen off, as have also the Tar-fillers.

The rates of application per square metre vary :—For Tar, (18 to 24 lb. for 100 sq. ft.) from 0.9 to 1. 2 kg.; for Cutbacks, from 1 to 1.5 kg. (20 to 30 lb. per 100 sq. ft.); for Emulsion, from 1·3 to 1·6 litres (26 to 32 lbs per 100 sq. ft).

The quantity of chippings varies from 10 to 12 times by weight more than the binder.

* One Kilogram per sq. meter =20 lb. per 100 sq. ft (very nearly).

Surface Dressing Research

Surface dressings in France have been the object of relatively extensive research, directed upon: (a) The viscosity of the binders; (b) The grading and size of the stone; (c) The consistent rate of application of binder; (b) The use of mechanical equipment.

As a general rule the following general principles seem to emerge:—

1. The more fluid the binder the smaller the amount to be used, in order to avoid losses through draining off into the channels and to reduce the drying time. There is, however, a minimum rate of application below which it is not prudent to go.

2. If the binder is fluid and if it must be applied at a high rate of application, then it is better to do so in two applications, each followed by an application of chippings.

3. On heavily trafficked roads, viscous binders should be used. Fluid binders are unsuitable for fast and heavy traffic immediately after laying. If they are used on such roads, traffic must be prohibited until they have set.

4. The more viscous the binder the larger should be the average size of the aggregate. Thus, fluid tar requires sand or small-sized chippings.

5. To achieve a close mosaic, a uniform size of chipping is essential. The difference between the maximum and minimum sizes in the aggregate should not exceed 10 mm. ($\frac{3}{8}$ in.), but preferably 5mm. ($\frac{3}{16}$ in.). The chippings should be regularly shaped, approaching as near as possible a cube, and should contain no splinters or "flats".

6. Fluid binders are well suited to a deferred gritting, but the viscous binders on the contrary require the immediate application of the chippings. In cold weather the chippings should be applied sooner after spraying than in hot weather.

7. Hard chippings give a longer lasting mosaic.

Binder Application

The official specifications determine the quality of a surface dressing by the following conventional method:—

Taking D and d as the maximum and minimum thickness of binder film on a transverse strip of the road, and r as the ratio:

$$r = \frac{D-d}{D+d}$$

The quality of a given spraying will be determined by the value of the ratio r, e.g., r=below 0.15—very good; r=0.15—good; r=0.20—fair; r=0.25—passable.

Blinding is effected either by hand or mechanically. The machines are either small barrows or lorries, equipped for the spreading of chippings. The American spreader-boxes are now starting to be used in France.

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ECONOMY

Three old cronies were discussing the funeral of a friend in his hearing. He was at death's door. National economy led the first to say they should do without a third carriage. The second agreed, and the third said, "Cut out all carriages, and the flowers. We'll just have the hearse."

Then a tired voice from the bed intervened: "If you give me my trousers I'll walk!"

CONCRETE DEVELOPMENTS

[Extracted from "Highways and Bridges" Aug. 9, 1950]

THERE appears to be no end to new ideas applied to concrete. There must be many engineers still in active practice who can remember the time when the introduction of steel reinforcement was a startling new development, regarded with considerable misgivings by most of the "old school" of the period. Civil engineering, however, like all other forms of applied science, never remains static and hardly had reinforced concrete become established as an almost universal method of construction than "pre-stressing" and "post-stressing" appeared upon the scene.

The basic principle of these processes has been aptly explained from the analogy of a man carrying a row of books by pressing hard against the ends, the horizontal pressure counteracting the weight. That is all very well as long as the pressure is maintained, but if circumstances arise which cause its relaxation, disastrous consequences will follow.

To the untutored mind, such as we ourselves possess on this subject, there seems to be some possibility that a relaxation of compression might occur in a beam, just as it might in the analogy of the books. The compression is imparted to the concrete by the steel. Does the maintenance of this compression depend on the continuous action of the steel as the source of this stress? If so, might fatigue or, possibly lack of bond due to vibration, or deterioration of the metal, impair the efficiency of the steel in this respect? In this case, what happens?

No doubt such a contingency, if it actually exists, has been thought of and provided for, and we would like to hear more about it from those better qualified to discuss it than ourselves.

Another recent development is the manufacture of "air entrained concrete," in which minute air bubbles are introduced into the mix. It is claimed that this imparts improved workability and plasticity, but it is a strange reversal of the old idea that good concrete should be as voidless as possible. Some years ago, in fact, attempts were made to mix concrete in a vacuum with the idea of preventing any possibility of "entrained air" getting into it.

It is interesting to recall also that concrete deliberately honeycombed by hydrogen gas was made some time back by mixing finely-powdered aluminium with the cement. This material, of course, was intended for lightweight partitions and other constructional units where weight was important, but no particular strength was required, and is completely different from "air entrained" concrete.

The successful mixing, placing and finishing of concrete is by no means the simple process which it appears at first glance and, in talking recently with a concrete expert on recent progress and developments, he summed up the situation with the wise remark: "We are just beginning to find out how little we know about it."

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THE OLDEST PROFESSION

A surgeon, an engineer, and a politician were arguing over whose profession was the oldest.

The surgeon said, "Eve was made from Adam's rib and that was a surgical operation."

The engineer said, "May be but before that, order was created out of chaos and that was an engineering job."

"Ah" said the politician. "But who created chaos."

PROBLEM OF TRACK COSTS

(Extracted from "Modern Transport"- August 12, 1950)

THE imposition of higher taxation on motor fuel has prompted Sir Osborne Mance to renew his advocacy of a proper distribution of track costs. In a letter to the 'Financial Times' he suggests that the solution of the road-rail problem in this country is hampered by the fact that in spite of nationalisation we still have a competitive system, locally as regards the short-distance haulier and nationally as regards the C-licensee. It is doubtful, he says, whether the British Transport Commission has been given wide enough powers to secure proper co-ordination. "It is surely illogical for the track of one of the means of transport to be completely outside the field of the co-ordinated system and for the British Transport Commission to have no say in the expenditure on the upkeep and development of roads, while having to pay to an authority outside themselves sums for the use of the track which bear no relation to that part of the expenditure on the maintenance and development of roads attributable to motor transport. Apart from this, the basis of charging for the use of the road is surely a question of policy which may be an important element of the co-ordination of transport." In his view the decision to double the fuel tax and credit budgetary revenue with the proceeds shows a complete lack of appreciation of these points. This is a cogent argument and one which has not hitherto been heard among the protests voiced against what is tantamount to a crippling burden on a key industry.

Equalising the Burden of Expenditure

Sir Osborne Mance's assertion that the conception of taxation according to damage done to the roads by the various classes of motor vehicles is out-moded will find ready acceptance in many quarters. The provision of highways is a service which should be paid for by the ultimate users in proportion to the benefits obtained therefrom, without regard to the hypothetical damage done by particular vehicles. This benefit might be measured by ton-miles of load, or possibly ton-capacity miles of the vehicle, and passenger-miles or passenger seat-miles. Thus, it would first be necessary to assess the contribution to the cost of the roads due from users other than motor transport, including pedestrians, cyclists and undertakers of drainage, water supply and telegraph services, which would be paid for through State or local taxation, as at present. The remaining cost would be allocated in block to motor transport and paid for to a central road authority in an annual lump sum by the B. T. C. who would collect the amount on a toll levied on all traffic carried by motor vehicles. Sir Osborne suggests that under such a system the B. T. C. would be meeting the actual track cost of road, rail and canal and would collect or book an appropriate contribution to track costs from the traffic passing by each means of transport. With an equalized toll for the tracks, that form of transport would tend to be used which costs the least to operate, and the C-licensee would contribute on an equal basis with the public haulier. There is logic in this proposal and it is certainly worthy of closer examination than it has obtained hitherto. No harm would be done by subjecting it to independent examination.

AN INSPIRATION

Contractor Jones, a good family man, had been inveigled into a poker game, and experienced growing apprehension as the hands of the clock moved relentlessly on toward morning. Finally, at 3 a.m., he had a sudden inspiration. He called his home and when his wife answered the phone, he shouted, "Don't pay the ransom; I'm back!"

HERE AND THERE

1. THE WISH OF EVERY GOOD CITIZEN

(What follows was writen as long ago as 1907)

THE motor, which the frenzied cupidity of manufacturers hurls like a Juggernaut's car upon the bewildered people and of which the idle and fashionable make a foolish, though fatal, elegance, will soon begin to perform its true function and, putting its strength at the service of the entire people, will behave like a docile, toiling monster. But in order that the motor may cease to be injurious and become beneficent, we must build roads suited to its speed, roads which it cannot tear up with its ferocious tyres, and from which it will send no clouds of poisonous dust into human lungs. We ought not to allow slower vehicles or mere animals to go upon these roads, and we should establish garages upon them and footbridges over them, and so create order and harmony among the means of communication of the future. This is the wish of every good citizen.

Penguin Island, Anatole France, 1907.

Forty three years latter, every good citizen still has this wish – Ed.

(Extract from 'Traffic Engineering'—July 1950.)

2. ROAD BUILDING IN MEXICO REVOLUTIONIZES LIFE

FIVE years ago the mountainous state of Nayarit on the central part of the Mexican west coast, had about nine miles of crude roads. Today it has 65 miles of first-class paved highways in a 325-mile road net-work, just completed.

Almost overnight the astonished 220,000 inhabitants find themselves in an industrial, agricultural, and social revolution, almost unparalleled in modern times-as a result of the new road system. Here are the amazing figures:

Land under cultivation has been increased 25 per cent. **Corn production has increased 570 per cent to 178,000 tons.** This year will see an estimated 12,000,000 dollar fruit crop, which before the new roads was less than one-third of that. Before, Nayarit barely produced enough rice for its own population. Today the value of its exported rice crop is expected to be 98,000,000 dollars.

The new roads have permitted the opening of new lands, the easy export of all surplus commodities, the import of all new kinds of farm equipment and machinery, and a wholesale opening up of this rich territory.

Following on the heels of this agricultural prosperity have been many social gains. Schools have mushroomed all over. Hospitals and dispensaries staffed by able nurses and doctors, are quickly licking the diseases among the people which until now have been regarded as a necessary evil of living. Crime has been reduced to a new low and alchoholism is disappearing.

A few years ago a movie theatre was something no one in Nayarit was sure existed. Today there are many of them. The women are buying out the new clothing stores of the latest style clothing. The braceros—wandering farm hands—no longer exist. They have their own places.

What has happened to Nayarit as a result of the road building programme is being cited as an example of what can be done for all of Mexico. Similar highway projects are being launched all over the country.

(Extracted from 'World Construction'— Sept.-Oct., 1950)

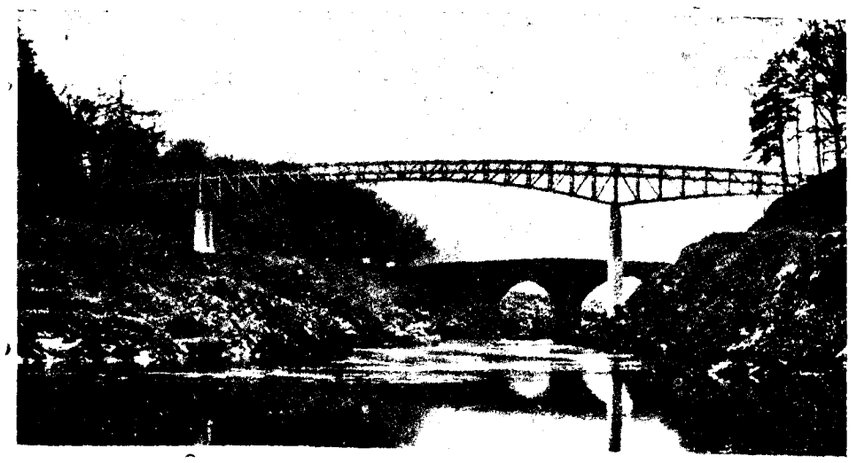
3. DURALUMIN FOOTBRIDGE AT CLUNIE, SCOTLAND

PART of the Tummel-Garry hydro-electric scheme in Scotland required the raising of the level of the River Tummel by 50 ft by means of a dam at Pitlochry. This in turn brought up the problem of a bridge to replace the old stone one at Clunie (near Pitlochry) which was to be demolished as it would be submerged in the reservoir. The answer has been found in a structure of interest and beauty, a bridge 310 ft 6 in. long overall with a centre span of 172 ft. 6 in. and two side spans each of 69 ft, made entirely of "duralumin," the light aluminium alloy manufactured by James Booth and Co., Ltd., of Birmingham.

The metal is duralumin "H," used in the full heat-treated condition, and all rivets were made in "MG5" light alloy and driven cold by ordinary percussive means. Considerable use was made of "duralumin" beaded "I" beams for the compression members.

In the fabrication of the bridge it is claimed that much time was saved by the lightness of the material—the engineers found there was no necessity to wait for a crane to lift even some of the largest parts. The structure will not be painted so as to indicate clearly the nature of the material used.

(Extracted from 'Highways and Bridges'—August 9, 1950)



View of Clunie duralumin foot bridge from downstream.

4. COARSELY-GROUND CEMENT FOR EXPERIMENTAL ROAD

IN order to get information on the relative durability of concrete roads in which coarse and fine Portland cements are used, the State Highway Commission of Kansas, U.S.A., is to use coarsely-ground cement for about 18 miles of a new 24-mile concrete road carrying considerable traffic including heavy vehicles. The coarsely-ground cement will be made as nearly as possible to match the Portland cement used in the district thirty years ago, while the remainder will be Type 1 finely-ground cement as made to-day.

The experiment is being made as a result of an investigation made in the years 1940 to 1944, when an inspection of 1,270 miles of concrete roads showed that those laid before the year 1930 were more satisfactory than those laid since; it was found that the older roads, although cracks had appeared, were sound and more durable. The specifications for the whole of the road are exactly the same except for the fineness of the cement.

(Extracted from 'Concrete & Constructional Engineering' August, 1950).

5. 300,000 VOLUNTEERS FOR ROAD BUILDING

IN earnest, as it were, of the lifting of travel restrictions, Yugoslavia has just completed a new national highway linking her two biggest cities, Belgrade and Zagreb.

One of the main projects of the Five Year Plan, the 230-mile long concrete track shortens the distance between the two terminal points by nearly 60 miles. It is 36 feet wide—and a vast improvement on the old road. Three-quarters of the 400,000 workers who, with spades and shovels, lent a hand in its construction were drawn from volunteer youth brigades with practically all nationalities of the world represented on them.

Much water has flowed down the Danube since the construction was started in the spring of 1947 and some old friendships have gone sour. This has not deterred the Yugoslavs from naming the highway "Brotherhood and Unity."

(Extracted from 'Times of India' August 8, 1950).

6. NEED FOR ROADS GREATER THAN EVEN SCHOOLS OR HOSPITALS

Assam Governor's Call.

MR. Sri Prakasa, then Governor of Assam, opening the ninth annual conference of the Subordinate Engineers' Service Association at Shillong on May 3, said that Assam needed better communications above everything else. In the tribal areas, he found that the need for roads was greater than even schools or hospitals. He advised the engineers to develop the attitude of managing public affairs at a cheaper cost.

(Extracted from 'Monthly News Letter' IRTDA, June, 1950).

7. DISSEMINATION AS IMPORTANT AS RESEARCH

* * *

EXPERIENCE is a great teacher, but by itself it may only deepen a rut. Experience coupled with study and research may produce revolutionary improvements. That this has been the case in the development of highway transportation during the past 30 years may be seen in "before" and "after" pictures of the roads and vehicles of three decades ago and now. Without the search for new knowledge, for understanding of it and for ways to use it, the lessons of experience would be learned to little profit.

Research as an end in itself may be desirable, but without correlation and widespread dissemination, it may also be of little account. Even the lessons taught by experience will not spread without assistance.

It is the needs for correlation, stimulation, authoritative group study and dissemination of knowledge that makes necessary some such agency as the Highway Research Board.

(Extracted from a Report of The Highway Research Board.)

[*The Indian Roads Congress tries to promote and encourage the science and practice of the building and maintenance of roads provides a forum for discussion and group study and disseminates knowledge through its journals, information service, and library service.—Ed.*]

8. A PRAIRIE PARABLE

THE past 50 years have seen outstanding technical achievements in the transport as well as in every other field. Yet despite the revolution in the means of communication which has occurred since the days of Jules Verne's globe-circling hero, Phineas Fogg, in one respect at least travellers of to-day do not differ from those who in the past also found their journey really necessary. **The starting point for every traveller, by land, sea or air, still remains the road, whether it be the access road to the aerodrome, the feeder road to the dockside, the built up city street leading to the railway terminus or the open road itself.**

The road, then, is not only an important means of communication in itself — it is also the link with the other means of transport. The principle of the maximum integration of all the methods of transportation is the logical outcome of the recognition of this fact. Such an integration has long been the aim of wise administrators but from theory to practice is still a long cry. It is to be hoped that with the nationalisation of road and rail undertakings in various countries a few, at any rate, of the obstacles to the realisation of this concept in the past may have been removed.

It may be instructive, in this connection, to turn from theory to a concrete example of just such an integration, albeit in a small way, brought about by the application of technical skill. In Canada, in the Middle West, the combination road-rail vehicle is already proving its usefulness. This vehicle carries passengers or freight and, just as the amphibious landing craft, the "Duck" used during the War, "took off" from terra firma into the water, so the road-rail vehicle changes over from the permanent way to the road at the movement of a lever. The smooth merging of road and rail travel facilitates handling delivery problems and, by making use both of rail and road brings hitherto isolated prairie communities within easy reach of one another and of the larger centres. It is not too much, in these days, surely, to hope that the solution of the road versus rail problem will, as in the Prairie "compromise" vehicle, be found in the initiation of a policy which will enable the best use to be made of all the available means of transport.

(*Extracted from I.R.F. London Bulletin Number 4, — Nov. '49.*)

SMARTER!

Goering said to Hitler one day, "You know, I believe you're mistaken in saying that all non-aryans are below German mentality." The Fuehrer replied: "How do you know that?" So Goering said, "I'll show you." They went out together and called at a china store, owned by a member of the Party. Goering asked, "Have you a left-handed tea service?" The proprietor replied, "No, I'm afraid I haven't such a thing." Then they went to another shop owned by a Party member and received the same reply. Finally, they came to a store owned by a Mr. Cohen, and Goering again asked, "Have you a left-handed tea service?" and Cohen replied, "Well now, you're very lucky, I've just got one in stock. But naturally it will cost you more than an ordinary tea-service." Goering paid for it and came out with Hitler, turned to him and said, "There you are! Didn't I tell you they were smarter than us?" After a minute or two, Hitler replied, "I still don't see you've proved anything. It was only a bit of luck his having one in stock."

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THE REINSTATEMENT OF TRENCHES

[Extracted from 'Highways and Bridges'—July 19, 1950]

THE road, in addition to acting as a channel for transport, is expected to provide a right-of-way for water and gas mains, sewers, electricity cables, and telephone ducts and, as a result of housing development in a great many areas, existing highways are being opened up to enable these essential services to reach the new estates.

Thus, the roads are not only starved of badly needed maintenance, but they are mauled and maltreated, their surfaces are ruined and their foundations dislocated. There are miles of road which have been given the knock-out blow of trench openings and are now reduced to a condition when they are almost unusable except at the risk of serious damage to the vehicles which bump and crash over the reinstated excavations.

It is extraordinary that with all the available knowledge derived from the current extensive study of soil mechanics the simple job of filling up a trench and compacting the fill should invariably be carried out in such a haphazard and unsatisfactory manner.

Experts in soil mechanics have written book after book and technical treatise after technical treatise dealing with every detail of soil compaction, density-moisture relationships, voids and all the rest of the factors which are involved in this elementary problem; the makers of road plant have produced many ingenious types of mechanical tampers which are surely more economical and efficient than a weary labourer thumping up and down with a pre-historic "punner." But still the bad old ways continue.

A favourite dodge is to overfill the trench, leaving an irregular mound of clay and stones proud of the adjacent road surface, thus allowing for an unknown amount of future settlement. If a spell of wet weather follows, this ridge, in time, will become a valley and when sufficient settlement has occurred to render the trench an obvious danger to life and limb another ridge is formed by throwing in a surplus of miscellaneous filling material which is given a small amount of casual compaction.

It should be easily possible, with the amount of scientific data now available, to reinstate trench openings with the certain knowledge that no appreciable settlement will occur and this would enable a permanent surface to be laid over the filling material to match up perfectly with the undisturbed road surface.

If the job were done properly, once and for all, the final cost, even allowing for the extra care and supervision involved, would be no more than that of casual work requiring added attention, from time to time, in the form of makeshift patching.

Even when longitudinal trenches are kept as close as possible to the channels of the carriageway, unsatisfactory reinstatement means that the effective road width is reduced by several feet and this adds considerably to the dangers of a two-lane road.

Trench filling seems to be one of those humble little jobs which no one bothers about, but in these days, when surveyors are seriously concerned about the widespread deterioration of road foundations and surfaces, it is surely more essential than ever that their much harassed highways should be treated as kindly as possible by careful filling and compaction after these necessary excavations are made.

WELDING FOR HIGHWAY BRIDGES

Lessons from Australia

(Extracted from "Engineering News-Record"—June 1, 1950)

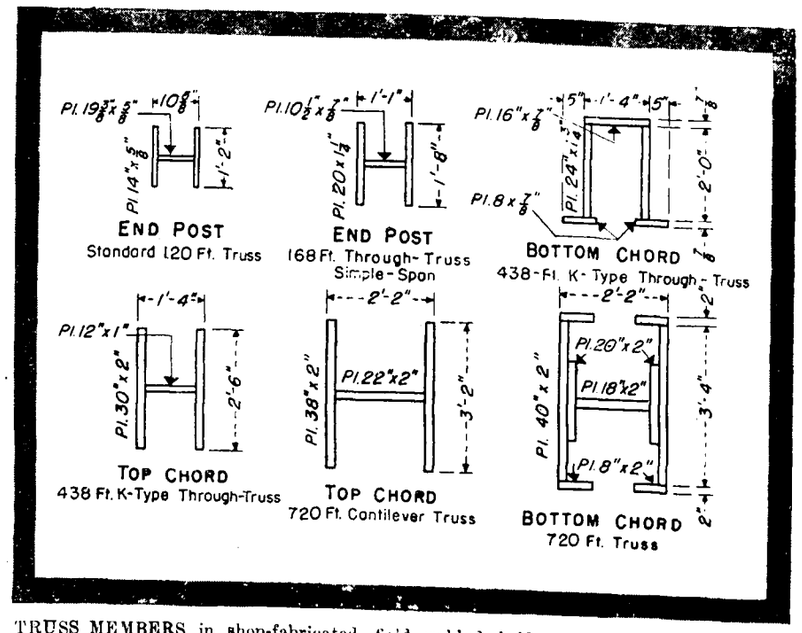
FOURTEEN years ago, the Department of Main Roads, N. S. W., Australia, designed and built its first welded truss bridge—a 100-ft. span over the Manilla River at Barraba. Since then, all the department's major bridges have been welded. These include 14 completed, 4 under construction, 2 being designed, and 2 proposed.

* * *

Welded bridge construction in Australia does not necessarily mean "all-welded." The Barraba bridge is the only all-welded truss bridge in country.

A number of conservative Australian designers still prefer riveted work and oppose welded construction; their arguments being based chiefly on the failure of a few major welded undertakings in other countries. Proper analysis of the causes of these failures, however, actually gives the designer every reason to be more confident in welded bridge construction.

Summing it all up, there are about seven principal considerations in the design and construction of welded steel bridges. They are: composition of steel; increased stresses due to "notching"; fatigue of metal; rapid cooling of weld metal; stresses due to weld being restrained from contraction on cooling; distortion of steel due to weldings; and proper reduction of permissible design stresses.



TRUSS MEMBERS in shop-fabricated, field welded bridges are made up of plates ranging from ⅝-in. thick in a standard 120-ft. span to 2-in. for 720-ft cantilever span.

Other truss spans are shop welded and field riveted. Simple span plate girder bridges are all-welded, but continuous girders are shop-welded and field-riveted. Likewise, towers of lift bridges are shop-welded and field-riveted.

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Composition of Steel: A certain limit must be placed on the carbon content of steel to insure good weldability: carbon in steel increases its ultimate strength but reduces its ductility. The maximum allowable carbon content in welded structural steel, specified by the Standards Association of Australia, is 0·3 per cent.

Other elements present in the steel also reduce its ductility, but to a lesser extent than carbon. For example, six parts of manganese are equivalent to one part of carbon in hardening the steel. The total amount of these substances, when reduced to the equivalent of carbon, should not exceed 0·4 per cent. Otherwise the welds tend to develop cracks unless special precautions are taken.

Effects of Notching: Additional stresses are introduced in the welds or in the parent metal by notches in the structural member. A "notch" is any discontinuity...an abrupt change of section: undercut of the weld: cracks: porosity: and inclusions in welds.

Notch effects in welded work are not as well known as in riveted work (section-changes, rivet holes, etc.), but with proper precautions in design and construction no failures are likely to occur from notching in welded construction.

In the case of an ordinary welded plate girder precautions against notching effects can be taken by locating butt-splices of the flange plates some distance from the centre of span. This will avoid high bending stresses. Likewise, butt-splices of web plates should be near the centre of the span to avoid high shear at the supports. No undercutting can occur in these welds, and cracks can be easily detected since all butt-welds are built up to 10 per cent in excess of the required section, and ground smooth.

Notch Sensitivity of Steel: A certain quality of steel tending towards a brittle fracture in the presence of notches in the member is called "notch sensitivity." This quality is likely if the manufacturing process or subsequent heat treatment produces a microstructure in the steel known as "martensitic." In this condition, the steel consists of thin, elongated crystals (dendritic structure) produced by rapid cooling. Extreme cold seems to aggravate the notch sensitivity of such steel. This problem does not exist, however, with Australian-made steel; probably due to the absence of severe freezing temperatures.

Fatigue of Metals: The well known phenomenon—fatigue of metal due to cyclic stressing—is an important factor in the design of either welded or riveted bridges. Because of this factor, permissible stresses for welded work in Australia are usually reduced. The amount of this reduction is based on the relative magnitude of maximum and minimum stresses in the members; and the number of cycles occurring during the estimated life of the bridge.

Rapid Cooling of Weld Metal: Another factor contributing to reduced ductility of the weld metal is its rapid cooling by a large mass of parent metal. The thicker the plates being welded, the more rapidly heat is absorbed from the weld. This causes brittleness of the weld.

As a precaution against serious effects from too-rapid cooling of welds, Australian bridge-practice specifies the minimum area of weld run for any given thickness of plate. For example, fillet welds are required to be at least 3 8 in. nominal size for plates 1 in. thick and over.

Special attention also is given to the equivalent carbon content of the steel. If it is excessive, pre-heating and post-heating of the parent metal are required.

Other precautions are the size of electrode and the amount of electric current. Both are strictly controlled. Excessive current gives high local heat which is deleterious; low current permits too-rapid cooling of the weld by conductivity with the parent metal.

Contraction on Cooling: Prevention of the contraction of a weld, on cooling, also produces high initial stresses. This is a common fault in welded structures; yet one that is obvious and easily understood.

This is how it works: The metal deposited in a butt-weld cools to normal

temperature. In the process of cooling, its volume is reduced. If the two plates being butt-welded are free to move on a welding table, contracti n of the weld metal will pull them together. If the plates are not free to move, the weld must crack or at least yield.

One method of avoiding this effect of contraction on cooling is shown in the Australian practice for welded plate girders.

Web Plates, made by butt-welding short sections, and flange plates are completely welded full-length, individually, prior to assembly. During this operation all welds are free to contract.

The completed flange and web plates are then assembled, together with stiffener angles. The assembled members are first tack-welded; then completed by continuous fillet welding.

SHOP WELDING a heavy truss member (20 × 1¼-in. flanges and 10' × ⅜-in. web) for a 192-ft simple span. Plates are tack-welded in an assembly jig.

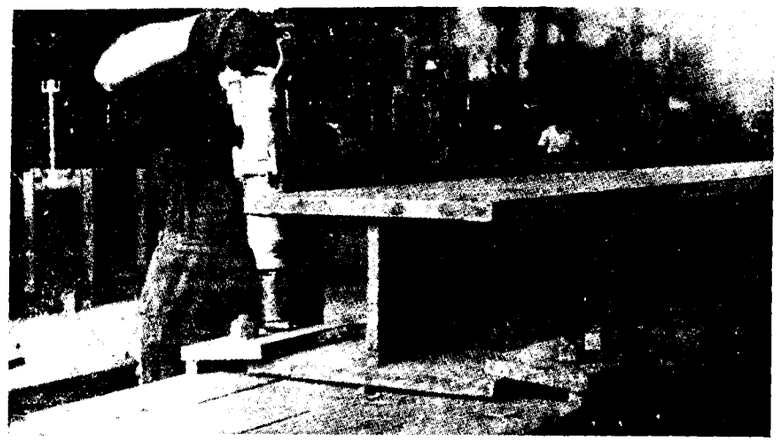
Butt-welding of rigid sections should be avoided as it must result in restrained shrinkage of the welds. This is especially true in butt-welded connections of continuous rolled beams. If the flanges are welded first, contraction of the weld metal will draw the two halves of the beam together. Then when the webs of the beams are butt-welded, that weld material will be restrained from shrinkage, by the previously welded flanges. This will give large tension stresses, causing cracking during cooling or as soon as the beam is in service.

Distortion due to Welding: Distortion of members and their components due to contraction of the weld metal must be carefully considered in the design and fabrication of welded structures. Two measures may be taken to avoid, or at least relieve, stresses due to the contraction of the weld metal. Welding runs, if possible, should be balanced by symmetrical positions in relation to the unit being welded. If the member is built up from separate plates, the welds should be placed symmetrically in relation to the whole section.

The simplest example of this procedure is a double V-butt welded plate. Runs of welds are placed symmetrically on both sides of the plate. This equalizes tension stressess in each V, caused by cooling of the weld metal. Since the stresses are balanced, the plate will remain flat after welding.

Another example: An I-section represents a symmetrically welded built-up section. Since the four welds are symmetrical about the vertical and horizontal axes of the member, it will be straight after completion of the welding.

Unsymmetrical members — such as top chords of trusses made up of two channels and a cover plate — present another problem. Welding is required only to connect the channels to the cover plate. These welds, not being symmetrical about the horizontal axis of the member, will produce bowing of the member.



FLANGE PLATES then are prebent over a $\frac{7}{16}$ in. packing strip before making ⅜-in. fillet welds between web and flanges to insure straight flanges after fabrication.

To avoid this bowing, the components should be pre-bent in a jig, and welded in this position. Shop experience, only, will be able to determine the amount of pre-bending needed for various unsymmetrical sections, and different sized welds.

One word of caution however. The fact that there is no resultant distortion of a welded member does not indicate that there are no initial stresses in the welds. Elimination of this distortion by balancing the welds does not reduce these initial stresses. They must be considered in the design.

Reduced Design Stresses. Ever since the N. S. W. Department of the Main Roads designed and built its pioneer welded truss bridge 15 years ago, it has followed conservative design specifications. Allowable working stresses for butt and fillet welds are 70 per cent of stresses permitted in the parent metal. Also, butt welds in direct tension members can be used in direct tension only under dead load. Butt-welds in members subjected to bending stresses may be stressed in tension by any loading.

These conservative specifications do not seriously affect the economy of welded bridges as might be expected for the following reasons: In bridge trusses the lengths of steel shapes supplied by the mills is sufficient for all truss members to be fabricated without splices between panel points. Welding is used only in the longtitudinal direction of built-up truss members. Field connections of trusses are riveted. For plate girders all butt welds are placed at positions of low stress, since no increases in sections are needed.

Sequence of Welding: A sequence of welding for built-up I sections (the principal ones used) has been developed that assures straight members requiring no corrections by press or heating.

The I-section assembled by tack welding is laid down on the welding table, with the flange plate pre-bent over the packing strip (Fig. 2). Two welders, opposite each other, work from the centre of the member by the back-step method, *i.e.*, weld one, miss one. The length of each run is equivalent

to the use of two electrodes. Instead of returning to the centre and finishing the "misses" the member is turned over and clamped over the packing strip: the welders weld the second flange as the first, then return to the centre and finish the "misses." The member is then again turned over, and clamped down over the packing strip, and the weld of the first flange completed.

Savings by Welding: Close study of designs, contract bid prices and construction techniques during the development of Australia's welded bridges revealed four main savings by welding. They were: Utilization of gross sections for tension members: better distribution of metal in compression members: elimination of costly lacing for upper chords and end posts: and no deductions necessary for rivet holes in flanges of cross girders.

An indication of the saving by all-welded or shop-welded-field-riveted, against riveted construction, may be gained by the result of alternative tenders for the first two welded truss bridges designed by the department in these three types of construction. To obtain a fair comparison, all designs were made by the same engineer.

The saving in weight of the all-welded over that of the all-riveted structure was 20 per cent, and in cost 13 per cent.

The saving in weight of the shop-welded-field-riveted over that of the all-riveted structure was 16 per cent, and in cost 13 per cent. It may be mentioned here that the department's latest standard truss bridges, designed for American loading H20-S16, show a saving in weight, by shop-welded-field-riveted construction, of 17 per cent over the latest all-riveted equipment. The saving in cost, however, should exceed the saving in weight, as recent quotations show that the manufacture of welded members per ton is now less than for riveted members, owing to the advancement of welding methods in Australia.

The reasons, however, for the decision to adopt the shop-welded field-riveted construction instead of the all-welded, were based on the following considerations: The department demands full assembly of all steelwork in the shop, and rivet holes for field connections facilitates this assembly: the quality of field welding, done under inferior conditions, compares unfavourably with shop welding: and supervision of field welding is more expensive than for riveting. Finally, to weld connections of large members without distortion presents many difficulties in the field.

A GOOD INFLUENCE

A minister, while visiting one of his flock who had been a sailor, heard the parishioner's parrot make a few remarks in the way only a true sailor's parrot can. The man was very much embarrassed and apologized. The minister didn't seem alarmed, but said he had a parrot that prayed all the time. After a while the good Reverend made the suggestion that he thought his parrot would have a good influence on the sailor's bird. The sailor agreed, so the next day the minister brought his parrot to spend a few days with the other bird.

When the sailor's parrot saw the addition to his cage he immediately remarked, "How about a little loving, babe?"

Answer: "What the hell do you think I've been praying for all these years?"

INFORMATION SERVICE

(i) A REVISED RECOMMENDATION FOR PLASTIC WHITE LINE COMPOSITIONS

* * *

(1) Two important requirements of a plastic white line composition are (a) freedom from flow in hot weather, and (b) freedom from brittleness and disintegration in cold weather. These two requirements are both governed mainly by the hardness of the binder and only to a small extent by the binder content.

(2) The best hardness of binder appears to be in the range 45 to 50 deg. C. ring-and-ball softening point. This corresponds to an oil/resin ratio of approximately 20/80. Compositions containing this binder have little tendency to flow in the summer, and have proved durable when laid in the winter.

(3) The best binder content appears to be 18 per cent, not 20 as previously recommended. Materials with this lower binder content are just as easy to lay and as durable as those with 20 per cent of binder, and have the advantages of being (a) less expensive; (b) rougher in texture, and (c) slightly more resistant to flowing.

These conclusions make it necessary to revise the recommended specification: the revised oomposition is given in Table 2.

Although a pigment content of 10 per cent is necessary to obtain a high degree of whiteness, if a rather lower standard of whiteness is accepted it is possible to effect a small saving in cost by specifying a lower pigment content. In no case, however, should less than 5 per cent of titanium dioxide be specified.

Table 2.—Revised Specification for Plastic White Line Composition.

Gum rosin (Grade W W, extra W W, or Y)	14·5	per cent by weight.
Mineral lubricating oil (viscosity ½ to 2 poises at 25 deg. C.)	3·5	- do -
Titanium dioxide pigment	10·0	- do -
Extender (calcium carbonate, barium sulphate or silica, passing 200 mesh B. S. Sieve)	10·0	- do -
Aggregtae (white sand, calcite, glass, calcined flint, or other approved aggregate passing ⅛ in. and retained on 200 mesh B. S. Sieve	62·0	per cent by weight.
	100·0	

(Extracted from 'The Surveyor' June 23, 1950.)

(ii) CONTINUOUS REINFORCEMENT IN CONCRETE ROADS

CONCRETE roads without closely-spaced transverse joints generally crack transversely at frequent intervals. The cracks tend to open appreciably in time unless the slab is reinforced. For some years highway engineers have considered the practicability of concrete roads constructed without transverse joints and with sufficient longitudinal reinforcement to hold the cracks closed. In the autumn of 1938 several continuously-reinforced lengths of road, from 20 ft. to 1310 ft. long, were constructed in Indiana, to enable the effects of various amounts of longitudinal steel to be studied.

The behaviour of the roads during the first ten years shows that continuous reinforcement will prevent the opening of transverse cracks. In long sections with the greatest amount of reinforcement many fine superficial cracks developed in the central region. The cracks have not opened and have ravelled only slightly due

to traffic and exposure, but have required no maintenance. The road remains strong and durable. The presence of even the greatest amount of longitudinal bar reinforcement has apparently not effected adversely the concrete, which appears to be sound throughout, there being no spalling and an absence of longitudinal cracks above the bars. The manner in which the steel has held all cracks closed, especially those in the parts with the greatest amount of reinforcement, is believed to be conducive to distributed inter-facial pressure at the cracks which tends to reduce the damage to the concrete from concentrations of pressure such as sometimes develop at cracks in plain concrete slabs.

"Pumping" has occurred at many of the transverse *joints* but, with two exceptions, has not been observed at any of the many transverse *cracks*, indicating that a concrete road without transverse joints and containing adequate longitudinal reinforcement is not so susceptible to "pumping" as roads of other designs. In spite of the many transverse cracks that occur in the long sections, the riding quality of the roads remains excellent and the road is therefore protected from damaging impact forces.

The experimental roads are 20 ft. wide with a central longitudinal joint and the slab is 7 in. thick at the middle and 9 in. at the edges. The longitudinal reinforcement comprises deformed round bars from ¼ in. to 1 in. diameter or a mesh of cold-drawn wire from 0·2 in. to 0·4 in. diameter. The longitudinal bars or wires are at 6 in. centres. The transverse reinforcement is roughly proportional to the longitudinal reinforcement and varies from ¼ in. deformed bars at 12 in. centres to ½ in. bars at 24 in. centres, or 0·2 in. wire at 12 in. centres to 0·24 in. wire at 12 in. centres.

(Extracted from "The Journal of Concrete and Constructional Engineering" June, 1950)

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A SLIGHT ERROR

The big American magnate had boarded the train and was instructing the negro to put him off at Buffalo. "Now," he said, "it will be in the early hours of the morning when we reach Buffalo and I'm an exceptionally heavy sleeper. Besides, I'm entertaining friends the night before, so I shall probably be in a comatose condition. No matter how I protest, you must get me out of bed and see that I get out at Buffalo—it's very important. I shall probably swear at you for disturbing me, and even struggle with you, but never mind—take no notice and just see me off the train. There'll be a twenty dollar note for you for your trouble." The magnate awoke, however, to find the train hundreds of miles past his destination. He got the negro steward and raved and cursed him for five minutes for not putting him off at Buffalo, as instructed. The Negro listened calmly and replied: "Yess, sir, you sure can swear. But nothing like the man I put out at Buffalo."

The West Bengal Budget 1950—51 with Special Reference to Civil Works

The following relevant extracts have been taken from the West Bengal Civil Budget for the year 1950-51 in respect of revenue and expenditure on Civil Works:

REVENUE

	Actuals 1948-49	Revised estimates 1949-50	Budget Estimate 1950-51
		(Rs lakhs)	
1. Transfer from Central Road Development Account ...	5.78	49.57	92.92
2. Transfer from Capital Account of grain purchased Schemes of surcharge levied for improvement of village roads in heavy procurement areas ...	—	13.60	30.00
3. Rents ...	2.82	3.00	3.23
4. Tolls on roads ...	1.36	1.50	1.50
5. Recoveries of expenditure ...	3.70	1.00	1.00
6. Miscellaneous (after deducting refunds) ...	2.32	1.98	2.51
TOTAL ...	15.98	70.65	121.16

EXPENDITURE

	Actuals 1948-49	Revised figures 1949-50	Budget Estimate 1950-51
		(Rs lakhs)	
1. Original Works Buildings ...	19.60	35.36	42.97
2. Original Works Communication.	7.42	53.45	98.28
3. Original Works Misc. ...	3.59	0.90	0.41
4. Repairs Communications ...	42.57	58.00	57.86
5. Repairs Misc. ...	45.48	51.00	56.82
6. Establishment ...	16.38	21.49	28.87
7. Tools and Plant ...	4.55	5.00	6.27
8. Grants-in-aid ...	18.15	23.69	30.09
9. Suspense ...	—0.38	—1.75	—0.15
10. Development programme ...	—	49.42	42.73
11. Other heads ...	0.17	—	—
TOTAL ...	157.53	295.56	364.15

Capital Account of Civil Works expenditure outside the Revenue Account

Development Programme	Actuals 1948-49	Revised figures 1949-50	Budget estimates 1950-51
		(Rs lakhs)	
Original Works—Buildings ...	0.01	—	—
Original Works—Communications...	75.99	174.20	211.18
Establishment ...	8.20	17.42	24.03
Tools & Plant ...	18.04	44.50	20.00
Suspense ...	—14.26	—1.62	—1.30
Deduct—Receipts and recoveries on Capital Accounts ...	—0.01	—	—
TOTAL ...	87.97	234.50	253.91

THE WEST BENGAL BUDGET 1950—51 WITH SPECIAL REFERENCE TO CIVIL WORKS.

THE total revenue receipts for 1950-51 including those of the merged state of Cooch-Bihar have been estimated at Rs 3,390 lakhs and the total expenditure at Rs 3,523 lakhs indicating a deficit of Rs 133 lakhs. The corresponding figures for 1949-50 (revised estimate) are Rs 3,473 lakhs and Rs. 3,326 lakhs respectively, and 1948-49 (account) are Rs 3,177 lakhs and Rs 2,910 lakhs respectively. The fall in the estimated revenue compared to the revised estimate for 1949-50 is mainly due to the low revenue on account of Customs, Provincial Excise, Extra-ordinary Receipts and other Taxes and Duties. The major changes in the estimated revenue and expenditure under ***Civil Works*** for 1950-51 are explained below :—

The estimated revenue under Civil Works amounts to Rs 121 lakhs as against Rs 71 lakhs for 1949-50 (revised estimate) and Rs 16 lakhs (account) for 1948-49. This is 36 per cent of the total revenue estimated for the year 1950-51. Similar percentages for 1949-50 (revised estimate) and 1948-49 (account) are 2·0 and 0·5 respectively.

The State Govt. have budgeted an expenditure of Rs 364·15 lakhs on 'Civil Works' compared to Rs 296·56 lakhs (revised estimate) for previous year i.e. 1949-50 and Rs 157·53 lakhs (account) for 1948-49. This represents an increase of Rs 67.59 lakhs under this head over 1949-50 figure, out of which about Rs 45 lakhs are proposed to be spent on the development of communications alone in the State. The proportion of expenditure in the Original Works of Communications to Buildings for 1950-51 is expected to be 2 : 1 as against 3 : 2 for 1949-50. This means that more expenditure is intended to be incurred on the development of communications during 1950-51 compared to the previous year. This difference is more prominent compared to the year 1948-49 (account) when this proportion was 1 : 3 only.

Capital expenditure on Civil Works outside the Revenue account has been estimated at Rs 253.91 lakhs during 1950-51 as against Rs 234.50 lakhs during 1949 50 and Rs. 87.97 lakhs in 1948-49 (account). The corresponding figures of expenditure on the development of Communications alone are Rs 211.18 lakhs, 174.20 lakhs and 75.99 lakhs respectively which show that the major portions of the expenditure on Civil Works have been exclusively on Communications of the State.

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OF COURSE NOT!

A man called into a theatrical agent's office, and asked if his two performing dogs could have an audition. The agent told him to let them go ahead. After they hat gone through all their tricks, the smaller dog turned to the agent and said, "Well, how did it go?" The agent jumped out of his chair, turned to the dog's owner and said, "Good Heavens! Does that little dog talk?" "Of course it doesn't," answered the trainer, "The bigger dog is a ventriloquist."

BOOK REVIEW

Traffic Surveys Under Indian Conditions

by

C. S. Anantapadmanabhan, Roads Organization, Ministry of Transport,
Published by the Manager of Publications, Delhi ; 1950,
pp. iii + 75 ; paper bound, Price Rs 2-6-0 or 6s.

THIS handy volume discusses fairly exhaustively various methods of traffic survey employed in India and such of the methods adopted in foreign countries as are specially applicable to Indian conditions and comments on the merits and demerits of each method.

While primarily intended for traffic surveys on roads, the volume is sure to interest others—railway officials concerned with surveys in connection with proposed railway lines, port trust officials designing yards and clearing routes, economists studying economic aspects of transport, statisticians interested in applying statistical technique to transport problems, in fact all those interested in the study of traffic problems and locomotion in all its aspects.

The book treats of volumetric surveys of traffic, both urban and rural, and origin and destination surveys. It describes the analysis and presentation of data in tabular, graphical, or map form, and tells clearly of the various practical uses to which traffic survey data can be put. It gives the method of forecasting traffic while, at the same time, warning the reader of the dangers involved in drawing hasty conclusions.

Till now there has been, in this country no readily available compendium of the various possible methods of carrying out traffic surveys under Indian conditions. This compilation will supply this want and form a useful book of reference.

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MORE HASTE LESS SPEED

Horse-drawn carriages used to travel an average of 11·5 miles an hour in New York's mid-town traffic. Today the average speed of the automobile being used on the same streets is six miles an hour.

From 'The Reader's Digest'—May, 1950.

List of Approved Road Development Schemes.

S. No.	Job No.	Name of Work.	Amount approved Rs	Remarks.
		MADRAS		
1.	402 MD 47.	Construction of a bridge over the Noyyal river at mile 331/1 near Coimbatore on Madras-Calicut Road.		State Government have been authorised to incur expenditure up to Rs 50,000/- pending technical approval & financial sanction to the estimate.
		WEST BENGAL		
2.	399 BG 2.	Land acquisition for Calcutta-Delhi National Highway No. 2 in West Bengal.	2,09,534/-	
3.	404 BG 34.	Construction of National Highway No. 34, section from Dhulian to Raghunathganj.	21,96,700/-	(excluding agency charges)
		PUNJAB		
4.	400 PB 1.	Widening of miles 116/6 to 161 of the G.T. Road in Ambala District.	10,57,500/-	
5.	403 PB 1.	Widening miles 39-73/5 of G.T. Road in Karnal District to 22′ width.	10,38,600/-	
		BIHAR		
6.	397 BR 30.	Construction of Patna Byepass, first phase work, portion from 8th mile 6th furlong of Patna-Fatua Road to Agam-kuan-Fatehpur Road, including arboriculture.	14,34,700/-	
7.	398 BR 30.	Construction of Patna-Byepass, first phase work, portion from Pahari to Agamkuan including arboriculture.	2,42,700/-	
		ORISSA		
8.	401 RS 6.	Construction of the road portion of the Rail-Cum-Road Bridge over power channel of the Mahanadi river on National Highway No. 6.	*2,00,000/-	* Excluding agency charges. The total estimated cost of the road portion of the combined-rail-cum road bridge amounting to Rs. 6,92,009/- out of which an expenditure of Rs 2 lakhs is to be debited to N. H. funds and the balance is to be debited to the HirakudDam Project.

List of Books added to the Roads Organisation Library during October, 1950.

1. **Directory of British Construction Equipment 1950.** (The Federation of Manufacturers of Contractors, Plant, River Plate House, 12/13 South Place, London).

2. **The Effects of Modern Road Layout on Bridge Design**—Road Paper No. 5 by Cyril Stapley Chettoe. (The Institution of Civil Engineers, Great George Street, Westminister, London, S. W. 1, 1942).

I. R. S. SPECIFICATIONS.

3. **No. B.I-1947 Steel Girder Bridges.** (Manager of Publications, Delhi). 2 copies

4. **No. M. 4-1949-Class I, III and IV Steel Bars.** (Manager of Publications, Delhi.) 2 copies

5. **No. M. 6-49-Class V Steel (Plates, Sections, Bars etc., Boiler Quality).** (Manager of Publications, Delhi.) 2 copies

6. **No. M. 7-1947-Class VI Steel Rivet Bars and Drawn Steel Wire.** (Manager of Publications, Delhi.) 2 copies

7. **No. M. 9-1949-Class VIII Steel (Bright Drawn Bars).** (Manager of Publications, Delhi.) 2 copies

8. **No. M. 26-1949-Class X and XI Steel Forgings, Blooms for forgings and Bars. (For Locomotive Crank and Gudgeon Pins and other special purposes).** (Manager of Publications, Delhi.) 2 copies

9. **No. M. 27-38-**Class XII Steel Rivet Bars (High Tensile). 2 copies

10. **No. M. 8-45-Class VII Steel Rivet Bars (Ordinary Quality).** Manager of Publications, Delhi.) 2 copies

11. **No. M. 23-38-Class IX Steel Plates, Sections Bars etc., (High Tensile).** (Manager of Publications, Delhi.) 2 copies

12. **Highway Materials by Edward E. Baner.** (McGraw Hill Book Co., Inc., New York. 2nd Edition, 1932.)

13. **The Construction of Roads & Pavements by T. R. Agg.** (McGraw Hill Book Co., Inc., New York).

14. **Third Year of FREEDOM August 1949-Aug. 1950.** [The All India Congress Committee, (Publications Deptt.) 7 Jantar Mantar Road, New Delhi.]

15. **No. G/Misc.-66D-I. S. D. Standard Specification for Road Signs and Standards.** (Director General of Industries and Supplies, New Delhi).

16. **The General Theory of Employment, Interest and Money** by John Maynard Keynes. (Macmillan and Co., Ltd., Martins' Street, London, 1949).

17. **Towards a Dynamic Economics** by R. F. Harrod. (Macmillan and Co., Ltd., St. Martins' Street, London, 1949).

18. **Body Engineering Design and Construction of Motor Vehicle Bodywork** by Sydney F. Page (Chapman & Hall Ltd., 37 Essex Street, London, 1950.)

19. **Non-Pressure Treatments of Round Northern White Cedar Timbers with Creosote**—Bulletin Series No. 379 by Everett Edgar King. (University of Illinois, Urbana).

20. **Third Progress Report of the Investigation of Methods of Road-bed Stabilization** by Rockwell Smith. (University of Illinois, Urbana).

21. **Flexural Fatigue Strength of Steel Beams** by Wilbur M. Wilson. (University of Illinois, Urbana).

22. **Report of the Committee on State Trading.** (Manager of Publications, Delhi.)

23. **Elementary Structural Analysis** (First Edition), by John Benson Wilbur & Charles Head Norris. (McGraw Hill Book Company Inc., New York 1948).

24. **Highway Statistics Summary to 1945.** (Superintendent of Documents, U. S. Govt. Printing Office. Washington 25, D.C.)

25. **Historical Records of the Survey of India Vol. II 1800 to 1815** by Col. R. H. Phillimore. (The Survey or General of India, Office of the Survey of India, Dehra Dun,) (U.P 1950).

26. **Elements of Mechanical Vibration** (2nd Edition) by C. R. Freberg & E. N. Kemler. (John Wiley & Sons, Inc., Starrett Lehigh Bldg., 601 W. 26th St., New York, N. Y., 1949.)

27. **B. S. 292. 1950 Dimensions of Ball Bearings and Parallel Roller Bearings.** (British Standards Institution, London.)

28. **ASA Z. 17.1-1936-American Standard Preferred Numbers.** (American Standards Association, New York).

29 **ASA Z. 15. 3-1943-American Standard Engineering and Scientific Graphs for Publications.** (American Standards Association, New York).

30. **ASA Z. 32. 13-1946-American Standard Abbreviations for use on Drawings.** (American Standards Association, New York).

31. **ASA Z. 32. 2-1941-American Standard Graphical Symbols for Use on Drawings in Mechanical Engineering.** (American Standards Association, New York).

32. **ASA Z. 14. 1-1946-American Standard Drawings and Drafting Room Practice.** (American Standards Association, New York.)

33. **A. S. No. CZ. 1-1946-Australian Standard Engineering Drawing Practice.** (The Institution of Engineers, Australia.)

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