Technical Reference Developed for Indonesian Staff Responsible for Local Roads

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A major nationwide program has been established in Indonesia to bring reliable road infrastructure into the rural areas that contain major economic potential or currently possess high levels of population. Although national and provincial roads have been increasingly brought into a uniform system of tendering and maintenance, the county-type roads have remained outside such standards. A multiyear commitment to maintenance and construction of rural low-volume roads is in hand. However, local problems have been identified for the on-going maintenance of such new roads. Therefore, two departments within the Ministry of Public Works of Indonesia have been assisted by New Zealand consultants under a loan from the International Bank for Reconstruction and Development to compile a maintenance-related technical reference. This document encompasses the needs of all 246 counties regarding options between contracting and force-account methods. It compares labor-intensive and machine-intensive maintenance methods for local roads. This reference is to be distributed to civil engineers, contractors, and officials involved in local routine road maintenance as well as to county staff.

When ENEX, a New Zealand consulting engineers consortium, undertook a World Bank assisted contract with the Indonesian Ministry of Public Works, it was cognizant of the political, economic, and engineering problems to be broached regarding the construction and maintenance of low-volume rural roads. Although New Zealand has used much technology and evolved procedures from the experiences of the United Kingdom and of the United States, it had nonetheless retained its own pattern of road development. Succinctly stated, the national government and the county governments of New Zealand have seldom undertaken the construction of a new alignment or the rebuilding of an existing road without strong agreement between the Department of Public Works and the Department of Finance for the ensuing years of commitment for funds to guarantee adequate maintenance of such roads.

INDONESIA'S ROAD DEVELOPMENT NEED

The past experience of Indonesia is a bit like the observed activities within the United States regarding roads. First, the government worries about the placement of the road but seldom thinks about the long-term commitment it has initiated by such construction. Too frequently the road is built and grand ceremonies are made for its opening, but the ensuing maintenance needs are partly or totally avoided. The result is a greatly shortened life for the road investment and social turmoil generated by the local residents affected. Too frequently, the proposals for rural low-volume-road construction have also been at cross purposes due to differences between the design specifications and the actual needs. This can originate from the engineering staff at the national or the local level or it can emanate from powerful senior government officials. In most cases, such overdesign is not proposed for short-term self-serving desires but rather is demanded through the misguided belief that bigger and better road designs will better serve the community. However, the normal conflict with national budget is encountered. It revolves around the question whether it is better to build 5 km of very good road or 40 km of acceptable-quality roads. In such a case, the problem is the outstanding backlog of road repair and betterment. If a few kilometers are built to a high, expensive standard, then the majority of the roads fall further into disrepair and reduced reliability. If the maximum amount of road is built to a minimum standard, then much more of the region has the benefit of good road transport and the transport restraint to local development is removed. The conflict within this latter view is establishment of an acceptable professional minimum. There are persons (let us not call them engineers) who have tried cosmetic techniques for road improvement. These have lasted less than one rainy season. There seems to be a common error worldwide that simple spraying of a black-top mixture on the top of a bad road will do wonders for good transport. Even though such error has been seen for more than 60 years, it is still with us. When we collectively approach the problem of making a minimum, we would define it as a degree of construction and design that will permit light traffic for up to 10 years but at least for 5 years without there having to be a major project of repair or rehabilitation.

The development of such minimum design standards frequently runs into opposition from politicians and government officials, who consider the adoption of such policy to reflect a certain inferiority on their territory. They do not judge this option as the means to prudently cover the maximum road network but rather as a make-do option that bolsters the suboptimal conditions of the district. Again, it is difficult to clearly show them--to their satisfaction--the advantage of such an option. Officials will always prefer to cut the ribbon on a new bridge than to initiate a simple ferry service on a river. Fords or Irish bridges are forever lackluster compared with box culverts and tall concrete bridges.

ROAD DEVELOPMENT EXPERIENCE

Although the national capital, Jakarta, has a population of more than 7 million, more than 70 percent of Indonesia's population still reside in rural locations within the 26 other provinces. No successful inventory has been completed of the full road network. As the restoration of national and provincial roads has progressed, the partial documentation of county and village roads has given working figures of between 80 000 and 300 000 km. Based on sample tests within the provinces, it is not unreasonable to consider that all transport links--including footpaths--would total more than 1 million km. Of this amount, less than 25 000 km has been paved within the last 15 years. With reasonable amounts of central government budget, it has been possible to program more than 4000 km of road improvement per year. However, even with this expanded level, it is not hard to fathom the huge backlog that exists and that is growing. Roads that are directly outside the national and provincial categories are administered by counties and local villages. Although they handle a minor portion of the overall goods and passengers nationwide, they are vital links for the residents and their improved economic activities.

At the start of the first five-year plan in 1969, it was clear to all senior government officials that the road transport priority was the improvement of the strategic national and provincial road network.

However, by the start of the third five-year plan, the success of the earlier projects indicated that some shift in emphasis was required. As a result, major government budget and talent was directed to the strengthening of the rural road network at the county level.

NEEDS OF RURAL ROAD PROGRAM

The rural road program had to encompass many governmental and social needs. Some of these are as follows:

1. Establishment of a reliable road link for rural citizens,
2. Reduction of transport costs for users and potential users,
3. Intensification of agriculture through better marketing links,
4. Encouragement of greater employment opportunities,
5. Physical proof of government interest in the rural population, and
6. Retarding of urban migration by improvement of rural conditions.

When we--both engineers and economists--sit in our offices over a number of years and become immersed in the day-to-day activities of our specialization, it is too easy to overlook these types of fundamental facts. At first viewing, they seem too general and too idealistic. However, they are the foundation of such programs. Within the context of Indonesia, they have worked reasonably well.

Whatever projects and programs are to be undertaken will be done by local people, for better or worse. This fact is too frequently overlooked by the international consultants and specialists. A perfect program can be drafted on paper and submitted to international agencies and local ministries, but if it is beyond the scope or the interest of the local administrators or the local engineering staff, the time expended and the paper consumed can only be of academic interest. The need is a physical one: to establish road links to the majority of rural citizens who are engaged in low-level agricultural activities without major amounts of capital and with limited equipment and staff.

NEED FOR WRITTEN MATERIALS

One component of this need within the highway sector was to assist the local county staffs and their associated private firms in developing a maintenance capability for the road network once it had been upgraded. For this, the consultants prepared a draft manual that sets forth the fundamental maintenance needs for county roads. Within the Ministry of Public Works, the Directorate General of Roads and the Directorate General of Regional Planning coordinated this work. The idea was not to provide an encyclopedia of engineering information but rather to provide a reasonably complete manual of technical reference for the county engineering staff and private firms and individuals associated with road repair and construction. Within many of the counties, the maintenance work is undertaken by private firms in contract with the local government. In some localities the contractors have their own equipment, whereas in other remote locations they lease the equipment from the public works depot. The merits of this system are at least equal to the alternative methods, including force-account procedures.

At the outset of the technical reference manual, an engineering design standard was laid out (Table 1). It was formulated with considerable local input, not only by civil engineers but by other governmental officials. The standards should be considered as the minimum levels acceptable in maintaining and rebuilding the various road segments. However, within the first years of the program, it is more realistic to conclude that they will be used as a general guide to the work. The continued limitation in budget per kilometer of road will require such limited achievement.

The rural road designs were divided into five types. Four of these types were relevant for the county road system, whereas the fifth related to earth roads that might fall outside the county's jurisdiction. The designs were based on the estimated amount of third-year traffic. Such traffic was considered in total average daily traffic (ADT) and for vehicles of more than 3.5 tons. These considerations were further divided by three types of terrain.

These minimum standards endorsed the use of two-lane paved roads only in those locations that have more than 100 heavy vehicles daily or an ADT of more than 500 vehicles. Such a road would be built to a paved width of 6.0 m with sufficient shoulders for parking or nonvehicle roadside activities. Within mountainous sections, the maximum gradient would be 10 percent with sight distances maintained to 60 m. That would permit a design speed of 40-50 km/h.

While some engineers may earnestly argue with such values and designs, the overall need for improvement had to be considered. Indonesia did not want to become embroiled in the type of problem seen in the United States a few years ago. It did not want to establish standards that were so high that the cost per kilometer became too great for the government and no action could be taken. The roads had to be established and maintained. This had to be done nationwide, not simply in a very restricted location. As Indonesia perceives it, within the United States many counties during the late 1970s made the serious complaint that they could not do anything, especially with state or federal money, because the newly established road design standards were so overdesigned that conformity with them required inordinate amounts of funds. Some locations found it cheaper to pay for the modest improvements desired totally out of county funds. In some cases this local payment was less than the contribution required for the state matching money that relied on federal-type standards.

The second minimum design was proposed for rural roads with a daily traffic of 200-500 ADT or a heavy-vehicle frequency of between 50 and 100 vehicles daily. This provides for a paved road to the width of 4.5 m on a roadbed of 7 m. Gradients and horizontal curvatures would be nearly the same as in the first design. However, bridges of more than 35 m in length could be built to single-lane design.

The third and fourth types of design did not involve the paving of the road. These roads would be gravel or stabilized surfaces. In both cases, the road and its design reflected the more limited needs of the zone of influence. In the Class IIIC road, the future traffic envisioned would be less than 200 ADT, whereas in the Class IIID road, the traffic would be less than 50 ADT. On these types of road, "portals" would be used so that large trucks and buses would not be physically able to pass the entrance to the road link. Such a procedure is widespread within Indonesia. It is far more effective for the conservation of the roads and weak bridges than a passive road sign. Such portals are also less expensive than stationing guards at each end of the affected road. Although a road or a bridge could have a guard stationed for surveillance of

Table 1. Rural road study project: road engineering design classification and standards for Kabupaten roads.

Design Feature	Class III A Major Collector			Class III B Collector			Class III C Minor Collector		
	Flat or Rolling Terrain	Hilly Terrain	Mountainous Terrain	Flat or Rolling Terrain	Hilly Terrain	Mountainous Terrain	Flat or Rolling Terrain	Hilly Terrain	Mountainous Terrain
Traffic volume									
Avg vehicles/day	>500	>500	>500	200-500	200-500	200-500	50-200	50-200	50-200
Avg heavy vehicles/day	>100	>100	>100	50-100	50-100	50-100	10-50	10-50	10-50
Traffic lanes	2	2	2	1+	1+	1+	1+	1+	1+
Design speed (km/h)	80	60-70	40-50	60-80	50-60	35-50	50-60	40-50	30-40
Gradients (limiting) (%)									
Desirable	4	5	8	4	5	8	4	7	8
Maximum	4	7	10	5	7	10	5	9	12
Sight distance (minimum stopping) (m)	140	110	60	120	100	60	100	60	50
Pavement width (m)	6.0	6.0	6.0	4.5	4.5	4.5	4.5	4.5	4.5
Pavement type[b]	A	A	A	B	B	B	C	C	C
Road width									
Roadbed (minimum) (m)	8	8	8	7	7	7	7	7	7
Right-of-way (m)	20	20	20	10	10	10	10	10	10
Shoulder width (m)									
Desirable	2.0	1.5	1.5	1.5	1.5	1.0	1.5	1.0	1.0
Minimum	1.5	1.0	1.0	1.0	1.0	0.75	1.0	0.75	0.75
Road camber (%)									
Pavement	3	3	3	3	3	3	4	4	4
Shoulder	4	4	4	4	4	4	5	5	5
Bridge width (m)									
≤6 m	7	7	7	7	7	7	7	7	7
7-35 m	7	7	7	7	7	7	4.5	4.5	4.5
>35 m	7	7	7	4.5	4.5	4.5	4.5	4.5	4.5
Bridge design loading[c]	F	F	F	G	G	G	G	G	G

[a]As practicable.
[b]Pavement type: A = asphalt surface 20 cm thick; B = asphalt seal 15 cm thick; C = well-graded gravel, 10-15 cm; D = 7-10 cm of gravel; E = selected local material.
[c]Bridge design loading: F = 50 percent BM (>1000 vehicles/day, 100 percent BM); G = 50 percent BM; H = minimum 10 tons.

heavy vehicles, the low monthly wage would frequently result in the taking of payments, gifts, or favors for the occasional blind eye to prohibited passage.

Since Indonesia has a major domestic resource of natural bitumen (asbuton), there is currently a question within the government about spraying the gravel roads with this type of material in a manner that would permit better runoff of heavy rainfall and semistabilization of the gravel. Such work would only be done after the proper drainage systems and the proper foundation of the roadbed had been achieved.

Table 1 does not show that the length of each type of rural road is varied. That is, Class IIIA roads and Class IIIB roads could be quite long; road lengths could be up to 80 km. However, the Class IIIC and Class IIID roads would be less than 30 km in length. The earth road, as suggested in the standard, would be less than 10 km in length. These types of road should not be confused with pioneer roads of the Brazilian type. In Indonesia the rural roads are generally being established in locations that have a former alignment or walking trail. There is a resident population and in most cases there is a reasonable economic potential from existing activities for improvement. In some parts of Kalimantan and Irian Jaya, the roads required are more of the pioneering type. Such roads form part of the national strategic road network and therefore fall into the responsibility of central government and/or provincial government.

COUNTY ROAD MAINTENANCE PROBLEM

With each county being able to establish a local, reliable road network, the major problem will become maintenance. Maintenance of road infrastructure and bridges is a philosophy and procedure that has not yet been deeply established within the understanding of many Indonesian officials. The parts of a bridge that can be easily seen are painted so that they look nice, not to prevent corrosion. The undersides of bridges are not painted since nobody is supposed to look under bridges. With this degree of potential for guiding and training local staff in maintenance, the technical reference manual was developed.

ASPECTS OF TECHNICAL REFERENCE MANUAL

The first section of the manual was drafted for the direct needs of county engineers and administrators who have the responsibility of setting up the effective maintenance function. Within the eight chapters, the fundamentals for organization and supervision of the maintenance function are given. Special emphasis is given to the need for developing a costing ability at the county level. At present the small and medium-sized jobs being done by force account are being done without a full understanding of the cost incurred for the actual work.

Within the first chapter the objectives of a county maintenance program are listed. Five basic steps are endorsed for attaining these objectives:

1. Maintenance standards for each type of road must be established.
2. An organization with management ability must be set up for implementing the maintenance function.
3. Release of budgeted funds must be changed from the all-or-nothing system currently practiced into a system with uniform distribution throughout the 12 months.
4. Acquisition of sufficient plant, equipment, and labor force is required.
5. Adequate supervisory staff at the field level must be trained and employed.

When the problems of rural road maintenance are approached from the viewpoint of a local official in the more remote counties of Indonesia's provinces, it is necessary to define the exact nature of the needs and the actions. In this way it is clearly written that the maintenance standards for county roads are designed and adopted to protect the in-

Class III D Access			Class Earth DESA		
Flat or Rolling Terrain	Hilly Terrain	Mountainous Terrain	Flat or Rolling Terrain	Hilly Terrain	Mountainous Terrain
10-50	10-50	10-50	<10	<10	<10
≤10	≤10	≤10	NA	NA	NA
1	1	1	1	1	1
30-50	20-30	15-25	a	a	a
5	8	12	–	8	12
6	10	15	–	12	18
60	50	40	a	a	a
4.0	4.0	4.0	3.5	3.5	3.5
D	D	D	E	E	E
6	6	6	5	5	5
10	10	10	10	10	10
1.0	1.0	1.0	1.0	1.0	0.75
0.75	0.75	0.75	0.75	0.75	0.75
4	4	4	5	5	5
6	6	6	6	6	6
3.5	3.5	3.5	3.5	3.5	3.5
3.5	3.5	3.5	3.5	3.5	3.5
3.5	3.5	3.5	3.5	3.5	3.5
H	H	H	H	H	H

vestment of society within that road and to ensure the continued reliability of each road segment. The needs of the community can be met at an annual maintenance cost that is bearable.

Through the use of simple figures, the concepts of serviceability and maintenance need are shown (Figures 1 and 2). In this context, serviceability refers to condition and quality of surface and can be rated as such. It has been shown that with an economic discount rate of 12 percent, it is more effective for the development of the nation to build a minimum-standard road and expend annual funds for its maintenance than to build a road to a higher standard and provide no annual maintenance. Such a conclusion is solely related to the direct costs of the county road engineering department, not to the changes in cost and time incurred by the road users.

The differences between routine maintenance and periodic support maintenance are provided. The day-to-day activities within routine maintenance are listed. (Some examples are shown in Figures 3-8.) This provides the county engineer with a clear list of the types of tasks that must be done each day rather than a few times per year. The county engineer is given five groupings within routine maintenance: pavement surface needs, drainage needs, shoulder requirements, traffic-related items, and bridge needs.

On roads with a bitumen surface, the maintenance staff must conserve the carpet by close inspection for patching needs and pothole repair. On gravel and earth roads there will be a frequent need for grading and reshaping of the material. Given the high rates of precipitation, the field staff will have to monitor the pavement needs at least weekly. Special sections within each road may be found where more than normal attention must be directed.

The task of cardinal importance to be encouraged and supported throughout the program is drainage. From the viewpoint of routine maintenance, it is taken as valid that the subbase and base of the road have been constructed in a correct manner. Even if this aspect is not totally correct, except in swampy locations, the drainage commitment of field staff can counter many potential problems. Within the comments about surface and drainage it is continually stressed that drainage is the major problem for the continued good condition and serviceability of the road. With 2000-4000 mm of annual rainfall, emphasis is placed on the camber of the road. After the road has been constructed with adequate camber, it is the duty of the maintenance forces to monitor changes and attempt to retain the camber. The result of lack of camber is that the roadway becomes a conduit for water rather than shedding the downpour.

For culverts, bridges, and related drainage structures, it is strongly stated that frequent work must be done in removal of siltation, repair of side walls, and protection of piers and abutments. During the last three years, Indonesia has lost more than 115 bridges due to flash floods. In accordance with the available labor supply, maintenance forces should have greater reliance on gabions and deflec-

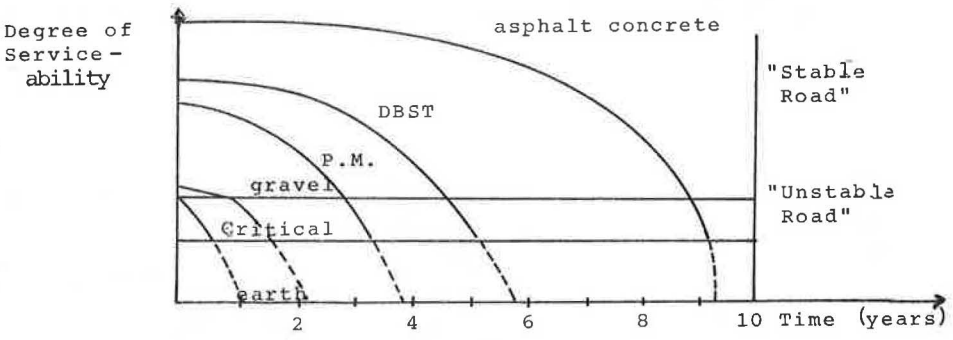

Figure 1. Levels of serviceability for various pavements.

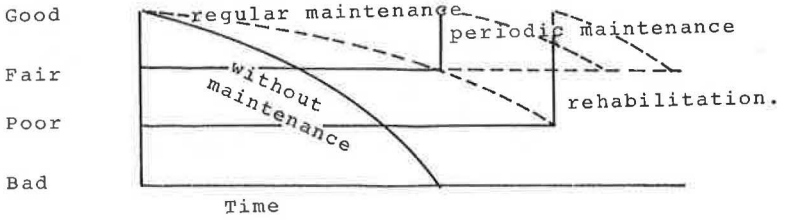

Figure 2. Regular maintenance extends serviceability.

tive work at crucial locations within the runoff pattern. When a proper, frequent inspection and supervision system is established, the public works officials will be able to more readily respond to the telltale signs of culvert and bridge deterioration. An inventory of culverts and their characteristics is required. Currently, county road culverts are seldom officially cleaned until the road is undermined or the culvert lost.

The technical reference manual discusses the types of surface drainage that are required. It details the needs of side drains and cross drains and their relation to the road's foundation.

Figure 3. Labor-intensive placement of sand, chips, and bitumen (Sukabumi, West Java, Indonesia).

Figure 4. With high rainfall, lateritic soils, and tropical vegetation, need for drainage is primary (Sekayu, South Sumatra, Indonesia).

Figure 5. Construction of new surface should be combined with effective drainage (Dairi, North Sumatra, Indonesia).

Figure 6. Metal beams placed at road entrance guard from use by overweight trucks (Jonggol, West Java, Indonesia).

Figure 7. Fifty-year-old bridges did not envision current transport demands (Kuningan, West Java, Indonesia).

Figure 8. Incremental improvement to county roads continues nationwide (Cianjur, West Java, Indonesia).

Shoulder Maintenance

A review is given of the needs of shoulder and roadside maintenance work. The majority of existing field staff believe that shoulders on county roads are unimportant to their work and somehow are a no-man's land when maintenance is required. The manual explains that the shoulders are one of the field staff's best indicators of maintenance need and corrective actions required. First, clear and sloped shoulders without heavy vegetation indicate that the road's foundation should be in good condition. Second, the provision and maintenance of usable shoulders will permit drivers and law-enforcement officers to use the side of the road more rather than remain totally on the pavement surface. At present the driving public, both professional and nonprofessional, has no faith that the road shoulders are usable. Therefore, any breakdown is left directly on the pavement. Vegetation control is very difficult within the tropical locations of Indonesia. However, for drainage control and for horizontal sight distance it is necessary to maintain a vigorous cutting program. Local residents are encouraged to cut and use such vegetation for their livestock needs. Even so, routine roadside cutting is required at least quarterly.

Periodic Support Maintenance

A description of the more frequent needs of periodic support maintenance is provided. These are types of major repairs to the road that require special gangs of workers or special equipment. Such support work can be programmed and preplanned for 90 percent of the requirements. The remaining 10 percent will relate to emergency-type maintenance, notably land slips.

The work classifications for periodic support reflect our earlier comments about drainage. The majority of tasks are found in drainage--ditches, culverts, and bridges. On some roads the first years of this program may incur above-normal amounts of time on ditch and culvert repair. This is due to the long-standing lack of routine maintenance. For many county roads the side drains require complete regrading. In the past it has been the practice for crews to clean ditches by placing the debris between the ditch and the road pavement. As a result, the runoff stays on the shoulder and this results in weakening of the road foundation and seepage into the pavement. Therefore, this excess debris must be removed with grading equipment and the shoulders leveled.

Bridges

The main work for bridge locations is inspection of the flow characteristics and preemergency protection of the banks. Since many county roads are of pre-1938 colonial design, a frequent problem is overexposed abutments. Bridge designs prior to independence in 1950 frequently permitted an embankment to jut into the riverbed with the bridge structure resting on it. With the passage of four decades, this design has incurred many failures due to weakening of the embankment. Bridges must be closely inspected, at least annually if not quarterly, due to their age and the unanticipated weight of medium-sized trucks. An iron or steel truss bridge erected in the 1920s for 2-ton trucks and horse carts is frequently now required to support 5- to 10-ton buses and trucks. With lack of routine maintenance for more than a generation such bridges can be termed fair in their integrity, at best. During 1981 there were 14 bridges that collapsed with overweight traffic. The number that had partial failure or delayed collapse has not been compiled. However, 25 000 m of bridges are built entirely of wood. The decking on most nonconcrete bridges is wooden plank. Scores of bridges are known to be still in existence but without decking due to natural rot, with damage due to overweight vehicles, and with theft of material by short-sighted residents.

As a means to establish continual planning of road maintenance needs, the technical reference manual reviews various construction standards that are found for Indonesia's county roads. Types of base course and different combinations of pavement surfacing are detailed. Within the four classes of county roads, a review is made of the pavement design requirements when variations in water table and subgrade composition are considered.

MAINTENANCE ORGANIZATION

Many county road engineers responsible for road maintenance have obtained their position from tenure and advancement within the county public works agency. This means that many of them have not been introduced to management and administrative methods that could be successfully employed for their department's activities. With years of existence on meager budgets and with little long-term assistance or interest on the part of provincial officials prior to 1975, there is a pressing need for information about organization options and methods.

Even when a county has little equipment, it will generally have 300-600 km of county-administered road. The authorities must start to plan logistics and outline their scope of operation. To do this, they must determine the amount of decentralization that will be given within the county. They must establish a means of communications. Frequently this will be done without radio communications or without telephones. Not all of the 246 counties have public telephone links between the main towns or the provincial capital. Only 160 counties have a central electric supply, 50 have self-provided generators (not always working), and the remainder function without electricity for county government offices.

After reasonable consideration of the existing and the future pattern of routine maintenance work, the county must provide locations and equipment for field depots. Specialized gangs and/or a plant will be located at these points. While counties on Java Island are typically less than 1200 km^2, the counties of Sumatra, Kalimantan, and Sulawesi are more than 4000 km^2. Field depots are required in all. Some counties are composed of many islands. Therefore, even though the actual network may not justify permanent plant locations, the logistics for moving equipment in and out will dictate the reasonableness of placing equipment on each island that has a modest road infrastructure.

The scope of work and the size of gang must be determined. Management and accountability for plant and field workshops must be established. Some counties currently possess field workshops, but these are not accountable for spares, for use of equipment, or for the attendance of staff. Too frequently a workshop mechanic will be seldom found in the government facility but may be the same person to repair the government equipment under contract in a private garage nearby.

The establishment of a 24-h emergency call system is required. When special road sections are known for frequent generation of problems, the county roads engineer should have a plan in hand for deployment of staff, gangs, and equipment. Even if insufficient budget and communication facilities are

experienced during the first few years, the plan should still be developed and adhered to as much as possible. In effect, the attempt to follow such a plan will permit officials to test it and improve it during the time of organization strengthening.

Overall to this development is the requirement for a rigid progress-reporting system. This will be handled by the better supervision of county road maintenence staff. The two will go together in their development.

To accomplish their formidable countywide need, the road section of public works should function in four divisions below the county engineer. These would comprise the budget and planning section, the section for field operations, the traffic services function, and a local training program.

The field operations should be formed into a mobile crew system in counties with sufficient equipment and small road networks. The larger counties would use a local (section) roadman system. Especially in locations without telecommunications, the older system of a local or regional roadman has much merit. Within paved road sections the roadman would have charge of 2-3 km of road. For gravel and earth roads, his charge would be 4-5 km in length. During the transition period to the new maintenance system, the roadman in more isolated county locations will organize his neighbors for one- to two-day work assignments to deal with emergencies that would otherwise require dispatch of mobile crews or plant. Major slips and drainage failures will be corrected and repaired by the county road forces.

COUNTY NEED FOR PLANNING

Within the technical reference manual, emphasis is placed on the need for local planning, local assessment and assignment of plant, and local development of budgeting control.

The county engineer must undertake to provide the provincial officials and others with an annual maintenance work program. This plan will bring forth the performance of the previous year so that variations can be observed. It should provide an update of the physical inventory of roads and drainage structures. The maintenance needs for each road segment should be shown. These needs may vary due to the local conditions, but such variation should be well documented. The county engineer will provide a summary of field inspection comments in a manner to show the types and the magnitude of periodic support works and special repairs that are required. A summary listing of the staff and equipment on hand will be provided. Such a report will contain information about the condition of the equipment and the further training of individual staff persons. Finally, a summary of the quantities required for the annual maintenance program will be furnished. This will be used to determine the performance standards of various gangs and the need for additional training, additional equipment, or additional supervision.

Within the manual, the local assessment and logistics for plant were reviewed on the basis of a county with 200-250 km of network that could be reached within a contiguous road network and that was contained within one island or land mass. If sufficient available labor is at hand, the county could have a functioning road maintenance operation with 10 major pieces of plant, three pick-up trucks of less than 1.5-ton capacity, and four two-wheeled vehicles. The difference in plant need between labor-dominant and machine-dominant maintenance operations is derived by annual hours of use and the quantity of rain to be experienced within the county. At the outset, additional units of tippers (dump trucks) will be required. In some counties located within the eastern swamplands of Sumatra Island, the long leads for materials may require additional tippers even though labor-dominant placement is desired.

One of the factors incurred during this work was the interest of international lending institutions and nations desiring bilateral aid assistance. In such cases, the rational review of the merits of labor-dominant and machine-dominant systems was moot since the party desiring to lend the foreign-exchange component of the work was not highly interested in domestic expenditures but was more in favor of purchase and import of equipment. As a result, an actual detailed consideration of labor and equipment variation could not be undertaken. The government was interested in the foreign aid for the project, whereas the lender was interested in the international tender for equipment, so labor requirements within remote locations were not a high priority to either of them. The types of work that were considered for labor-dominant methods were limited to medium and small earthworks, land clearing, side drainage when less than 1.5 m deep, procurement of river gravel, spreading of surface chips, and vegetation control. These comments are not made in a manner to discount the needs or the priorities of the nation but simply to place in perspective how the final program was reached.

COUNTY ROAD COSTING AND BUDGET DISBURSEMENTS

The manual contains one section on the needs for the county and its road engineer to take responsibility for costing of each maintenance job and each gang. A costing system is proposed, without reliance on computer technology. Costs are reviewed between the actual in-field work and the overhead costs. The variations in labor costs, material costs, and plant-hire rates are reviewed. Maintenance work cost sheets are provided in specimen form for local engineers to adopt. In this way separation can be made between the routine maintenance items and the periodic support work items. The maintenance service levels for various types of roads are provided. This permits the local engineer to understand the type of format that should be devised for control (Table 2). As of early 1982, the average cost for provision of this type of road maintenance is shown in Table 3. At the time of the study, the Indonesian rupiah was exchanged at $1.00 U.S. equals Rp 635.

For the proper execution of road maintenance at the county level, the consultants advised the Government of Indonesia that a more effective system of disbursements had to be developed if uninterrupted road maintenance was to be obtained. At this time there is a serious delay in the release of funds for all county activities, not only road maintenance. Rather than being able to provide the anticipated funds on a uniform basis for 12 months or even 10 months, the administrative delays in transfer of funds result in the reduction of disbursal time to as little as four months. This has the added problem that the funds are not available during the best of the dry season, so work must be delayed. The release of budget occurs too close to the commencement of the rainy season, so extra cost is incurred and the quality of repairs has been frequently seen to suffer. Within the Ministry of Finance, the Ministry of Home Affairs, and the Ministry of Public Works, modifications are in hand to alter this problem.

WORK PROCEDURES

The second section of the manual was arranged for

the field staff and the overseers of the maintenance work. It provides six chapters detailing the road maintenance practices that should be considered for Indonesia's county road conditions. Since greater amounts of local or international equipment will be obtained under this program, there is a review of the types of equipment that should be used. Some of the equipment was transitional in type. For example, prior to acquisition of a motorgrader, some counties may find value in the use of a Minnesota road plane. Since horses are not used in road maintenance, the adoption of the Fresno was not suggested.

Within this section, much coverage is given to the procedures for drainage maintenance. It is stressed that the county road engineer must ensure that routine maintenance is performed on the various portions of the drainage system. Corrective actions are best done at the outset of the problem. When evidence of failure or deterioration is observed, this condition should be communicated immediately and proper maintenance practices should be used for the repair.

Table 2. Rural road study project: routine and periodic support work and maintenance levels of service for Kabupaten roads.

Road Work Activity	Classification	Performance Criterion	Road Class and Traffic Level (vehicles/day)				
			Class III A, >500	Class III B, 200-500	Class III C, 50-200	Class III D, 10-50	Earth, <10
Road surface	Periodic support work	Periodic work to be included in yearly program	Surface reseal (5-year cycle)	Surface reseal (5-6 year cycle, 4-year gravel cycle)	Gravel overlay (6-year cycle)	Gravel overlay (8-year cycle)	Earth road (10-year gravel cycle)
Resurfacing							
Reseal (SST)							
Regravel (≤6 cm)							
Patching and pothole repair	Routine work	Annual work program within budget limitations	70 m^2/km	50 m^2/km	50 m^2/km	40 m^2/km	40 m^2/km
Reshaping and grading			NA	6 times/year	4 times/year	3 times/year	2 times/year
Drainage							
Drains and culverts	Routine work	Continuous work carried out by roadmen allocated specific lengths of road	2-km length	2-km length	3-km length	4-km length	5-km length
Cleaning and repair							
Major repair to drains	Periodic work	Annual work program	Routine[a]	Routine[a]	Routine[a]	Routine[a]	Routine[a]
Roadside							
Vegetation control	Routine work	Continuous work carried out by roadmen allocated specific lengths of road	2-km length, once/year	2-km length, twice/year	3-km length, 3 times every 2 years	4-km length, 3 times every 4 years	5-km length, once/year
Erosion control							
Minor repairs to shoulder to include trimming and reshaping	Routine work	Work by tractor or grader (per unit)	4 times/year	2 times/year	Once/year	Once/year	Once/year
Bridges							
Channel cleaning	Routine work	Continuous work carried out by roadmen	Within 2-km length	Within 2-km length	Within 3-km length	Within 4-km length	Within 5-km length
Deck cleaning							
Timber deck renewal	Periodic support work	Annual work program	Routine[b]	Routine[b]	Routine[b]	Routine[b]	Routine[b]
Bank and scour protection							
Painting steel work							
Structural repair							
New handrails or approach							
Traffic services							
Traffic sign maintenance	Routine work	Annual work program	One/2 km	Two/5 km	Three/10 km	One/4 km	One/5 km
Line marking	Periodic work		Negligible[c]	Negligible[c]	Negligible[c]	Negligible[c]	Negligible[c]
Contingencies		Annual work program	-[d]	-[d]	-[d]	-[d]	-[d]
Sundries and emergency work		Annual work program	Routine[e]	Routine[e]	Routine[e]	Routine[e]	Routine[e]

[a]10 percent of routine-work budget. [b]15 percent of routine-work budget. [c]Include in sundries. [d]Add 10 percent to total maintenance estimate. [e]5 percent of routine-work budget.

Table 3. Average maintenance cost per kilometer in thousands of rupiahs.

Maintenance Activity	Road Class and Traffic Level (vehicles/day)							
	Sealed Road				Gravel Road			
	Class III A, >500	Class III B, 200-500	Class III C, 50-200	Class III D, 10-50	Class III B, 200-500	Class III C, 50-200	Class III D, 10-50	Earth, <10
Routine-work budget	770	631	417	283	907	632	466	399
Pavement reseal	779 (5)	584 (6)	487 (7)	373 (8)	–	–	–	–
Gravel overlay	–	–	–	–	819 (4)	546 (6)	365 (8)	357 (10)
Other periodic support work (45 percent)[a]	347	234	188	122	408	284	210	179
Total periodic support work	1126	818	675	500	1227	830	575	436
Routine work (sundries)	847	694	459	312	998	695	513	439
Total budget	1973	1512	1134	812	2225	1525	1088	875
Analysis (periodic support work/routine work)	1.33	1.18	1.47	1.60	1.28	1.19	1.12	0.99
Percentage of Class C	100	76.6	57.5	41.2	112.8	77.3	55.1	44.3

Note: Figures in parentheses indicate cycle in years.
[a]Periodic-support-work budget is shown here as 45 percent of routine-work budget.

The routine and periodic support maintenance needs of bridges are placed in a separate chapter. A detailed review is given of the needs for cleaning and inspection of all bridge structures. The procedures for proper inspection are listed.

The maintenance needs for road surfaces are divided into four types. Bitumen-sealed roads are treated for their needs of water runoff and surface repairs. A detailed procedure is given for earth and gravel roads. The potentials for lime-stabilized roads are cited.

SUMMARY

The technical reference manual is planned for distribution throughout the county road agencies of Indonesia. The manual is in the local language, which more than 60 percent of the staff can read. It is planned for distribution to all county road engineers, officials, and contractors. It is envisioned that more than 2000 copies will be printed. Following the adoption of this manual, the Ministry of Public Works may issue additional types of manuals. After four or five years of use for this first manual, a gradual introduction of updated techniques can be made. Changes in maintenance practices on the county roads may occur by that time.

Taken individually, the county roads are not of major importance to the central government. However, collectively these roads are the capillaries to be used by government for implementing new social, economic, and agricultural programs for the continued development of all strata of Indonesian society. As such, this program for county road maintenance will play a crucial role. If successful, it will become a modest daily routine without special fame. However, if it fails, the costs for attempting to keep roads open will increase severalfold and the social and economic benefits desired for rural citizens will be in jeopardy.

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We take full responsibility for the statements made here. Such comments may not represent the policies or views of any other individual, firm, agency, or ministry of the Government of Indonesia. Such viewpoints may not reflect the plans or policies of international agencies or bilateral national trading partners.

Low-Volume Roads: Closure and Alternative Uses

CLETUS R. MERCIER

The problem of low-volume secondary roads in Iowa is discussed. Specifically, this paper summarizes the position of counties as they seek to close roads, and their financial dilemma as they try to stretch limited funds to cover a large amount of maintenance and construction needs. Current status of the secondary road network is reviewed in terms of needs and budget constraints. In particular, applicable elements of the Code of Iowa are reviewed and related court cases are evaluated. An analysis of road-closure problems is provided, along with a description of a set of three alternative uses for the vacated road right-of-way. The three alternatives are use as a private access road, conversion to agricultural use, and conversion to agricultural use and as a shelterbelt. An assessment of benefits and costs is included for the three alternatives. The paper ends with a set of policy recommendations. In essence, it is recommended that the state legislature act to mandate road closure and vacation and to provide assistance in the form of a more appropriate functional classification system and technical and legal assistance.

Significant portions of Iowa's current secondary road system are used very lightly. In fact, of the more than 90 000 miles of secondary roads in Iowa, nearly one-fourth (more than 22 000 miles) carry an average of less than 25 vehicles/day. Expressed in terms of vehicle miles, this one-fourth of the secondary road network carries slightly more than three percent of the total secondary road traffic.

Managers of the secondary road network are facing the problem of rapidly escalating costs while growth of revenues has slowed. Closure of some of these low-volume roads would help road budgets in the short term and benefit Iowa's economy in the long run by making more land available for tillage. One of the problems to be faced is how to use the right-of-way of the closed and vacated roads. This is the topic of this study.

BACKGROUND

When the road network was created in Iowa more than 100 years ago, the average farm was about 90 acres in size. The road network was a grid, generally with roads at 1-mile intervals, both north-south and east-west, and the land was subdivided into pieces about 640 acres in size. This pattern was only interrupted by natural barriers such as rivers and lakes.

The road network greatly facilitated land development, as it provided access from the land to markets for the farm's products. In addition, most of the state's population lived on farms, and the road network was also used for social interaction and as an access to necessary goods and services.

Mass migration into the cities accompanied major increases in the productivity of the individual farmer due to improved technology, and the average farm size increased to 158 acres in 1930 and to 253 acres in 1976. Iowa's rural population was 1 528 000 in 1920 but dropped to 1 318 000 in 1960 and 1 097 000 in 1980. Farm population dropped from 662 000 in 1960 to 512 000 in 1970 and 294 000 in 1980. (The 1980 figure is probably understated, as the method used for classifying farm population was changed for that census.) Rural road mileage dropped during this period, but not significantly.

When the road network was originally developed, there were 6-8 farms/mile^2, each with a farmstead and each requiring direct access to the road network. Consolidation of farms since that time has reduced that number to between 2 and 4 farms/mile^2 and made similar reductions in the number of farmsteads. The road network is still being used for the same purposes as before but by fewer people on fewer farms. Although the number of farms has decreased, there is evidence that the number of trips generated by each farm has increased, as well as the