# AN INTEGRATED NATIONWIDE RURAL ROAD SYSTEM FOR THE GAMBIA

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The rural road system in The Gambia, West Africa, comprises over 2300 kilometers of paved, gravel, and earth roads. These connect rural communities with each other, to riverside staging points, to the larger towns and cities, and to produce storage and transshipment depots. The role of the road system is considered in regard to these functions and as related to needs for future rural development consistent with national goals and objectives. Data based upon recent studies in The Gambia are presented, particularly those which address future agricultural development potentials and road integration with river linkages. The categories of primary, secondary and principal feeder roads are examined from the viewpoint of current function, traffic, and existing deficiencies. Future highway needs based upon optimum use of the River Gambia and the road network for transporting a variety of import and export commodities are described and a tentative road investment program is proposed. Guidelines are then outlined to assist in the geometric and structural design of future highways in The Gambia and a review is made of material types and availability for future use.

## Location

Located on the west coast of Africa, The Republic of The Gambia covers an area of 10,400 square kilometers, and extends eastward from the mouth of the Gambia River a distance of approximately 330 kilometers inland. At its widest point, the country is approximately 40 kilometers wide and is surrounded, except for the coastal strip, by Senegal.

## The Existing Road Network

The two basic forms of transportation in The Gambia are river and road. Due to the elongated east-west orientation of the country, surrounding low-lying topography and presence of the navigable River Gambia extending nearly the entire length of the country, the river was historically the preferred means of transporting persons and goods. The later development of roads has increased economic development and agricultural production. Need for improved communications and general inland travel was therefore a secondary development in the transportation scene.

In general, travel by road has proved to be more desirable for persons and small cargo loads and for certain trips which do not involve movement between opposite sides of the River Gambia. Bulk cargo movements along the river and passenger and small cargo movements involving cross-river movements remote from ferry crossings, or longer trips where time is less important, are almost exclusively accommodated by use of river craft.

## Road Classification

Existing roads throughout The Gambia are shown in Figure 1, indicating the Public Works Department's functional classification system of primary, secondary, and feeder roads. It can be seen from this that many roads lead directly to and from riverside points--used extensively as river-road goods transfer nodes.

Primary roads are defined as those connecting the main centers of activity, and form the major, continuous, all-weather lines of communication. These roads carry most of the rural traffic in The Gambia. Some sections have been bitumenized and the remainder are gravel roads. The alignments and widths (generally 6.7 meters) are such as to allow a free flow of two-way traffic, except at some bridges and at ferries.

Secondary roads are all-weather roads connecting a particular region or locality to the primary network. They are essentially gravel roads of somewhat lower standard than the primary roads and do not form a continuous network.

The largest group of secondary roads serves the coastal area and the southern border of The Gambia. Others are isolated connectors to the primary roads.

Feeder road is the term used to describe the multiplicity of routes used primarily for access between villages, and to transport crops to buying stations, riverside depots and processing centers. They are basically unformed roads, with little or no provision for drainage. They range from well-defined (and sometimes gravelled) tracks for vehicular use to footpaths or cart tracks. Some of these roads, located on higher, stony or free draining land, are usable throughout the year, but most feeder roads provide reliable access during the rainy season only for four-wheel drive vehicles.

Of the national total of approximately 2,360

Figure 1. Existing rural road network, The Gambia.

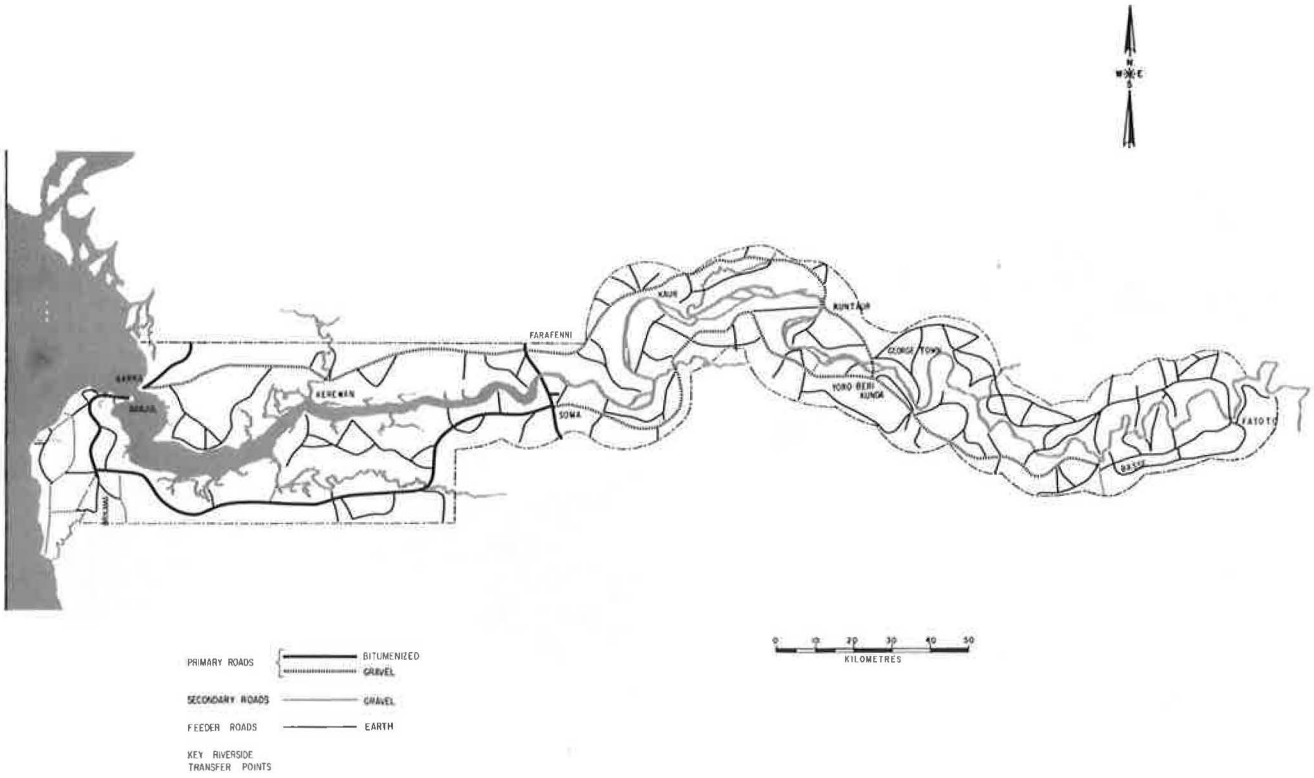



Figure 2. PWD road classifications.

kilometers, the greatest length, 1,555 kilometers, or 66 percent, are major feeder roads, while primary and secondary roads comprise 28 and 6 percent of the total, respectively. Examples of each classification category are shown in Figure 2.

Primary road, gravel surface.

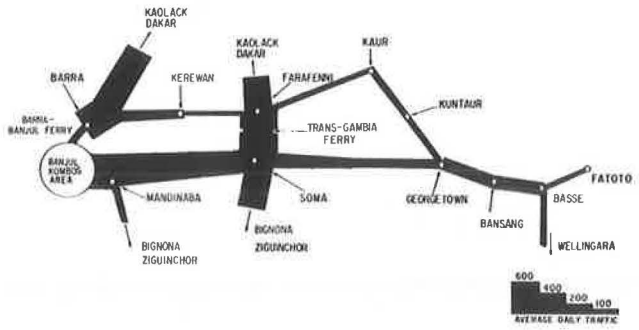
Feeder road, earth surface.

## Traffic Characteristics

Sample traffic counts were made at 14 locations and origin-destination interviews were conducted at 8 locations on the road network. The counting period lasted from 0700 hours to 1900 hours in two-hour divisions. This procedure and the data obtained, together with monthly indications of traffic trends in The Gambia, formed the basis for estimating annual traffic levels and related characteristics.

Daily traffic volumes on rural roads, as shown in Figure 3, were estimated to vary between nearly 700 vehicles on the Barra to Kaolack Road (leading to Senegal) to approximately 40 vehicles on roads in eastern areas of the country on the north bank. Over 600 vehicles per day occurred between the major centers of Banjul and Soma. On the Trans-Gambia Highway, between northern and southern areas of Senegal, 230 vehicles per day occurred at the ferry crossing and approximately 350 on the road segments leading

Figure 3. Estimated daily traffic volumes on principle rural roads.




to and from it, indicating considerable local activity. Volumes diminished significantly toward the eastern extremity of the country, reflecting primarily the reduced settlement density.

Traffic volumes in urban areas, as might be expected, were much higher than those on rural roads. Nearly 9,000 vehicles per day were observed on the main road into Banjul, the Capital.

The percentage of non-Gambian vehicles in the traffic stream varied from approximately 75 percent at the Trans-Gambian ferry to approximately 2 percent on other major roads. As expected, apart from the Trans-Gambia highway, the greatest volumes occurred on roads leading to and from Senegal, varying between 8 and 25 percent.

Vehicle classification observations indicated that passenger cars were the largest component of the traffic stream, usually varying from between 60 and 80 percent on the roads with the higher volumes to as low as 25 percent on the more remote roads. Most passenger cars were used as taxis. Between 10 and 20 percent of vehicles were trucks. However, this was exceeded on the Trans-Gambia highway, where 31 percent of all vehicles were recorded as trucks. The percentage of buses is considerably lower, varying between zero on some north bank roads which are unpaved, to 32 percent on the Trans-Gambia highway ferry.

On feeder roads in The Gambia, traffic rarely exceeds an average of 50 vehicles per day, based upon existing records and observations made during reconnaissance and evaluation trips throughout the road network. In many cases the volume appears to be in the order of 20 vehicles per day or less, and a large proportion of this traffic consists of animal-drawn carts, government vehicles, motor and pedal cycles. In some instances where villages, groundnut buying stations or other activity centers are located near main roads, higher volumes occur. However, these may be regarded as access volumes on a very limited portion of the total network.

## Physical Deficiencies of the Road System

Field inspections of road conditions were made to establish a "condition log" which could be used as a basis for establishing needed improvements and costs.

The condition of the road pavement has been ranked from a numerical index to one of an index of five, as follows:

Index 1 - New Pavement
Index 2 - Pavement not new but with adequate riding quantities and transverse shape
Index 3 - Pavement irregular in shape but still basically sound, correctable with grading and/or a premix regulation course
Index 4 - Excessively deformed pavement shape requiring base and surface repair
Index 5 - Pavement failed; route detour required

Typical examples of the above conditions are shown in Figure 4.

Figure 4. Road condition index.

Condition 2 - acceptable.

Condition 3 - surface deterioration.

The nature of general deficiencies noted at specific locations during the field observations are as follows:

Shell Bitumen Surfaced Roads

1. Excessive camber and longitudinal deformation in outside wheel tracks.
2. Some heavily travelled road surfaces are in imminent danger of failing.
3. Edge failure of the bituminous surface.
4. Uncut grass to the edge of the bituminous surface (December, 1977).
5. Culvert markers, headwalls, bridge parapets and bridge handrails need repairs and repainting.

Sand Bitumen Surfaced Roads (mostly Banjul and adjacent areas)

1. Excessive deformation.
2. Pavement failures on heavily travelled sections.

3. Edges eroded and regraveling needed.

Basalt Chipping Bituminous Surface Road (Trans-Gambia Highway)

1. Failure of the base and subbase on approach sections to Gambia River ferry. (This road carries heavy vehicles.)
2. Ferry approach sections need reconstructing.
3. Edges eroded; regraveling needed.

Gravel Surfaced Roads

1. Surfaces worn and corrugated.
2. Cross-section irregular.
3. Needs regraveling to restore the pavement strength and camber.
4. Edges eroded.
5. Culverts, bridge edges eroded and require repair.

It should be noted that many of the above observations were made shortly after the wet season, 1977, and maintenance was being undertaken to remedy deficiencies.

## Future Design and Construction Guidelines

During the 20-year period from 1977 to 1997, an increased demand for road and river transport will occur to accommodate increased crop movement, imports and exports, and general demand for personal mobility. A review of the planning and systems aspects of the proposed system is provided below to provide a background to the design and construction guidelines recommended for future development.

### Transportation Systems Review

Following estimation of the major future demands and formulation of potential river and road improvement alternatives (three road networks), cargo and passenger demands were assigned to the networks. This process consisted of a series of manual iterations of traffic assignments, initial cost evaluations, network adjustments and consideration of the potential benefits expected from unit expenditures on the principal projects.

The river and road traffic estimated to occur in the future was reviewed for consistency with general economic indicators and with potential development in The Gambia as described in the Five-Year Plan and other documents.

In general, traffic volumes are expected to be approximately 3.5 to 4 times greater in 1997 than in 1977. This includes an anticipated increase in the size of trucks from 6 to 11 ton capacity for most groundnut transport and consolidation of buying stations and shipping points. Associated use of ferries is expected to increase in direct proportion to traffic volumes.

Functional Classification. The recommended roadway system is classified into three functional components--primary, secondary, and tertiary roadways. See Figure 5.

Of the 1,212 kilometers of highway in the designated system, about 658 are classified as primary, 345 as secondary, and 209 as tertiary. With the completion of the recommended plan, almost 55 percent of the principal roads system will have a bitumenized paved surface; a little more than 45 percent will be gravel surfaced.

### Road Network Development Guidelines

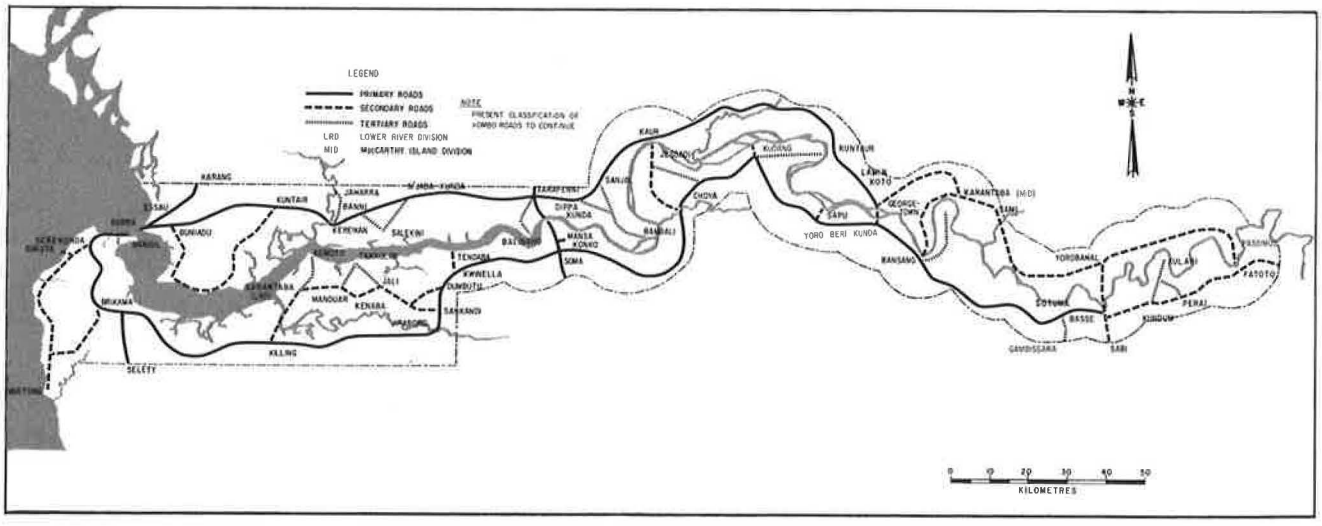
It was apparent that new or modified practices would be beneficial in several areas related to design, and construction. This section, therefore, indicates guidelines to assist in these areas.

Basic Considerations. One of the characteristics of road traffic in The Gambia is the diversity of both vehicle types, ranging from ox carts to articulated lorries, and operating speeds. This, combined with pedestrian activity within and between the many villages along main roads, is likely to continue into the forseeable future. Road design standards must recognize these complexities to minimize hazardous situations encountered by the road user and at the same time attain the maximum facility effectiveness.

Recognizing the diversity of travel needs, vehicle types and operating speeds, the following basic criteria for the major roads were set:

1. Pedestrian paths or tracks should be provided along all paved roads, adequately separated from motor vehicle traffic.

Figure 5. Recommended roadway system, functional classification.



2. The road pavement should be wide enough to allow two large commercial vehicles to pass safely, without reducing speed.
3. Road geometry should be able to accommodate operating speeds of up to 80 to 100 kilometers per hour, depending upon the type of road.
4. The road shoulders should be wide enough to accommodate very slow moving vehicles well clear of the road pavement. They should also provide a safe refuge for disabled or parked vehicles.
5. The horizontal and vertical alignments must allow ample opportunities for overtaking with safety.
6. The right-of-way should be wide enough to minimize the chance of a vehicle, when forced to leave the travelled way, colliding with a man-made structure or other object.

Suitable provision should be made for bus, taxi, and lorry stops. Adequate lay-byes and, particularly in built up areas, service or frontage access roads should be provided, together with appropriate signs and markings for pedestrian crossings.

The guidelines on road design and construction and the general approach to their implementation have been developed with the above considerations in mind.

Classification of Roads. In recommending a road classification system, the following objectives were set:

1. There should be only one classification system established which can be used by all interested parties.
2. The classification must have a specific purpose, be capable of clear definition, and be adaptable to future needs.
3. If the classification results in visually distinctive road types, then the road system must appear to be logical to the road user.
4. The road classification system should be consistent with the method of financing. Nationally important roads could be financed from the national sources, locally important roads from local revenue.
5. Definition of the various classes of roads should be sufficiently rigid, on the one hand, to enable any road to be logically classified, and sufficiently flexible, on the other hand, to allow for improvement of a road without having to change its class simply because of the improvement.
6. The system of roads that the user perceives and uses should be logically constructed. For a major road, the standard of construction should be uniform throughout its length. Progressively lower standards will apply to roads carrying less traffic.

Guidelines. The future classification of roads in The Gambia described here are based on functional performance categories. They can be applied as a tool for national planning.

It was recommended that the primary, secondary, and tertiary roads should be officially gazetted and road design standards adopted for each class. Local roads should not be gazetted. The main features of these categories are as follows:

1. Primary Roads. Those roads which, at a national scale, form a continuous all-weather network of roads, linking all major centers of population and providing the major international links.
2. Secondary Roads. Those roads which, by their connection to the primary road network or the river transport system, serve to maintain all-weather access to and within the various regions of the country.
3. Tertiary Roads. Those roads which are necessary for the maintenance of all-weather access to local areas, from either the primary or secondary roads or the river transport system.
4. Local Roads. Those roads which are made solely for local use. They may or may not be all-weather roads.

Responsibility. Central Government should accept responsibility for:

1. Definition of the actual network of primary, secondary, and tertiary roads.
2. Adoption of road design standards for these roads.
3. Construction and maintenance of primary roads.
4. Construction and maintenance of secondary roads on the understanding that as local government develops, maintenance of the secondary roads could be undertaken by local government, with some financial assistance from central sources.
5. Such financial and technical assistance to local government as may be necessary to enable Area Councils to develop and maintain the gazetted tertiary roads.

There are many aspects as to classification, funding, and general administration of a national road system. It is believed that the guidelines mentioned above will provide a sound basis for more extensive planning.

Road Design Standards. Road design standards so far submitted for projects in The Gambia have either been for a particular road or have been formulated by road class. However, these design standards, although based on sound engineering principles, may not be sufficiently flexible to efficiently cater for existing and proposed road traffic movements within The Gambia.

Consequently, based upon specific requirements in The Gambia, five design classes were recommended, predicated on average daily traffic volumes on opening and modified to recognize the type of terrain (flat or rolling) through which a road would pass. (On a newly constructed road, it may be necessary to base the design class on predicted rather than actual volumes.) A summary of the main features of these guidelines is shown in Table 1, and typical cross-sections are shown in Figure 6.

These design recommendations are based upon a World Bank review (A Review of Highway Design Practiced in Developing Countries, Con, F. W., May 1975) of highway design as practied by developing countries, wherein design standards are related to anticipated traffic flows, rather than road classification. Adoption of this principle will enable The Gambia to make most use of available funds, at the same time ensuring that each road segment is adequately designed to carry the present and future traffic.

Essentially, the design classes as shown in Table 1 and Figure 6, vary from Class A with over 2,000 vehicles per day to Class E, with less than 50 vehicles per day. For each design class, the following design elements are considered:

1. Design speed.
2. Width of surfacing.
3. Shoulder and formation width.
4. Width of bridge decks.

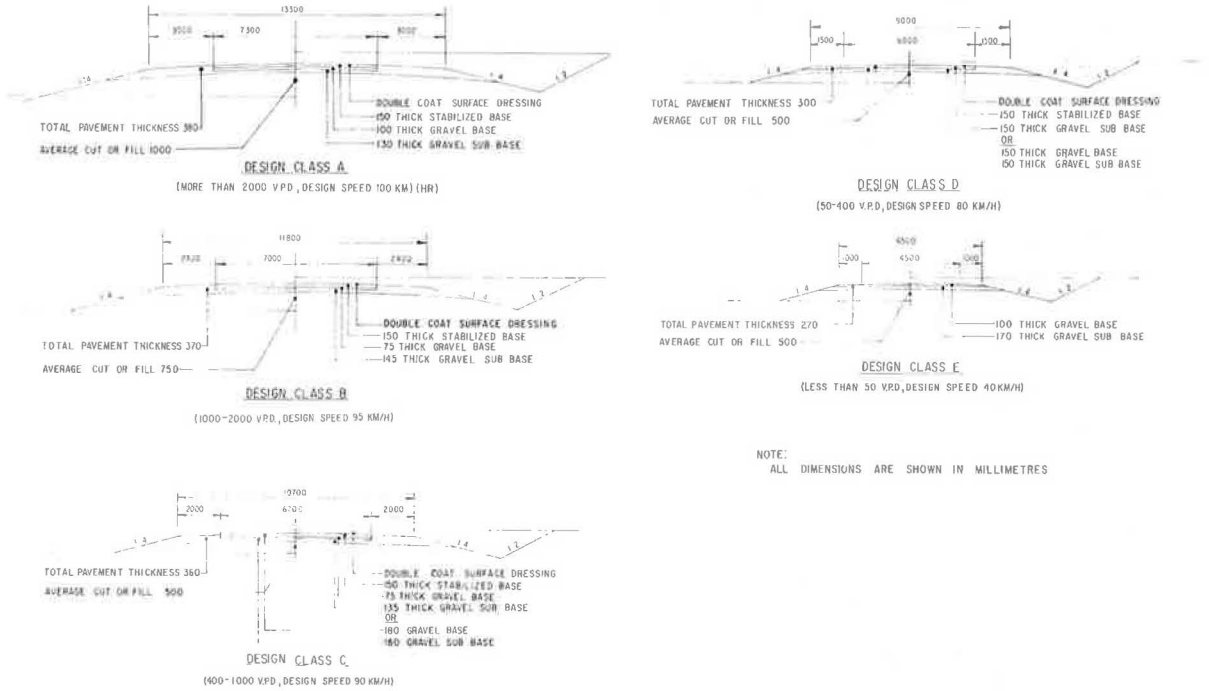
Table 1. Summary of geometric design standards.

| Design Element | Unit | Primary Roads | | Design Class by Terrain | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | | B | | C | | D | | E | |
| | | Flat | Rolling | Flat | Rolling | Flat | Rolling | Flat | Rolling | Flat | Rolling | Flat | Rolling |
| ADT on opening (mixed traffic) | Veh. | | | Over 2,000 | | 1,000 to 2,000 | | 400 to 1,000 | | 50 to 400 | | Under 50 | |
| Design Speed | km/h | 100 | 90 | 100 | 90 | 95 | 80 | 90 | 80 | 80 | 65 | 60 | 40 |
| Surfacing width | m | As for Design Class | | 7.3 | 7.3 | 7.0 | 7.0 | 6.7 | 6.7 | 6.0 | 6.0 | 4.5 | 4.5 |
| One shoulder width | m | As for Design Class | | 3.0 | 3.0 | 2.4 | 2.4 | 2.0 | 2.0 | 1.5 | 1.5 | 1.0 | 1.0 |
| Width between bridge parapets | | | | | | | | | | | | | |
| 20m. long or longer | m | As for Design Class | | 13.3 | 13.3 | 11.8 | 11.8 | 10.7 | 10.7 | 9.0 | 9.0 | 4.0 | 4.0 |
| less than 20m. long | m | As for Design Class | | 9.3 | 9.3 | 9.0 | 9.0 | 8.2 | 8.2 | 7.7 | 7.7 | 4.0 | 4.0 |
| Stopping sight distance | m | 160 | 135 | 160 | 135 | 150 | 115 | 135 | 115 | 115 | 80 | 70 | 40 |
| Passing sight distance | m | 670 | 600 | 670 | 600 | 635 | 530 | 600 | 530 | 530 | 420 | 380 | 240 |
| Maximum gradient | % | 4.0 | 5.0 | 4.0 | 5.0 | 4.0 | 5.0 | 5.0 | 6.0 | 6.0 | 7.0 | 6.0 | 8.0 |
| | | (note: Maximum gradients may be exceeded by 1% on short lengths of road) | | | | | | | | | | | |
| Horizontal curve minimum radius | m | 345 | 280 | 345 | 280 | 310 | 210 | 280 | 210 | 210 | 135 | 115 | 50 |
| Vertical Curve K value | | | | | | | | | | | | | |
| Crest curves | | 128 | 91 | 128 | 91 | 113 | 66 | 91 | 66 | 66 | 32 | 25 | 8 |
| Sag curves | | 38 | 31 | 38 | 31 | 35 | 25 | 31 | 25 | 25 | 16 | 13 | 6 |

| | | Primary Roads | Secondary Roads | Tertiary Roads | Local Roads |
|---|---|---|---|---|---|
| Right of way width | m | 60 | 60 | 40 | 30 |
| Minimum distance of services from centre line of road | m | 25 | 25 | 15 | 10 |

| | | All Roads | |
|---|---|---|---|
| Crossfall on half width | | | |
| Bituminous surface | % | 2.5 | |
| Gravel surface | % | 4.0 | |
| Embankment fill slopes | | | |
| Up to 2m. high | % | 25 | |
| Over 2m. high | % | 50 - 67 | Depending upon stability requirement |
| Cutting slopes | % | Up to 100 | Depending upon stability requirement |

Figure 6. Standard cross sections.



5. Sight distances.
6. Gradients.
7. Vertical curvature.
8. Horizontal curvature.

Right-of-way widths are proposed by road classification, and a uniform set of cross-slopes is recommended for all road types.

The degree to which a road can be built to satisfy the above standards will depend primarily on the funds available and the actual dimensions and limits adopted will depend upon the status of the road and the number of vehicles using it.

Axle Load Regulations. It was recommended that a ten ton axle load limit be applied to all vehicles operating on Gambian roads. This limit would be applicable to all roads--primary, secondary, and local.

However, it is recognized that at least one road in The Gambia, the Trans-Gambia Road, will be carrying significant volumes of international traffic with axle loads up to a limit of 13 tons.

The existing Gambian axle load limits for Special Roads (The Laws of The Gambia, Motor Traffic Act, 1966) (The Trans-Gambia Road and the Banjul-Mansa Konko Road) are 12.2 tons for a two-axle vehicle and 16.8 tons for an articulated vehicle.

It was recommended that these limits be rationalized to 13 tons, regardless of vehicle types, for Special Roads. In the very long term, other international routes may be declared Special Roads, although there appears to be little need to do so in the near future.

Pavement design recommendations (United Kingdom, Department of Transport, Road Note 31, A Guide to the Structural Design of Bitumen-Surfaced Roads in Tropical and Subtropical Countries, 1977) take axle loading into account.

## Materials Availability

Within the foreseeable future, there is a definite possibility of a road construction materials shortage occurring in The Gambia. In the cases of laterite, material of the required quality and grading has been identified in various locations throughout the country. Sand and shells, however, appear to exist only in the western parts of the country, making transport to other locations an expensive necessity. As regards construction timber, the ruhm palm is becoming increasingly scarce, therefore jeopardizing the economical construction of jetties, bridges, and related works.

Several actions concerning the construction materials situation are recommended. The provision of a limited amount of shell extraction and washing equipment could be procured and assembled locally. A construction materials availability study, including the technical feasibility of ruhm palm plantation establishment, could be considered an essential feature of a national construction program of benefit to governmental and private organizations alike.

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