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"Areawide Performance -Based Rehabilitation and Maintenance Contracts for Low-Volume Roads"

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Abstract

To address internal inefficiency and accountability issues , a number of Latin American countries have, over the last decade, moved decisively and successfully from force-account (direct labor) to contract maintenance. Also, there has been considerable progress in the region to transfer to the private sector, through concessions, the responsibility of improving, maintaining, and operating high-traffic volume roads, the cost of which is recovered from tolls. Among the most advanced countries in this respect are Argentina, Brazil and Chile. More recently, some countries, particularly Argentina, have switched from the traditional quantities and unit price-based short-term maintenance contracts to long-term performance-type or results-based contracts. The new approach encompasses either routine maintenance activities alone, or integrated contracts involving both the rehabilitation and routine maintenance of road networks. The latter form, the so-called CREMA system (Contrato de Recuperación y Mantenimiento) is now being implemented in Argentina and covers approximately 12000 km., i.e., about 40% of the national paved road network. Such contracts comprise the rehabilitation and subsequent maintenance over a 5-year period of 200 to 300 km long subnetworks.

This paper presents a framework for extending the CREMA concept to low-volume roads. It shows how this newly developed system could be extended to cover both the paving and future maintenance of low-volume roads. The paper analyses the reasons why this type of contract which extends the Contractor's share of responsibility over relatively a long period of time, would be particularly suited to the specific design and construction features of low-cost, low-volume paved roads: in particular, the risks related to uncertain traffic projections and in the use of local or non-traditional materials in thin pavement structures. Finally, the paper discusses some of the issues related to the use of the CREMA system, especially the need to prepare adequate contract bidding documents, to conduct proper bid proposal evaluations, and to monitor contractor's performance during the rehabilitation/paving and maintenance phases.

{PRIVATE }

BACKGROUND

Over the last decade, several Latin American countries have successfully switched from force-account (direct labor) to contract maintenance (1,13) and are in the process of replacing the traditional quantities and unit price-based contracts by performance-based contracts. The new systems of contracting involve either routine maintenance activities alone, or integrated works comprising both the rehabilitation and subsequent recurrent maintenance of road networks.

The concept of performance-based contracts originated from a consideration of four factors, namely: (a) the increasing lack of personnel within the National Road Departments available for measuring the vast quantities of activities involved in the more traditional maintenance contracts and for monitoring performance standards using inputs indicators such as materials, equipment and labor, or more frequently, tons of pothole patch material used, number of linear meters of pipe culverts replaced, number of square meters of cracks sealed...etc.; (b) the frequency of claims resulting from the necessity to increase the quantities of activities initially calculated and included in the original contracts, with the corresponding time-consuming efforts wasted in justifying such claims, looking for additional budget allocations and finally drawing up contract amendments; (c) the need to focus more on customer's satisfaction, seeking to identify the outcomes, products or services that the road users expect to be delivered, and to monitor and pay for those services on the basis of customer-based performance indicators; and (d) the need to shift greater responsibility to Contractors throughout the entire contract period as well as to stimulate and profit from their innovative capacity.

Although lacking extensive research support, the new approach has elicited considerable interest in the Americas. For example in Brazil, the Maintenance Division of the National Road Department (DNER) which has a long tradition of contracting out routine maintenance on the federal highway network is presently confronted also with the problem of shrinking staff and budget to manage and monitor the large quantity of maintenance contracts in operation and to supervise the quality of the works performed through the conventional measuring and testing mechanisms. The more simplified, rapid and less cumbersome approach has been well received and pilot performance contracts are now being implemented at the federal level and also by various state road departments such as Rio Grande do Sul and Santa Catarina. Likewise, the Transport Research Board (TRB) Committees concerned with Maintenance Management recently initiated a detailed review of the subject and have set up workshops to discuss how to perform highway maintenance, using Total Quality Management (TQM) which is defined as a "new approach to the art of management that seeks to improve product quality and increase customer satisfaction by restructuring traditional management practices"(2). To quote Dick Klobuchar, Area Maintenance Engineer, at the Minnesota Department of Transportation, from his presentation viewpoint at the Michigan Quality Initiative Seminar, in December 1994: (3). “Until now, we had been preoccupied with activities, such as mowing, plowing, and repairing; and that's what we have been measuring. Our customers, however, care little about activities. They are interested in the outcome of what we do, not how we do it, and they measure our performance by smoothness, neatness and brightness, not by miles, tons, or acres of activities".

This paper presents a framework for extending these new concepts to low-volume roads. After reviewing the performance-based maintenance contracts currently in operation (mainly in Argentina), it shows how the integrated system of rehabilitation and maintenance contracts could be extended to cover both the paving and future maintenance of low-volume roads. It emphasizes the particular features of paving techniques for low-cost, low-traffic networks, and underlines the reasons why performance contracts which increase the Contractor’s share of responsibility over a long period of time would be most suited to the specific design and construction characteristics of low-volume roads. Finally, the paper reviews the first experience of the National Directorate of Roads of Argentina in contracting a combined performance-based paving and maintenance project.

PERFORMANCE-BASED MAINTENANCE CONTRACTS IN ARGENTINA

Description of the Network and Current Maintenance Modalities

The national road network of Argentina has a total length of 38,744 km of which 30,912 km (or 80%) are paved and 7,832 km (or 20%) are unpaved. It represents a total asset of about US$7 billion equivalent. It carries most of the country's long distance traffic. Road users spend annually an amount equivalent to about US$10 billion (i.e. more than its replacement value) for operating their vehicles on that network. Already in 1975, 64% of the total network was paved (about 25,000 km) and a sustained rate of paving of about 300 km/year during the last 20 years brought the paved network to its current length of nearly 31,000 km. Of the 31,000 km, about 9,500 km with the highest density of traffic (generally exceeding 2,000 vehicles per day) have been concessioned since 1991 to the private sector for a period of 12 years and their upkeep is being financed essentially by road users toll. The rehabilitation and/or maintenance of the remaining non-concessioned 21,500 km are also intended to be contracted out of the private sector, using one or the other of the system described below. Current maintenance modalities on the national road network are shown in Table I:

The Kilometer/Month Contract

The first km/month contracts were used on the national road network in Argentina in August 1995. They presently cover a network of about 3,600 km of paved roads. All together, 11 contracts are under execution , each one covering a sub-network ranging in length from 105 to 536 km. The system applies essentially to a sub-network of paved roads which is in good to fair condition (typically with roughness of less than 3.5 IRI) and is further expected to remain substantially in that condition over the next few years only through routine maintenance activities alone, without any major strengthening or rehabilitation . As the name implies, the Contractor is paid on a monthly basis for specified services provided either to the road users or to the Road Agency, and only when the quality outputs comply with the technical specifications included in the contract. If the quality outputs, for any specific activity, are not in compliance with the prescribed requirements, penalties are applied on a daily basis and subtracted from the forthcoming payments, until the necessary repairs are carried out.

The contract comprises three main items or components (3), namely:

(i) Maintenance Works;

(ii) Site Installation; and

(iii) Emergency Works.

Maintenance Works are paid on a lump sum basis in terms of US$/month/km of roads maintained. Site installation is also paid on a fixed-price basis, at a rate of one-third at the completion of site camp installation and two-thirds when all the equipment and personnel necessary for the works are mobilized on site. Emergency works, i.e., items or services not included in the first component, are paid on the basis of unit prices and quantities related to any additional transport, equipment, or tons of asphalt concrete which may need to be supplied and placed for unexpected extensive repair.

Item 1: Maintenance Works

Contracts are for a duration of two years and are renewable. As mentioned before, they comprise essentially a specific road section or a sub-network which is free from deep rutting and longitudinal or alligator cracking. Such roads may have been recently resurfaced, rehabilitated or paved under a separate rehabilitation project. These maintenance contracts do not normally include any substantial investments for strengthening, widening or upgrading the infrastructure concerned, for which a residual life of at least five years is expected.

Penalties, as indicated in Table II, are applied in accordance with the deficiencies noted during inspections carried out three times a month, the last inspection taking place on the last week of the month. A period of two to three months following the award of the contract is waived, during which penalties are not applied in order to enable the contractor to repair and fix any deficiency existing at the time of contracting. Each inspection tour is followed by a written "statement of deficiencies" (eventually photo-documented), agreed and signed by the Engineer and the Contractors' representative on site.

Inspections are normally carried out on a sample basis, the minimum length to be inspected weekly representing 5% of the total length of the contracted network (or 10% if the inspection is for the purpose of establishing payments certificate). The minimum elementary length of inspection is 2 km.

In addition to the mandatory inspection tours, the Contractor is required to make his own inspection on a daily basis, and to report to the Engineer any abnormality observed (such as traffic overloading) that may have an impact on the contract or on the processes by which the maintenance works are carried out. Likewise, accidents attributable to users are to be reported, specially when they involve damages to the infrastructure itself.

The Contractor must also comply with national environmental standards, and apply all mitigating measures related to borrow-pits and to the disposal of all unsuitable materials removed from the pavement or its surroundings.

The contract documents include:

(i) the Contract itself;

(ii) Particular Technical Specifications;

(iii) General Specifications for Roadworks in use in the country;

(iv) a detailed Report on the actual condition of the road or network to be maintained, including a set of relevant maps and drawings;

(v) Environmental Manual in use in the country; and

(vi) Standard Unit Costs applicable to emergency works such as transport of materials, hours of rent for equipment and specific maintenance crews, and ton or cubic meter of asphalt concrete patching.

Monetary penalties applied for non-compliance with the Particular Technical Specifications are formally expressed in terms of equivalent liters of gasoline to allow for inflation adjustment . For practical purposes, they have been converted to current US$ equivalent. To provide for incentive for expeditious repairs, penalties are enforced gradually: 25% applied at the end of the specified response date (usually 2 to 5 days after the defect is observed); 50% applied at the end of the second inspection tour, and 100% at the end of the third inspection .

The contract provides for the highway department, on an exceptional basis, to carry out by force-account or through a third party any works or activities of an extraordinary nature, but limited to at most 20% of the total length or duration of the contract. The contractor, duly advised in advance, may only object to such an intervention by the highway department (including canceling the contract) if the specified limit

(20%) is exceeded. Likewise, the implementing agency may terminate the contract if the contractor does not perform in accordance with the General or Particular Technical Specifications.

Item 2: Site Installation

Site installation comprises the supply of all offices, equipment, material and personnel necessary to carry out the maintenance works, including the facilities to be provided for the supervision team. It is paid on a lump sum basis which does not exceed 5% of the total contract amount. The amount due is paid in two installments : the first installment representing one-third of the total to be paid at the completion of the site camp installation and after due justification is given of the right size and expertise of the personnel to be employed for the works. The payment of the remaining two-thirds occurs after the arrival on site of equipment and personnel.

Item 3: Emergency Works

Emergency works for an amount not exceeding 20% of the total contract cost are provided for and include: (a) exceptional transport of materials, equipment or personnel necessary for these works, to be paid on a US$/ton*km basis; (b) supplementary equipment and more specifically, two graders of 145 HP, one front end loader of 135 HP, four dump trucks of 10 ton capacity, and one bulldozer of 140 HP, all with their respective operators and to be paid on a standard hourly rate of utilization; (c) crew teams, each comprising six laborers, one truck and its driver, to be charged on a standard hourly rate of utilization; and finally (d) the supply and placement of asphalt concrete for patching purposes, to be paid on a standard US$/ton or cubic meter of material. The contractor, by signing the contract, accepts the unit costs established in the tender documents, by the National Road Directorate.

The experience on the 3,620 km of national roads maintained under this type of contract indicate that the system is working well with an average cost of routine maintenance of about US$175/km/month. Overall, and since the beginning of these contracts, about 600 certificates of non-compliance have been issued and given rise to penalties amounting to nearly US$300,000 which represent about 1 percent of the total contract's amount.

The CREMA Contract

The CREMA (Contrato de Recuperación y Mantenimiento) is a combined Rehabilitation and Maintenance Contract that requires the Contractor to rehabilitate and subsequently maintain a sub-network of roads under a lump sum contract for a total period of five years (4,5). In contrast with the km/month contract, the CREMA system applies to a paved sub-network which needs to be rehabilitated over a part of its length and subsequently maintained over the whole of its length. Rehabilitation works include either resurfacing with slurry seals and surface-dressing or overlays with asphalt concrete or reconstruction of the base and wearing course. These works are carried out during the first year of the contract while maintenance activities (patching potholes, cleaning drainage system, renew horizontal and vertical signs, clearing roadsides, etc.) are undertaken throughout the 5-year contract period.

The network is defined by the Employer and comprises contiguous or area-specific sections of roads having a total length generally ranging from 100 km to 300 km. The contract specifies the sections that needs rehabilitation as well as the minimum solution (i.e. overlay thickness) that is required in order to ensure a positive Net Present Value for the investment at a 12% discount rate. The contract is awarded to the lowest evaluated bidder. After award, the Contractor is required to carry out a detailed engineering design and is free to propose, on the basis of his own risk assessment, any rehabilitation solution above the minimum threshold defined in the Contract.

The payment schedule is designed to ensure that the Contractor maintains the network for the full length of the Contract after the first-year rehabilitation period. He receives an advance payment of 5 to 10% upon being notified that he may initiate work, between 15% and 25% at the end of the first six months when specified activities have been executed, and 25% at the end of the first year when rehabilitation works are completed. The remaining contract amount, i.e., about 50% of the total bid, is paid in 48 equal monthly amounts spread over the remaining 4-year contract period. A performance guarantee of 20% is required under the Contract.

Payments are made when a specified level of service is achieved and not on the basis of pre-determined bill of quantities and unit rates as in admeasurement-type of contracts. Performance is assessed during monthly inspections jointly carried out by the Engineer and the Contractor. The rehabilitation works must comply throughout the contract period (and in particular with the specified minimum thickness of overlay), to a maximum roughness level (usually 3.3 max. IRI) and maximum values of rut depth, cracking or raveling. Maintenance activities are broken down into a few essential items that are regularly inspected to ensure compliance with the specifications, such as : potholes, cracking, rutting on the pavement, and condition of shoulders, culverts and drains, roadside, environment, vertical and horizontal signs, lane marking, and guardrails For each item, and as shown in Table III, penalties for non compliance are set and applied in such a manner as to deter the Contractor from failing to comply. For example, a pothole left unrepaired beyond the authorized time limit will cost the Contractor about US$400 per day until it is patched. A pothole is defined as any cavity which is 25 mm or more in depth. The total amount of penalties are deducted from the monthly payments.

The status of the CREMA program currently in operation in Argentina is as follows**:**

- The CREMA network has an aggregate length of about 14,400 km, and represents 65% of the non concessioned national paved road network. It is generally in good to fair condition with an average roughness of 3.7 IRI (10% are in poor condition, i.e., with IRI>5) and an average daily traffic of about 750 vehicles.

- CREMA contracts for 11.818 km of the national road network were let in 1997 comprising 61 individual contracts on sub-networks totaling an average length of about 180 km, each.

- An additional 2,581 km network divided into 16 contracts are to be procured in 1998-99.

- Of the 14,400 km, about 7,500 km are to be rehabilitated , comprising: 1,700 km of slurry seals or surface-dressing , 5,300 km of asphalt concrete overlays ranging in thickness between 3 and 8 cm, and some 360 km of reconstruction.

- The contracts for the first 11,818 km network have been awarded for a total amount of about US$650 million, equivalent to US$11,000/km/year. Overall, the lowest bid proposals exceeded the budget estimate by about 20%, on average.

- Rehabilitation works alone are estimated to account for approximately 74% of the total bids amount (i.e., US$66,000/km) while routine maintenance activities estimated at about US$3,000/km/year, represent 26% of total cost.

- Private sector participation (essentially Argentinean contractors) was high, each contract having received between 5 and 20 bid proposals.

- The average contract price was about US$10 million.

The CREMA system has the following specific features:

- Focus is on road users' satisfaction and on Contractor's performance to achieve a minimum level of service, rather than on inputs, i.e., quantity activity and unit rates compliance.

- The system, which prescribes that the Contractor sets up his own quality control system, reduces the need for time and staff consuming (thus costly) supervision, by eliminating redundant quantities and quality-testing of activities performed. Inspection team size and tasks are reduced to the bare minimum.

- The risk of cost overruns is considerably reduced since contracts are fixed-price.

- Delays in project implementation, which in traditional programs are due to lack of stock of prepared sub-projects, are minimized since the Contractor is required to carry out a detailed engineering design before initiating the works.

- The use of CREMA contracts deters the Government from failing to provide stable funding for road maintenance sector as the long-term payment obligations under these contracts become legally binding on the Government.

- The risk of unsatisfactory quality in the capital (rehabilitation) works is greatly reduced by the obligation of the Contractor to maintain the roads over a five-year period.

- The system fosters innovation on part of the contractors in the programming and execution of works since acceptance and payments are not tied to rigid specifications related to workmanship but rather to end results and level of service.

- The design of the program requires the Road Agency to provide reliable network conditions and traffic surveys. In this case, the surveys were combined with an economic evaluation using the World Bank’s Highway Design and Maintenance Standards Model , HDM III (7,8) to define the respective extents of rehabilitation and maintenance works and to set minimum acceptable standards for rehabilitation works. After the network survey (traffic counts, surface distress, roughness, deflection and structural characteristics measurements…), each subnetwork was divided into homogenous sections for each one of which, six maintenance strategies were tested by the model, i.e.: (i) a do-nothing strategy consisting simply in routine maintenance, 100% patching, and reconstruction when IRI reaches 8; (ii) a 3 cm asphalt concrete overlay in year 1 with future 3 cm overlays when IRI reaches 4; (v) a slurry seal application in year 1 with future reseals triggered at surface distress value exceeding 30%; and (vi) applying a rehabilitation solution proposed by the district engineer responsible for the maintenance of that network. Based on the economic analysis, strategies that did not yield a positive Net Present Value were discarded, while sections that were found to be unlikely to exhibit roughness level higher than 4 IRI during the 5-year contract period were to be subject to routine maintenance only. The less costly overlay or resurfacing solution that gave a positive Net Present value was selected to be the minimum contract requirement (Table IV).

- The first generation of CREMA contracts called for the minimum (and not the optimum) technical standards to be applied on the sections to be rehabilitated to yield an acceptable internal economic rate of return (12% min.). The minimum standards were equivalent to a weighted average asphalt concrete overlay thickness of about 3.3 cm. The optimum standards were in the order of 5 to 6 cm equivalent thickness, and would have increased the cost about two-fold . However, the HDM economic evaluation indicated that the minimum solutions would improve the riding quality of the network by eliminating the maintenance backlog and bringing the network to a uniformly fair to good condition that could be maintained in the future through periodic, thin overlays.

- In the next generation of CREMA contracts consideration will be given to: (a) staggering the execution of rehabilitation works over the 5-year contract period, thus avoiding high peaks in resource allocations;(b) extending the contract period to 7 or 10 years; (c) adjusting the payment schedule to reduce the Contractor's need for borrowing on the commercial markets, thereby reducing further the financial costs involved; (d) adopting technical standards between the HDM recommended minimum and the optimum solutions; (e) selecting through an optimization process the right length of sub-networks or size of individual contracts; (f) fine-tuning the penalty rating system; (g) incorporating the lessons learnt during the implementation of the first generation program, including ways to deal with the claim by some Contractors that they should be given more freedom in offering and using their own performance standards and materials specifications. (h) involving users in monitoring and reporting road conditions and performance of contractors.

THE CREMA CONCEPT TO LOW-VOLUME ROADS

Engineering-economic Characteristics of Low-volume Roads

An overriding consideration in designing a paving program for low-volume roads, under budget constraint, is to ensure that the investment will yield an acceptable internal economic rate of return, generally more than 12%. In the majority of Latin American countries, the upgrading and paving of ground/earth roads carrying between 50 and 200 vehicles a day is economically justified - considering vehicle operating cost savings alone - provided the initial capital investment is substantially below US$ 100,000 per km. In order to keep project cost below this threshold, it is necessary not only to reduce the amount of earthworks and the drainage system to minimum standards, but also to design the pavement structure (which may represent more than 50% of the total cost), to provide good riding quality at the lowest possible cost. Thus, the design of low-cost pavements invariably implies the use of local and possibly sub-standard materials for the base-course and chip seal for the wearing course.

In addition to the need for providing thin pavement structures generally consisting of non-traditional materials, the designer is faced with many other challenges (9,10,11) :

- detailed site investigations aimed at capturing the large variations which may occur in the geotechnical properties of both subgrade and borrow-pit materials (a prerequisite to the success of such "borderline" designs);

- traffic projections and particularly estimates of generated traffic resulting from upgrading and paving of road are often difficult to make, especially under conditions of rapid economic growth;

- apart from the risks associated with traffic volume forecasts, axle overloading which often occurs on newly paved roads, is particularly detrimental to pavements having low structural number (less than 3), as compared to more conventional structures designed for longer service lives;

- considering all of the above, efficient and good quality control during works execution is of paramount importance, as well as the implementation of a timely and effective maintenance program, once the road is open to traffic.

Another specific design feature related to paving low-volume roads is the generally recommended practice of stage-construction: the uncertainties associated with traffic projections and the long-term performance of non-traditional materials, militate in favor of a stage-construction approach which calls for the postponement in the execution of an asphalt concrete wearing course (or the construction of more permanent bridges) until such time as pavement condition or traffic characteristics so warrant. Unless the necessary financial resources have been secured and released on time by the Treasury, the stage-construction approach runs a substantial risk of failure (10).

The above provide a strong analytical rationale to justify the extension of the CREMA concept to low-volume roads. By contracting on a lump sum basis to the private sector a long-term combined paving and maintenance program, while monitoring performance rather than inputs or activities, a number of the above-mentioned issues can be resolved. Contractors are likely to be more alert to quality and reliability considerations during works execution if they are held accountable in the future for the quality of service offered by the road. The permanent presence of the contractor’s maintenance crews on site guarantees an efficient monitoring of pavement and traffic conditions, enabling corrective actions to be implemented without delay. The recurrent problem of scant and unreliable budget for road maintenance is avoided, while the need for stage-construction, i.e., to strengthen the pavement structure in phases is automatically fulfilled, as integral part of the combined paving and maintenance contract.

Tender Documents and Bid Evaluation Procedures

The content of bidding documents and bid evaluation procedures for a combined paving and maintenance contract depends to a large extent on the degree of freedom left to bidders for offering their own designs and performance specifications for the works based on detailed studies carried out prior to submitting proposals. By and large, two approaches are possible.

The first one gives to prospective bidders the responsibility for the detailed design of the project, including the preparation of technical specifications that would ensure compliance with the level of service or performance required under the contract. The bidding document would only need to specify : the strip or corridor within which the alignment of the road should lie; the class of road with the design speed and related geometrical standards; bridge and other drainage structure type (whether temporary or permanent); pavement standards, including maximum design axle load, life period (equivalent standard axle load repetitions) and level of riding quality (roughness) throughout the contract period; safety and environmental standards; performance specifications similar to the km/month or CREMA for future maintenance; and such other information as the length of the contract period, the schedule for execution of paving, and possibly the maximum budget available for the contract. This approach which surely would stimulate bidders' creative capacity entails however the risks of : (i) having non responsive bids due either to lack of competition resulting from bidders' reluctance to engage in costly engineering studies or to costs proposals that exceed available budget by a substantial margin; and (ii) making bid evaluation a difficult and complex exercise, considering the number and diversity of alternative designs and costs that may be offered.

An alternative and preferred approach is for the Employer to remain responsible for the design and engineering and to invite bids for a single and lump sum responsibility contract for the execution of the works, as specified, and subsequent maintenance. Under this scenario, the bid package would only include both the general and particular specifications, drawings, the environmental manual, and a bill of quantities allowing the Contractor to estimate his fixed-price proposal. Furthermore, provision can be made to allow the bidder to offer alternative designs or standards which could later be discussed and eventually agreed upon, as long as the bid offer for the Employer's specified design corresponded to the lowest evaluated cost.

Integrated Construction and Maintenance Contracts: the DNV Approach

The success of the CREMA experience led the Directorate of Roads of Argentina to consider the possibility of expanding the system to include a combined Construction and Maintenance (DNV) contract (for a new paved road) and to initiate the preparation of the relevant bid package. On legal grounds, the procurement requirements used for the CREMA were found to be applicable to such programs. A set of bidding documents was prepared which includes the following parts:

- Section 1: Instructions to bidders outlining the formats to be used for bid proposals, qualification requirements, and basis for bid evaluation and contract award;
- Section 2: Standard forms of bids, and acceptance of invitation to tender;
- Section 3: General Conditions of contract including all information regarding Contractor's and Engineer's responsibilities, schedule of completion, quality and cost control, ... all in accordance with the World Bank Standard Bidding Documents (12);
- Section 4: Contract data sheet;

- Section 5: General Specifications for roadwork, including all requirements that must be met during work execution, as well as penalties which will be applied when construction and maintenance specifications are not complied with;
- Section 6: Plans and Drawings;
- Section 7: Formats for various securities and guarantees bonds;
- Section 8: Appendices including particular technical specifications and other specific requirements to be met during the execution of the various components of the contract.

Sections 5 and 8 constitute the critical core of the contract and were the most difficult to prepare. Under the CREMA system the Contractor was provided with a basic design, indicating the minimum standard to apply to the rehabilitation component of the contract. The bidder would thereafter inspect the site and based on his own evaluation, would submit a proposal on a lump sum basis for the works. Alternative designs or solutions were few in number and the prediction of pavement performance was feasible, while traffic volume and characteristics could be reasonably well defined. Overall, the resolution of the problem was relatively easy and the bidder could prepare and submit an offer at reasonable cost, with minor risk in pricing his bid.

In the case of the construction of a new road, the problem is different. There are many more questions to be addressed, more alternative designs are possible, and the quality and responsiveness of bids may vary substantially. Since bidders remain ultimately responsible for any error that they might make in their evaluation, it is desirable to specify a minimum set of requirements regarding alignment, geometrical standards, pavement design and drainage structures capacity, in order to ensure a transparent and uniform basis for bidding. The following requirements and parameters therefore were clearly defined in the technical specifications:

1) For the road: its origin and end; a preliminary horizontal and vertical alignment; the road class or category in accordance with DNV geometrical standards manual which specifies, per road class, the design speed and related minimum vertical and horizontal curvatures, maximum gradient, passing and stopping sight distances; and lane and shoulder widths.
2) For the pavement: A minimum structural design, (i.e. minimum thickness or structural number) the number of equivalent standard axles (ESALs) for design being determined by the bidder (the contractor could prepare an alternative design on the estimated ESALs to reduce future strengthening and maintenance costs).
3) For bridges: the minimum span, the final length being selected on the basis of the bidder's hydrological investigation; the width of deck and sidewalks; the minimum clearance between bridge deck and river bed; and the seismic coefficient values to be considered for design.

During bid opening offers would be considered responsive and acceptable only if the above requirements are met. Although deficiencies in the items described above are always possible at the preliminary stage of design, such shortcomings could be detected and corrected during the detailed surveys and final engineering studies to be carried out and presented by the contractor before starting the works

Regarding the pavement, and consistent with the CREMA contract, special attention would be given to its structural strength in order to ensure that premature failure and subsequent repairs, albeit at the expense of the contractor, are not likely to occur. Similar criteria were used for bridges and drainage structures with deficiencies to be corrected at the contractor's expenses. Under such conditions, each bidder understands the necessity to carry out his own design based on a detailed site investigation before tendering, and to incorporate his own experience including innovative technologies in order to submit the lowest cost while achieving maximum profit. Also, once the contract is awarded, the contractor is free to propose and use any enhanced technology that enables him to be more cost-effective and to optimize his investment.

Section 5 furnishes all information and conditions that the contractor must meet during the construction and maintenance of the road in order to ensure in a satisfactory manner the operation of minor and major drainage structures, the cleanliness of the roadside, the pavement markings and signs, the guardrails, side slopes and snow removal. Except in the event of *force majeure*, the contractor remains responsible for the reconstruction or repair of any failure, collapse, or damage occurring on the road. Finally the following requirements are stipulated for the pavement surface condition after construction:

- DNV Condition Index > 8 (with 10 being best, and 0 bad);
- Roughness IRI: < 3.1, 4.1, 3.9 for asphalt concrete, surface dressing and cement concrete surfacing, respectively;
- Rut depth < 4 mm;
- Cracking < 2% (type 2);
- Raveling and potholes = 0%;
- Friction coefficient > 0.4.(skid resistance)

As under the CREMA, bids are to be made on a fixed-price basis comprising both the construction and follow-up maintenance. Contract period is 7 years, including 2 years for construction, and 5 years for maintenance. An advance payment for site installation is allowed for, followed by 4 equal lump-sum installments made at 6 months interval during the construction period, with 60 equal monthly payments made thereafter, during the 5-years maintenance period.

CONCLUSIONS AND RECOMMENDATIONS

During the last decade, several Latin American counties, notably Argentina, Brazil, and Chile made a major transition in the execution of road maintenance operations from direct labor works (force account) to private sector contracting. An even more significant recent development is the introduction of results-based performance contracts that shift the emphasis from measuring and reporting maintenance inputs - labor, materials, machines, - (primarily to ensure due diligence in payments made to contractors), to performance outputs related mainly to service provided to road users, measured and evaluated through periodic inspections with pre-determined penalties for non-compliance. These multi-year contracts often include up-front rehabilitation and pavement strengthening to upgrade the roads to a level where they can be maintained in a cost-effective manner. In parallel to the Argentine initiative described in this Paper, a number of Countries on the Continent are selectively using many of the innovative features of long-term performance based lump sum contracts for the rehabilitation and routine maintenance of their road networks. Pilot or full-scale experiments (all together totaling about 20,000 km) are being implemented in Brazil (both at federal and state levels), Chile, Colombia, Guatemala, Paraguay, and Uruguay (13). It can reasonably be expected that within the next few years, these new systems of contracting will be expanded to cover both the paved and unpaved networks. A key advantage of such multi-year contracts is that they secure a binding commitment from the Government to ensure a steady and reliable flow of funds for road maintenance and there are significant penalties associated with canceling the contracts without cause.

This paper describes the Argentine experience with areawide, performance contracts for road rehabilitation and maintenance (CREMA) and its potential application to the low-volume road environment. The CREMA concept may be especially suitable for low-volume roads with gravel surfacings or thin bituminous surface treatments as the continued serviceability of such roads depends entirely on the quality and reliability of future maintenance. This experience could be beneficially transferred to other countries and regions as it offers an effective means to improve the efficiency and public accountability of road maintenance operations. Other benefits include improved service to road users, reliable and secure funding for road maintenance, and the reduced size of the Government establishment (staff, equipment, and buildings) needed for road maintenance operations. In the long-run, this approach could significantly reduce the unit costs of maintenance operations while improving the quality and cost-effectiveness of maintenance works .

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TABLE I: Maintenance Modalities on the National Highways Network

	Km		
	Paved	Unpaved	Total
Total concession (incl.access)	9,508	-	9,508
Untolled concession (COT)	1,879	-	1,879
CREMA 1st phase (1997-98)	11,818	-	11,818
CREMA 2nd phase (1998-99)	2,581	-	2,581
Transferred by contract to provinces	1,503	5,220	6,723
Contracted on km/month(routine only)	3,623	-	3,623
DNV force-account	-	2,612	2,612
	30,912	7.832	38,744

Table II: Km/Month Contract. Technical Specifications and Penalties

{PRIVATE }Service Provided	Performance Indicators	Penalties US$
A- To Road Users	1. No pothole more than 2 cm deep on paved roads.	110/day/potho
Riding Quality (smoothness).	2. No edge failure on paved roads(uplift or settlement due to plastic deformation).	110/day/failur
	3. No rutting more than 20m. long and 12mm deep on paved roads.	66/day/rut
	4. No cracking or raveling on paved roads.	88/week/km o
	5. Travel speed of at least: 50km/hr on earth roads and 70 km/hr on gravel roads (geometrical standards permitting).	176/day/km o
	6. No pothole more than 2 cm deep on paved shoulders.	44/day/pothol
Safety features	7. No gullies or rutting more than 2 to 5 cm deep and extending over 0.5m from pavement edge, on unpaved shoulders.	440/wk/km or
	8. Drains, ditches, culverts and other drainage structures to be cleaned.	44/day/culvert
	9. No obstructions on the pavement, such as fallen trees, dead animals, broken-down cars, slope slides...	44/hr or fracti

Table II continued	10. Vertical signs to be well-placed, clean and visible day and night.	88/day/statut.s
	11. Horizontal lane markings to be well maintained.	44/sq.m/day
	12. Guardrails to be clean, well maintained and visible during day- and night-time.	44/day/section
	13. Traffic control and safety in work zones to be fully operational and in accordance with standard specifications .	22/day/km or
Aesthetics, and attractiveness of roadside	14. Bush height not to exceed 0.15 m on shoulders and slopes, and 1 m. beyond but within right-of-way.	22/day/km or
	15. Trees and rest areas to be adequately maintained.	22/day/km or
	16. No litter or residues on or around pavement.	44/day of dela
B- To Road Agency	17. Maintain an operation center for supervision team with adequate furniture, rest room, and communication system (radio, phone).	44/day
	18. Be present during inspection.	660/absence
	19. Provision of vehicles.	

Table III: CREMA. Technical Specifications and Penalties

Service Provided	Performance Indicators
Rehabilitated Sections	Pavement cross-section features to remain within specified standards, throughout period
Riding & Strength Quality	Roughness IRI <3.3 after rehab. and throughout the contract period
	DNV Surface Condition Index to be >6 and PSI to be >2.8
	Rut depth to be kept below 12 mm after rehab. and throughout contract period
	Cracking to be less than 20% after rehab. and throughout the contract period
	No raveling after rehab. and throughout contract period
	Thickness of A.C overlay to comply with specification and total wearing course the end of contract not to be less than initial thickness
	No chip seal allowed on asphalt concrete without Engineer's authorization
Sections under Routine Maintenance	
Riding quality (Smoothness)	1. No pothole more than 2 cm deep on paved roads 2. All cracks to be sealed

TABLE III: Continued

	3. Trafficability ensured at all times
	4. Rut depth to be <3 cm, cracks to be <30%, and no raveling on paved shoulders structural strength
Safety Features	5. No rut, raveling, no cracks, and adequate cross-slope on paved shoulders with
	6. No erosion/ rut and good profile, min. width=3 m., drop-off < 3cm on unpaved
	7. Culverts and drains to be clean, free from debris, and with adequate longitudin
	8. Vertical signs to be clean, visible at all times, and complying with DNV standa
	9. Guardrails to be in good condition and visible at all times
	10. Lighting system and traffic lights to be in good working condition
	11. Bush height to be <15 cm over first 6 m. and <1 m. beyond and up to 10 m.
	12. Roadway to be free from litter and debris
	13. Trees and vegetation to be properly maintained
	14. Work program activities, to be executed on schedule
	15. Rehabilitation works to be completed on schedule

TABLE IV: Example of CREMA HDM Analysis of Rehabilitation / Maintenance Project Solution

Network No.: 507

Section	119 (S1)	119 (S2)	119 (S3)	119 (S4)	123 (S2)	123 (S3)	123 (S4)	123 (S5)
Survey Results								
Road length, km	30.8	50.6	19.5	8.6	30	42.7	15.2	36.7
Road width, m	6.7	6.7	6.7	6.7	7.3	6.7	6.7	6.7
One shoulder width, m	3	3	3	3	3	3	3	3
Altitude, m	60	60	60	70	60	65	70	65
Rainfall, m/month	0.09	0.09	0.09	0.1	0.1	0.1	0.1	0.1
Terrain	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat
Surface type	AC	AC	AC	AC	AC	AC	ST	ST
Surface layer thickness, mm	120	120	120	120	120	140	40	30
Base type	Gran.	Gran.	Gran.	Gran.	Gran.	Bitum.	Gran.	Gran.
Thickness of Base layer, mm	250	200	200	250	250	125	200	225
Subgrade CBR	7	10	10	10	8	10	14	14
Structural Number	2.23	2.83	2.34	3.19	3.65	4.5	1.56	1.13
Mean Benkelman Deflection, mm	0.85	0.57	0.67	0.45	0.5	0.35	0.9	1.1
Actual Average roughness, IR	3.3	3.42	4.11	3.07	3.53	3.07	3.76	8.01
% all area cracks	1	2	10	8	12	2	3	15
% wide cracks	0	0	3	0	3	0	1	10
% ravelled	0	0	0	0	5	0	0	40
% pothole	0.001	0	0.01	0.01	0.01	0.001	0.01	0.1
Mean rut depth, mm	20	18	18	11	18	8	9	13
Rut Depth standard deviation, mm	8	7	7	4	6	3	3	5
Surfacing age,yrs	16	16	16	8	8	8	9	22
ADT Cars	447	501	481	426	350	387	148	148
Pick-up	209	278	292	243	261	193	127	127
Bus	25	30	28	14	15	41	15	15
Medium trucks	160	134	148	93	104	81	43	43
Heavy trucks	0	0	0	0	0	0	0	0
Articulated trucks	209	207	201	174	120	148	67	67
Total ADT	1050	1150	1150	950	850	850	400	400
Traffic Growth	3	3	3	3	3	3	3	3
HDM analysis results								
NPV for Slurry seal, US$million	-2.1	-0.1	-1.64	1.44	1.6	2.5	0.17	-8
NPV for 3 cm asphalt overlay, US$M	**6.2**	**12**	**5.9**	**1**	**3.9**	3.2	**1.1**	-6.7
NPV for 4 cm asphalt overlay, US$M	5.9	11.6	5.7	0.97	3.6	**3.3**	1	-4.9
NPV for 5 cm asphalt overlay, US$M	5.73	11.4	6	0.92	3.3	3.1	0.88	-3.8
NPV for district Eng. Solution (7 cm overlay)	5.34	10.6	5.2	0.9	3.1	3	0.55	6
IRI in year 5 without project	4.3	4.4	5.5	**3.8**	4.5	**3.9**	4.9	9.9
IRI in year 5 with project	2.3	2.3	2.8		2.4	3.5	2.5	3.2
Interpretation/Conclusions								
Unacceptable solution	RM/SS	RM/SS	RM/SS		RM		RM	< 6cm AC
Optimum solution	3 AC	3 AC	3 AC	SS	3 AC	4 AC	3 AC	9 AC
Minimum HDM (contract) solution	3 AC	3 AC	3 AC	RM	3 AC	SS	3 AC	7 AC

Nota:RM = Routine Maintenance, SS = Slurry Seal, AC = Asphalt Concrete, ST = Surface Treatment, NPV = Net Present Value