

Construction of Farm-to-Market Concrete Roads in Guipuzcoa, Spain

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The historical territory of Guipuzcoa, which belongs to the Basque Autonomous Community, is uniquely characterized by its rural settlements, the so-called *caseríos*, which are small family farms that perform a great deal of the agricultural activity in this Spanish province. Most of the *caseríos* are located on the mountainsides, because a great part of the narrow valleys, where the population in Guipuzcoa has developed, is occupied by industries and urban centers. Rural settlements are consequently scattered in isolated farmsteads or small hamlets to which access is difficult. In 1982, the Basque Autonomous Community Government and Guipuzcoan authorities therefore established a Plan for Rural Infrastructure Improvement, including technical aid and financial support for the construction or rehabilitation of rural roads. As part of this plan about 600 km of these roads were surfaced between 1982 and 1985, which represents about 50 percent of the total existing network. Both rigid and flexible pavements were used in road construction. Asphalt pavements are always constructed by contractors, but a traditional procedure of communal work is employed to construct concrete roads. This procedure is called "auzolan" in Basque, which means unpaid work performed to fulfill communal needs. Reductions in construction costs of over 20 percent have been achieved through the use of the auzolan work organization. Maintenance costs are also lower when compared with those of flexible pavements, because any repairs that are needed are normally performed by the farmers themselves. Therefore, the number of municipal authorities that are choosing to build concrete roads is steadily increasing.

The use of concrete in the construction of rural roads in the Spanish province of Guipuzcoa is described. This technique has proved to be a suitable solution to the problem of linking urban centers with the small farming units, or *caseríos*. Substantial savings have been obtained by using communal labor methods to construct these concrete roads.

CONDITIONS IN GUIPUZCOA

Guipuzcoa is the smallest province (1997 km²) in mainland Spain, although it is also one of the most densely populated. The population was 717,372, or 359 people/km², according to the 1979 census. Situated in the north of Spain, Guipuzcoa is bordered on one side by the Cantabrian Sea. Together with the provinces of Biscay and Alava, it forms part of the Basque Autonomous Community.

Guipuzcoa is a very mountainous province that can be divided into two parts, depending on the altimetric distribution: the coast, with low altitudes that are generally below 400 m, and the interior, which gradually gains in altitude as the distance from the coast increases, and reaches elevations of above 1500 m at some peaks.

Its topography has a direct influence on the courses of its rivers. These rivers run perpendicular to the mountain reliefs, which they cross in very narrow, steeply banked valleys.

From a meteorological point of view, Guipuzcoa has a maritime climate. Average temperatures in the capital of San Sebastian, which is situated on the coast, vary between 8 and 19°C. The annual rainfall is over 1000 mm in the whole provincial territory.

All of these factors have conditioned the population of the province, because most human settlements are located on the coast and along the river valleys. Other regions are extremely underdeveloped, not only in demographic terms but also in terms of such factors as communications and the presence of industry.

The agricultural sector is not very significant in the Guipuzcoan economy; most economic activity is industrial. One of the components of industry, for historical reasons, is the metallurgical sector, which employs almost half of the active population. This type of company is usually established in the vicinity of important communications, such as ports, roads, and railways. For this reason, the topography of Guipuzcoa has led the majority of these industries to locate in a series of corridors along the river valleys, in addition to the metropolitan region of the capital, San Sebastian.

This combination of geographical determinants and industrial activity has resulted in a landscape typical of the superimposition of urban, industrial, and residential land in that it is characterized by congestion and a marked increase in the price of land. As a result of this phenomenon, farms have gradually retreated toward more inaccessible regions. Although agriculture has been modernized and farming methods and yields have improved, rural life has undergone an extensive decline parallel to the process of general development. Almost all agricultural production is based on the family-run *caseríos*.

A *caserio* basically consists of a house that simultaneously serves as a dwelling, a stable, and a storage facility; several head of cattle; arable land and pastures; and sometimes a lot of forest land. The family, which serves as both manager and farm hands, lives in and off the *caserio* itself. The family unit therefore comprises the basic component of social organization, an elementary community.

Farming systems vary, but are small in scale and above all inadequate for the type of activity involved. Most of the 11,700 *caseríos* that currently exist occupy an area of between 5 and 20 hectares. They are generally to be found to exist as isolated farms or in small settlements (Figure 1).

Although the *caseríos* are usually not situated very far from

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FIGURE 1 Typical rural landscape in Guipuzcoa in which caseríos are shown.

developed regions, the fact that they are located in mountainous areas makes access to the towns difficult. This causes problems in both obtaining supplies of raw goods, such as feed and fertilizer, and collecting or marketing produce.

The cost of constructing or improving rural roads is high because the farmsteads are scattered in location and the steep slopes of the land create a need for retaining walls and culverts. The economy of the farming community is generally too small to bear these costs.

The Government of the Basque Autonomous Community and Guipuzcoan authorities (provincial government or Deputation, and municipal councils) therefore developed a Plan for Rural Infrastructure Improvement in 1982 as part of a Plan of Aid to the Agricultural Sector. This plan included the technical and financial aid needed for the construction and rehabilitation of rural roads. It enabled about 600 km of rural roads, or approximately 50 percent of the existing network, to be surfaced between 1982 and 1985.

LOW-VOLUME ROAD TYPES

The pavements of these rural roads are an average of 3 m wide. The traffic volume is low in all cases. The average daily traffic does not usually exceed 50 vehicles. However, many different types of vehicles use rural roads, from private cars to six-wheel lorries that carry logs from forest developments.

Three types of pavement are commonly used: a triple surface dressing on a granular base course, an asphalt concrete on a

granular base course, and concrete. Concrete pavement is usually laid directly on the subgrade, without doing anything more than stripping the topsoil. However, a layer of granular material is sometimes laid to shape and fill the voids to ensure that the thickness of the concrete slabs, which usually varies between 10 and 15 cm, is as uniform as possible. The lengths of rural roads that were paved by each of the methods mentioned earlier over the period 1982 to 1985 are given in Table 1.

The municipal council within whose boundaries the rural road lies is responsible for deciding which type of pavement to use. As can be seen in Table 1, concrete has gradually come to prevail over the other alternatives. One of the reasons for this is that concrete roads are simple to build. Contractors are needed during the entire construction process on asphalt-paved rural roads. However, concrete pavements are constructed by using a method of communal labor that is a tradition in the rural Basque communities. This communal labor is called *auzolan*, which is a Basque word that means unpaid work performed to fulfill the needs of a community. This work can take such forms as road improvement, water supply, or repair to farms or chapels damaged by fire.

The farmers who use the rural road clear and shape the soil; spread and compact the granular material, if it is to be used; build ditches and culverts; and lay the concrete pavement. If they have no experience in handling concrete, a skilled worker is contracted to oversee the work.

The concrete is always prepared at a mixing plant (Figure 2). A proportion of 250 to 300 kg/m³ of cement is used to obtain a characteristic compressive strength of 15 MPa at 28 days. Lime aggregate, the most abundant aggregate in Guipuzcoa, is normally used.

A single layer of plain concrete is usually used for the pavement. A reinforcing mesh sometimes has been used, in which case the pavement is placed in two layers. Approximately 50 percent of the pavements have no joints. Joints with boards have been placed in the rest of the pavement and no subsequent sealing is performed.

The sides of the road are formed with wooden forms before the concrete is laid. Another form is placed across them to serve as a guide when grading and compacting the concrete, and it is moved along the road as needed (Figure 3). Vibrating beams have been used in a small number of cases.

No change is usually made in the alignment of these rural roads, although improvements may have been made. Consequently, slopes are sometimes extremely steep; gradient values sometimes reach 30 percent. In these cases, the pavement

TABLE 1 LENGTH OF RURAL ROADS PAVED FROM 1982 TO 1985

Year	Triple Dressing	Asphalt Concrete	Concrete	Other Materials
1982	77 611 m (254,642 ft)	17 338 m (56,886 ft)	28 241 m (92,659 ft)	11 070 m (36,321 ft)
1983	64 312 m (211,008 ft)	39 173 m (128,527 ft)	57 833 m (189,750 ft)	--
1984	33 466 m (109,802 ft)	36 643 m (120,226 ft)	53 421 m (175,274 ft)	300 m (984 ft)
1985	10 769 m (35,333 ft)	23 144 m (75,935 ft)	72 848 m (239,014 ft)	850 m (2,789 ft)
Total	186,158 m	116,298 m	212,343 m	12 220 m
1982/85 (%)	35.3	22.1	40.3	2.3

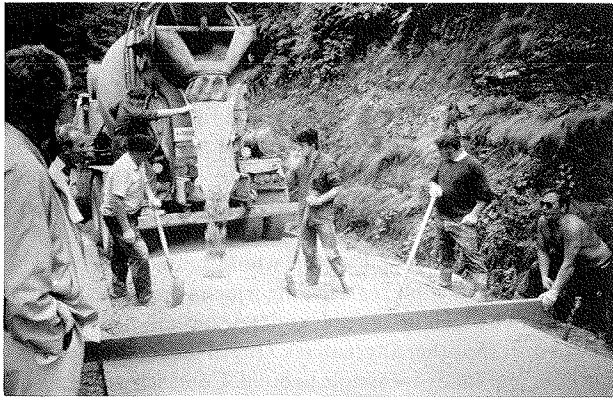


FIGURE 2 Supply of concrete for the construction of a rural road.



FIGURE 3 Compaction of concrete.

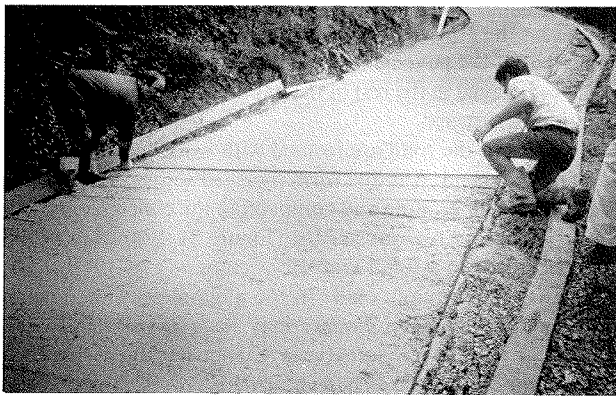


FIGURE 4 Applying grooves to freshly laid concrete in regions with steep gradients.

is usually given a transverse texture in the form of deep grooves that are made by combing the newly laid concrete with a metal rod (Figure 4).

In order to protect the edges of the pavement, a soft shoulder of one type or another is constructed of soil or granular material. The work is always performed under the supervision of engineers from the Deputation who are responsible for the design of the road.

Not only are concrete rural roads easier to construct than other types of pavement, but costs can be reduced by at least 20 percent through the use of the auzolan system in which the cost of labor is not added to the cost of materials.

CASE STUDY OF A CONCRETE LOW-VOLUME ROAD

The construction costs of a rural road 1500 m (4,920 ft) long that was built in 1985 are given in Table 2. The road is 3 m (9.8 ft) wide and the pavement is 15 cm (6 in) thick. The figures in the table were calculated on the basis of 1 U.S. dollar = 150 pesetas. The breakdown of the hours of unpaid labor is as follows:

Item	Hours of Labor
Clearing of site	682.5
Laying of pipes	190.0
Concrete pavement	1,329.5
Ditches and berms	2,154.0
Sign placing	8.0
Total	4,464.0

If an average value of 1 hour of labor at \$3.70 is estimated, the auzolan system saved \$16,147, or 25 percent, of the total cost of the work. This represents \$10.80/m of rural road or \$3.60/m².

In terms of the construction of the concrete pavement itself, the auzolan system saved \$4,920, or almost 15 percent of the cost of the pavement, and 9.4 percent of the total work cost. These savings could not have been attained with any other type of pavement. In addition, a cost of \$3.30/m (\$1/ft) of pavement was saved, and \$1.10/m² (\$0.10/ft²) was saved.

The concreting of the pavement took 18 days, which corresponds to an average daily rate of 83 m (272 ft). The labor needed amounted to 0.9 hrs/m (0.27 hrs/ft). These outputs are within the normal range for this type of work.

TABLE 2 BREAKDOWN OF 1985 CONSTRUCTION COSTS OF A CONCRETE RURAL ROAD

Item	Total Cost (\$U.S.) ^a	(%)
Cutting for road widening	1,897	3.62
Rockfill for soil retention	3,157	6.21
Clearing of site ^b	--	--
Excavation of ditch for water pipes	570	1.09
Laying of pipes	844	1.70
Granular base course	3,628	7.31
Concrete pavement	33,502	67.50
Ditches and berms	6,332	12.09
Sign placing	245	0.47
Total	52,359	100.00

^aThe exchange rate in 1986 was 1 U.S. dollar = 150 pesetas.

^bA total of 682 hrs of unpaid labor was used.

CONCLUSION

In addition to easier construction and lower costs, concrete roads in Guipuzcoa also have other advantages. Maintenance costs are lower because repairs can easily be made by the farmers themselves. Traffic safety is increased because a non-skid texture can be easily applied to the pavement. This is a great concern in regions with a topography and climate similar to Guipuzcoa. It is therefore not surprising to see that the statistics indicate that an increasing number of municipal authorities are choosing to construct concrete roads according to the auzolan system.