

WHERE OTHERS FAIL

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ABSTRACT: The work presented here consists of modification and subsequent design of a retaining wall of height of 32.00 meters. Initially the wall was raised of Reinforced Concrete and modified the project to execute the methodology of "reinforced earth", the support is calculated by means of elements of high elastic modulus polyester that interfere with the curves of sliding. The wall is executed in the town of Galdakao in the Pais Vasco, for the company Valeriano Urrutikoetxea, SA

1 INTRODUCTION

1.1 *Antecedent*

The modification is based on the own situation of the structure to execute and in anticipation of some major impacts on the environment, on the one hand, and economic, on the other side.

1.2 *Reasons for the modification*

In the primordial project envisaged a retaining wall about 28 meters high, concrete and bolting, which takes place on an embankment to reach the height required for installation of the polygon to executed.

This option, addition of about very important requirements for excavation, causing excessive visual impact.

In the year 2010 are contacted to gauge the possibility of alternatives to the implementation of reinforced concrete and, seeing the heights surveying, land, load, environment and generally the faces to quantify, we decided to propose the implementation and / or embodiment of a reinforced earth structure, or "Green Wall" to:

- Ensure stability.
- Use, as far as possible, the materials found in the work.
- Adequate space needs to the possibility of calculating.
- Reduce the environmental impact and integrate on the environment, highly vegetated, moreover.
- Leverage the flexibility and / or plasticity of the structure.

2 SITUATION

2.1 *Location geological – geomorphological*

The work area is located in a mountainous area of steep slopes, being classified as T-3: unfavorable terrain with slopes greater than 15 °.

It is situated, geologically speaking, between units of Oiz - Yurre. The materials are formed according to guidelines and advice northwest - southeast, congruent with the structure observed in the account Basque - Cantabrian..

2.1.1 *Stratigraphy (Fig 1)*

The different rock substrates where is located the area of work is from the Upper Cretaceous and consists mainly of:

- ✓ Siltstones (Lower Cretaceous. They are the oldest.)
- ✓ Reef Limestone (Block no importance)
- ✓ Sandstones and shales (covering the previous ones, though not in the study area)
- ✓ Marls and marly | (Oiz unit, marl gray - blue stratified decimeter dynamometers within the complex Urgonian)
- ✓ Shales and sandstones (similar percentage in both banks being arranged in alternating and alternative)

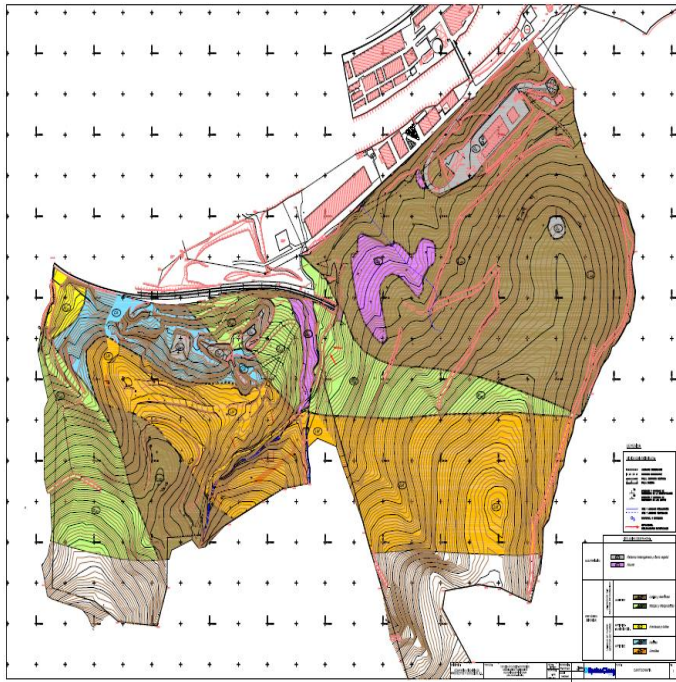


Figure No. 1: Map Geotécnical- Geológica of the area

2. 1.2 Tectonics

From the structural point of view, have been detected in the visits to the area and through the bibliography consulted (FSC hi 1:25.000 62. III Galdakao) the existence of several mechanical contacts, separating the different existing lithology. (fig 2)

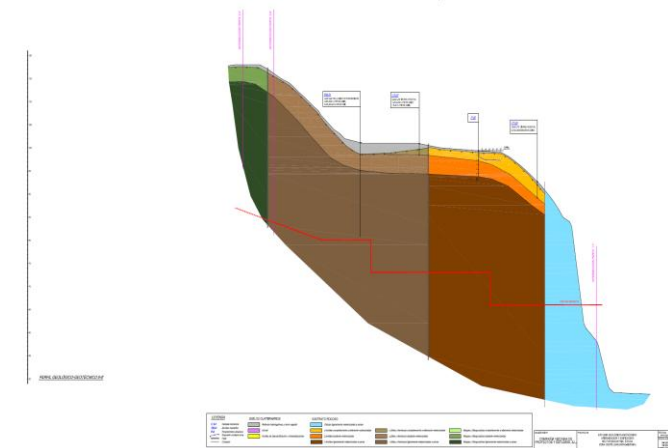


Figure No. 2: Geological Section profile 9

Except for contact reef limestones and siltstones which are separated by gradual consistent contact, other formations are limited for failures whose orientations are approximately north-east-southeast.

2.1.3 Geotechnical

West Zone

Is a zone much more heterogeneous in the type of existing materials and, therefore, as to conduct geotechnical.

Level I

Vegetal Earth: It appears as a thin cover, not exceeding 0.60 m, mostly of clay materials, with some sand and silt.

Heterogeneous fills: They appear in all the polls and show powers from 0.40 up to 4.00 meters. Are made mainly of the rock fragments or silty underlying, which in many cases have been used for the execution of road and / or tracks.

However, in some polls, has been detected that are mostly soft clay, with gravel and roots, the result of numerous earthworks for extraction of ferruginous materials, associated with limestone.

2.1.2 Seismicity

The "Earthquake Resistant Construction Standard" regulates, through the attached map of "Seismic Danger," areas of the territory in which the mandatory application of the same. In our study area the influence is less than 0.04 g, so do not take into consideration.



Map 1: Map of Seismic Hazard.

2.2 Analysis of the Problem

As existing materials, we might call "natural terrain" are, almost, fillers, but important stability, at least in the short term, we are obliged to conduct surveys and sampling to obtain reliable parameters for calculating

Based on these new tests:

- It discards the realization of a natural mound occupation necessary, and the unreliability of breaking circular. (Photo No. 1)
- Decision not to execute the concrete wall by the "showiness" necessary and it is chosen, definitely, for the making of "Land reinforced"

The adoption of the resolution of "reinforced earth" provides the following additional benefits:

- ✓ Possibility to use as filling materials / foundation existing in work.
- ✓ Streamlining the construction process, shortening the lead times significantly.
- ✓ Possibility of flexibility and revegetation with a significant reduction of environmental impact.



Photo No. 1 Aerial view of the work area

3 BUILDING SYSTEM. REINFORCED LAND

3.1 Concept

The term "Green Wall" is generalized due to the final facing, with due care, can be covered with vegetation.

In its purely technical concept is a reinforcing land used to get the end angles of the outer surface, over the earth's own natural.

These are achieved by inserting the elements of high resistance to breakage, and which are defined later, depending on various parameters that define later.

3.2 Principles of Implementation

Reinforced earth structures allow mainly:

- ✓ Use of own materials

- ✓ Flexibility
- ✓ Adaptability
- ✓ Admission of possible deformations and settlements.

3.3 Process

3.3.1 Preparation of the Base

The land must be leveled, compacted and cleaned of any sharp materials, in addition, of course, assure the compressive strength thereof in accordance with the loads that will support long-term and anticipate possible compressions and settlements.



Photo No.2: Home based support

3.3.2 Installing the base mesh

We proceed to the placement element determined in the calculation, in the prepared base. This is attached to the ground displacements avoidance.

Subsequently be placed on the grill or "lost formwork", it which the mesh is attached erosion control - securing the soil, as shown in the photograph 3.



3.3.3 Contribution, laying and compaction

Once placed the most external or visible part of the structure, we proceed to fill of embankment land that will be reinforced.

This contribution is to be done, as mandated by the PG3 in tiers less than 0.40 meters so as to permit a Proctor of 98 modified.

It should prevent the direct passage of machinery and trucks on the reinforcing mesh placed, proceeding to advance as they fill land. Logically thinking, the particle size must be adequate to the needs of supply and compaction.

The filling will be furnished, in our case, 0.70, according to the manual of execution of Reinforced Earth Walls of Public Works to flexible reinforcements, allowing spacing of 0.70 m.

This filling will reach about 0.40 m. From the grill, to make room for the provision of topsoil.

3.3.4 Supply of Topsoil

The last step to run is the discharge, laying and compaction of the earth "vegetable", which, depending on latitude medium to long term is to be implemented by reducing vegetation, so very important visual impacts compared with other types of retaining walls.

After running the first "tier" the process is completely repetitive, with appropriate limitations and / or technical adjustments to the lengths of reinforcing planimetry, their quality and fixings + overlaps.

This process is repeated, keeping the slopes of the "visible face" to be getting through to the slopes of the grill or formwork lost and correct alignment of the different phases leads to a figure like that is attached. (Scheme 5) in which there are three layers that suggest continuity of work or process.



Photo No.4: Home Filler reinforced embankment

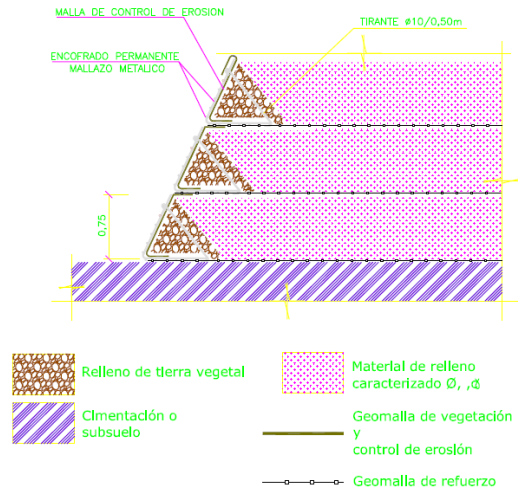


Figure 3: Scheme of mounting parameters

4 WALL OF GALDAKAO

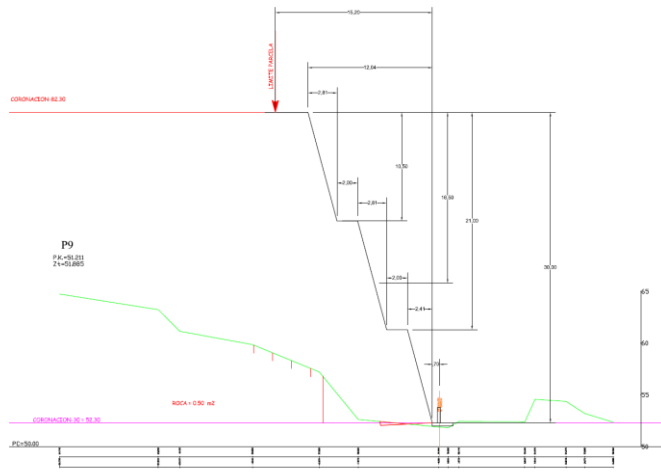
4.1 Antecedents

Regardless of the location of the work, which is already defined in the picture 1, we will describe step by step of design methodology, calculation and execution of the reinforced earth wall that will house the estate of the West phase Itzaga.

A reinforced earth wall of 32.00 meters not done every day and is an important milestone in the calculation and execution of a reinforced structure - or otherwise type - especially considering that is a methodology certainly not well known - and so its possibilities - in engineering support / soil stabilization.

4.2 Data collection.

The first stage of designing the structure to be calculated and subsequently executed, is to obtain data of the lands which are to contain, in addition to all the parameters taken into account when a design of a wall of any type. In this case we have obtained the following for the design and calculation, starting from the need for a section (flat # 1) predefined, with one or two intermediate berms, depending on the section.



Flat No. 1: Section profile 9

For good design of the structure to sketch, we must know the following initial:

- ✓ Land Data
 - Angle of internal friction
 - Density
 - Cohesión
 - Grading
- ✓ Of the three entities involved:
 - Land to strengthen
 - Land of tras – dos
 - Support of land
- ✓ Support bearing capacity.
- ✓ Geometry support (pending).
- ✓ Pending of face side.
- ✓ Surface finish.
- ✓ Loads on coronation.
- ✓ Distance at the top of slope.
- ✓ Existence of water, or not.

Land Data

To comply with the development of the necessary calculations for the design of the wall and the support of the safety factors, as indications of different government agencies - there is no standard - started collecting data for land.

These data collections are started for the first time in campaign of Eptica-Cinsa in 2007 in which on average are obtained land data (Table 1 and 2):

RESULTADOS ENSAYOS DE LABORATORIO EN MUESTRAS DE SONDEOS. ROCAS

REFERENCIAS		CARACTERÍSTICAS FÍSICAS			DESCRIPCIÓN	CARACTERÍSTICAS MECÁNICAS	
SONDEO	PROFUNDIDAD (m)	TIPO DE MUESTRA	HUMEDAD (%)	DENSIDAD APARENTE (t/m ³)		COMPRESIÓN SIMPLE (Kp/cm ²)	DESMORAMIENTO FRENTE AL AGUA (%)
SM-5	6.35-6.75	TP	4.49	2.562	Lutitas con pesadas areniscas (G-II)	49	--
SM-7	10.55-11.03	TP	5.11	2.529	Lutitas con pesadas areniscas (G-II)	23	--
SM-7	17.25-22.00	MA	--	--	Lutitas con pesadas areniscas (G-II)	--	53
SM-8	18.60-19.00	TP	6.98	2.495	Areniscas (G-II)	408	--
SM-14	4.20-8.20	MA	--	--	Lutitas con pesadas areniscas (G-III) y areniscas (G-II)	--	2.5
SM-15	4.70-5.10	TP	1.30	2.698	Margolitas (G-II)	297	--
SM-15	8.15-10.00	MA	--	--	Margolitas (G-II)	--	9.6
SM-16	8.10-8.40	TP	8.01	2.416	Margas (G-III)	11	--
SM-20	5.00-8.45	MA	--	--	Calizas (G-II)	--	0.1
SM-20	7.00-7.45	TP	0.21	2.800	Calizas (G-II)	971	--
SM-21	8.50-8.90	TP	0.12	2.732	Calizas (G-II)	761	--
SM-25	1.00-1.50	TP	0.61	2.717	Margas (G-II)	594	--
SM-27	15.60-15.95	TP	9.01	2.482	Limolitas (G-II)	40	--
SM-30	8.20-12.00	MA	--	--	Limolitas (G-II)	--	10.4
SM-33	3.35-3.70	TP	0.25	2.741	Limolitas (G-II-1)	578	--
SM-34	28.80-29.25	TP	0.69	2.720	Limolitas (G-II-1)	403	--

Table No. 2: Typology of land.

The data are obtained with a plan of probes and test pits performed so as to cover the whole work surface, given the importance of a good knowledge of the land of works by the dimensions of the wall to design and implement.

Again, after, before the date of start of work, in the year 2011 is carried out another campaign of study, and the method of direct cut of the land to be used at the landfill well reinforced as of after-two of the wall as well as the materials defined in the year 2007 have not altered in any way to retain the same initial conditions, land fill can be seen as various parameters are stockpiled to the open for almost four (4) years.

In 2011 the company Altamira Engineering XXI holds the sampling applied to the direct shear test getting results to accompany the summary. (Table 3)

MUESTRA	1	2	3	4	5	valores MEDIOS	UDS
PK	23	26	20	18	12		
D SECA	1,89	1,91	1,94	1,95	1,89	1,92	gr/cm3
D HUMEDA	2,29	2,37	2,15	2,23	2,18	2,24	gr/cm3
H NATURAL	21,3	23,7	10,8	14,4	15,8	17,20	%
L.L.	37,3	33,1	32,3	29,5	34,6	33,36	%
L.P.	25,3	27,7	21	19,2	24,7	23,58	%
I.P	12,1	5,5	11,3	10,3	9,8	9,80	%
P NORMAL							
D MAX	1,87	1,72	1,98	1,85	1,87	1,86	gr/cm3
H OPTIMA	15,8	23	12,4	16,4	14,2	16,36	%
P. MODIFICADO							
D MAX	1,97	1,94	2,05	1,97	1,98	1,98	gr/cm3
H OPTIMA	14	17,2	10,8	13	12	13,40	%
CBR	16	77	18	14	32	31,40	%
RO INTERNO	24,19	26,51	25,74	24,58	26,33	25,47	°
COHESION	5	14	5	6	12	8,40	Kpa

Table No. 3: Calculation Data

We obtain the averaged values:

- ✓ internal friction angle (°) 25,47
- ✓ Wet Density (grs/cm3) 2,18
- ✓ Dry Density (grs/cm3) 1,92
- ✓ Natural Moisture (%) 17,20
- ✓ CBR 31,40
- ✓ Cohesión (KPa) 8,40

RESULTADOS ENSAYOS DE LABORATORIO EN MUESTRAS DE SONDEOS. SUELOS

REFERENCIAS		CARACTERÍSTICAS FÍSICAS					CLASIFICACIÓN DE CASAGRANDE	DESCRIPCIÓN	CARACTERÍSTICAS MECÁNICAS			
SONDEO	PROFUNDIDAD (m)	TIPO DE MUESTRA	HUMEDAD (%)	DENSIDAD HUMEDA (t/m ³)	% PARA YANKEZ 2000	PLASTICIDAD LL (%)			IP (%)	COMPRESIÓN SIMPLE (Kp/cm ²)	COHESIÓN (KPa)	ANGULO DE RIZAMIENTO INTERNO (°)
SM-6	1.80-2.40	ME	15.0	2.05	62.9	43.4	24.4	CL	Arenal (arcillas arenosas)	--	43.9	25.9
SM-14	1.00-1.50	ME	22.5	1.989	79.0	30.5	12.6	CL	Lutitas con pesadas de areniscas (G-IV)	--	--	--
SM-16	2.00-2.60	ME	24.54	1.969	66.4	40.2	16.3	CL	Margas (G-IV)	0.67	--	--
SM-23	2.00-2.55	ME	14.7	2.076	78.1	31.2	12.6	CL	Limolitas (G-IV)	--	--	--
SM-30	1.50-1.85	ME	13.04	2.101	38.4	37.3	14.4	GC	limolitas (G-IV)	0.82	--	--

AGRESIVIDAD DEL SUELO AL HORMIGÓN EN MUESTRAS DE SONDEOS

SONDEO	PROFUNDIDAD	DESCRIPCIÓN	Ácidos Benzeno-Gully (ml/Kg)	Contenido en sulfatos (mg/Kg)	AGRESIVIDAD
SM-16	2.00-2.60	Margas (G-IV)	246.5	74.85	DÉBIL
SM-23	2.00-2.55	Limolitas (G-IV)	241.0	68.64	DÉBIL

Table No. 1: Physical values of working lands.

4.2.1 Calculation Data.

In order to be more conservative, moreover, that the data obtained by direct shear tests, the following values are taken for calculation, which will perform the same for different sections of calculation:

ReSlope Versión 4.0		MUROS DE VUSA EN GALDAKAO	
DATOS SOBRE EL SUELO			
SUELO REFORZADO:	Ángulo de fricción interno, ϕ°	25.0	
	Cohesión, c [kPa]	6.00	
	Peso específico saturado, γ [kN/m ³]	18.70	
SUELO DE RELLENO:	Ángulo de fricción interno, ϕ°	25.0	
	Cohesión, c [kPa]	6.00	
	Peso específico saturado, γ [kN/m ³]	18.70	
SUELO DE FUNDACIÓN:	Ángulo de fricción interno, ϕ°	40.0	
	Cohesión, c [kPa]	0.00	
	Peso específico saturado, γ [kN/m ³]	19.00	
DATOS GENERALES			
	Ángulo asumido de las fuerzas 'interwedge' (análisis del deslizamiento directo), δ	20.00	
	Coefficiente de interacción de estramiento (suelo reforzado), Ci	0.90	
	Coefficiente de interacción de estramiento (suelo de fundación), Cf	0.90	
	Coefficiente de deslizamiento directo (a lo largo del suelo reforzado), Cds	1.00	
	Coefficiente de deslizamiento directo (a lo largo de cimentación), Cds	1.00	
	Se especificó la longitud uniforme de todas las capas.		
PARÁMETROS SÍSMICOS			
	Coefficiente sísmico horizontal, Kh (100% used)	0.00	
	Coefficiente sísmico vertical, Kv	0.00	
	Kh y Kv SE ESTÁN APLICANDO al macizo reforzado y a la sobrecarga en los análisis de deslizamiento directo.		
EFFECTOS EN LA FUNDACIÓN			
	Para los análisis del refuerzo se permite que las superficies de la falla penetren en el suelo de fuera. Se solicitó un análisis profundo de Bishop y los círculos pueden penetrar en la fundación hasta una profundidad máxima de [m]		
		15.00	
PARÁMETROS DE DISEÑO CON GEOSINTÉTICO			
	(... Introducción manual de datos ...)		
	Factor de reducción por daños de instalación, RFI	1.20	
	Factor de reducción por durabilidad, RFD	1.10	
	Factor de reducción por deformación lenta, RFL	1.50	
	Radio de cobertura, Rc	1.00	
ORIENTACIÓN DE LA FUERZA ESPECIFICADA			
	Se ha prescrito la orientación relativa del refuerzo, ROR		
		0.00	
FACTORES GENERALES DE SEGURIDAD			
	Factor de seguridad en la fuerza de corte del suelo	1.00	
	Factor de seguridad en la resistencia del geosintético	1.30	
	Factor de seguridad en la resistencia al estramiento	1.50	
	Factor de seguridad en la resistencia al deslizamiento directo	1.30	

Figure No. 4: Spreadsheet, with the design values

In relation to the geometric parameters of the wall, where larger section (profile No. 9) arrives at the 31 meters high, with a slope of 75 ° each of the sections performed which, given the berms of 2 meters wide, has a general angle of 68 °. The applied loads will be about 10 kPa to 15.39 meters of the coronation of slope.

4.2.2 Design / Calculation

The next step is the development of calculation of the different sections that will develop the structure. In our case the cross sections are in number ranging from 8 to 30 meters high, with two berms, to 11.25 meters in height in the profile or PK 31.

The work of the wall goes from 6 to 32 profile taken at 10 meters apart each, giving a length of the wall, in a first phase, about 320 ml. This, with the different heights indicated, gives us an area of work about 7051.30 m²

4.2.3 Reduction Coefficients.

In the calculation process and development there are several factors or reduction factors significantly influence the final design of our structure.

Some of these factors are of materials, and provides the same manufacturer, such as,

- Reduction Factor for Durability (RFd)
- Reduction factor for slow Deformation, (RFc)
- Radio coverage (Rc)

Other values of correction factors, related to the implementation, such as:

- Correction factor for installation damage (RFid)
- Orientation on Reinforcement (ROR)

And finally, corrected, or not, as a supplement to computing security other inherent to the materials that also provides a manufacturer though in a separate account for an important be influenced by geology / geotechnics of soils treat and safety factors, rather than reduction factors:

- ✓ Fs of cutting the soil strength
- ✓ Fs of Resistance of Geosynthetic
- ✓ Fs of Resistance to Stretching
- ✓ Fs to direct sliding resistance.

These are reflected in Figure No.4.

4.2.4 Security Coefficients

SITUACIÓN DE PROYECTO	COMBINACIÓN DE ACCIONES	COEFICIENTE DE SEGURIDAD
Persistente	Casi permanente Característica	F ₁ F ₂
Transitoria y de corto plazo	Casi permanente Característica	F ₁ F ₂
Accidental	Accidental sin sismo Sismica (accidental con sismo)	F ₃ F ₃

Table No. 3

COMBINACIÓN DE ACCIONES	COEFICIENTE NORMAL	COEFICIENTE REDUCIDO
Casi permanente (*)	F ₁ ≥ 1,50	F _{1,red} ≥ 1,30
Característica	F ₂ ≥ 1,30	F _{2,red} ≥ 1,20
Accidental	F ₃ ≥ 1,10	F _{3,red} ≥ 1,05

(*) Como valor del coeficiente de seguridad para la combinación de acciones casi permanente, en situaciones transitorias y de corto plazo, podrá adoptarse el coeficiente de seguridad F₂ (véase apartado 2.10), o F_{2,red} según sea el caso.

Table No. 4: Security Coefficients

In the above tables (Tables 3 and 4) based on the "Guide to Foundations and Road works" of the Ministry of Public Works and in which they are based, also other publications such as "Manual for the Design and Execution of Structures of Reinforced soil", reflecting the different safety factors.

In both cases are references to the execution of such structures, they are NOT to Follow Rules.

In most cases follow criteria for durability, location, accessibility, and take into account some parameters, not included in these publications.

In our case have been calculated over a Global $F_s > 1.50$.

4.2.5 Results

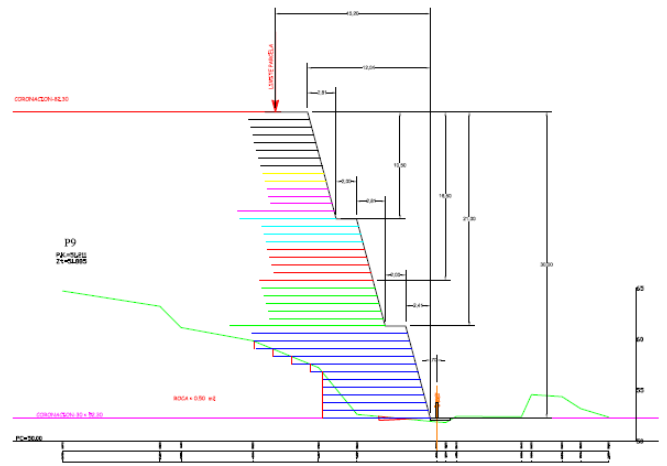
Once executed the design calculations, in which we evaluated and shuffle all coefficients, parameters, reduction factors presented above, the values of the lands with which we work, charges possible, the distances from the heads slope, in short, every one of the influential parameters in the design of the structure, as well as certain "values" intangibles such as climate, orientation, and others which, although not quantifiable, it is important when of looking at different alternatives and, thus committing the work to advance and which are not reflected in the calculation programs such as:

- State of the substrate support.
- Obtain of data and methodologies to use.
- Type of equipment to carry out the work.
- Activation or not, depending on the weather.
- Indication to the contractor of the headings and / or jobs that have to rush before, during, and at the end of the work, own execution of the structure.

In our case, the amount of mesh to use with the necessary qualities and lengths, reflected give the following values:

- ✓ height of the "layer"
- ✓ length of the same
- ✓ Mode of "failure"
 - Tie back=retención/atado
 - Compound=Compuesto
- ✓ Resistance to Breakage (kN/m) requested (Tr)
- ✓ Resistencia requerida a largo plazo, en kN/m, (T/ltds).
- ✓ F_s Total Real

This calculation is done for different heights of the wall which may or may not coincide with needs of performance to different height profiles as a function of the height of departure or coronation, so that we would obtain a series of lengths of reinforcement and qualities of materials leads us to optimize in terms of cost structure, always ensuring the required safety coefficients based on all the lands to be used.



Map No. 2: Representation of mesh to use in P9

This compendium of materials and lengths gives us as a result a section of the enclosed type, as we see is the most up to run on project design. (Map 2).

At the same can be seen some colors that used to differentiate the quality of the materials at break.

Obviously, depending on the effort required it is necessary a mesh or geosynthetic that meets these requirements so that, with appropriate safety coefficients, meets the same so that, in time, ensure the durability and stability (or vice versa) of the final structure.

In our case these qualities, as is attached in Figure 10, ranging from 300 kN / ml and 35 kN / ml. In order to safeguard the breaking efforts that we have requested the calculator (ResloPe[®] y Ressa[®]).

4.2.6 Materials

In this structure have used three types of materials, mainly:

- ✓ Reinforcement Mesh (polyester)
- ✓ Mesh erosion control (polyester or polypropylene)

4.2.6.1 Reinforcement Mesh

(1) Characteristics Physical and Geometrical

They specify the data of weight (g/m²) of the mesh coil dimensions, the weight thereof, the opening dimensions of the mesh, etc..

(2) characteristics of polyester yarns

(3) Mechanical characteristics.

The most important for the Planner.

- I. Longitudinal Tensile Strength in kN/m
- II. Transverse tensile strength in kN/m.
- III. Elongation at Break (%)
- IV. Resistance to 2% elongation kN / m, as the longitudinal axis.

V. Resistance to 5% elongation, according to the longitudinal axis

These values are typical of the materials and we must take them into account when making the calculation of stability.

As shown in the above data, exists two different voltages, a "longitudinal" in the longitudinal direction of winding of the mesh and transverse to the same. These directional should take into account also the calculation.

(4) Design Data. Factors reducing

As we said in section 4.2.3 must be taken into account in the calculation, is one you requested it and influence, some so determinant on the results of the final structure design.

4.2.6.2 Mesh erosion control.

This mesh has the main function is to prevent the action of external agents (water in particular) affecting and remove topsoil (why they are called "Green Walls").

Is a 20x20 mesh, in our case that apart from other values less transcendental, has the same breaking strength in both "directions".

In addition to preventing erosion also prevents "additional burdens" on the grill corrugated steel that is used as "shuttering."

5 DRAINAGE

Over the preceding paragraphs we have defined the design and calculation of the structure itself.

All it is exposed previously, not "serve of nothing if no action is taken so that water does not alter the calculation parameters in which we have based.

5.1 Function

The reinforced earth wall that we are defining is nothing more than a "land package" of certain characteristics that, in addition to "hold" themselves, they will "hold" other land behind them and loads at the coronation of the same with a certain geometric "forms" helped, albeit with some materials "support".

These lands, which make up the structure, not just their part "main", but the whole, cannot and should vary their original parameters of calculation and design that would be seen, so very important, affected by the influence of water.

If the water had penetrated the lands that have been reinforced would vary those mentioned calculation parameters as follows:

a) Internal friction angle

- . It would reduce, because of loss of adhesion between the particles, or to better understanding, decreased ability to "drag" between them. This loss leads to a decreased angle of internal friction, thereby increasing the risk of movement or slipping.

b) Density

- It would increase;

This is, as we know the density is weight / per unit volume. As we know, also, water is "stuck" to the soil particles, depending on their hygroscopy - or ability to absorb water - and therefore its weight increases. The land + the water.

This phenomenon would increase the loads, both vertical, as the tangential or sliding, ie at greater weight, the tendency to "take speed" and move are greater.

c) Cohesión

- Although in the calculation or design, we do not value the cohesion, for important reasons.

Executing the structure T.R. confine the land, "isolating" the condition of water; well for a drainage – for this exhibition, for a Proctor compaction, which prevents the "free flow of water through the pores and inter-particle spaces or, quite the opposite, that is, if we do not do the job well, water penetrate thus facilitates, first, cohesion (which is good), but it happens to break the grip and / or adhesion between particle (is bad).

Having clarified these concepts, as we initially said we must "avoid" the entry of water into the reinforced soil.



Photo No. 5: Image of Vertical Drainage

The geocomposite of drainage to act conveniently must be placed in the contact area between the "clearing" or natural ground and the reinforced soil, as shown in the accompanying photograph (Figure 5).

We believe that NO should be placed between "reinforced embankment" and fill in "tras-dos,"

because by having to compact the land into two "phases" would be a distinct and differential compaction, which, could cause embankment failure plane.

Geocomposite of Drainage



Figure 8: Detail of used Drainage.

The Geocomposite of drainage consists in

:

- ✓ Two (2) Geotextile of 120 g / m² of polypropylene, whose functions are:
 - The geotextile which is in contact with the natural ground, prevents the entry / fine movement to the "space" which generates the mesh network between the two geotextiles.
- ✓ The geotextile is in contact with the embankment land the nearest land reinforced prevents the entry of fines which may exceed the first geotextile, letting the water in one direction.
- ✓ A network of high density polyethylene PEAD with a thickness of 4.8 to 5.2 mm having, as its principal function, the "hole" for deriving the water by gravity into the collection tube with the base-nant dre or base.
- ✓ Depending on the type of geocomposite drainage ensure a flow depending on the pressures that depending on the height of land.

6 CONCLUSIONS

With all the above in this summary / study it has been designed / implemented the wall, we believe, the highest in Europe with the guidelines that have been described over the previous presentation.

In the execution, in addition to conditions technical, calculations, and drainage, exposed have followed best practices of implementation of

landfill or embankments that indicates the PG3, since the wall is not more than that: the execution a huge embankment in which we have tried to influence the friction angle, Natural, just to increase the angle seen from the same.

During the implementation process have been very careful to follow several premises in order to preserve the quality:

- ✓ Do not work on rainy days the land.
- ✓ Scarify the surface layer after the rains and re-compacted and take the Proctor.
- ✓ Keep a record of the lands of calculation.
- ✓ Adapting the slope of the layers into the drainage.
- ✓ The correct placement of vertical drains.
- ✓ Exhaustively studying the execution pending.
- ✓ Of course, to follow the planes of qualities of mesh and lengths of reinforcement each and of the corresponding layers.
- ✓ Once finished avoid at all costs the derivation of water runoff the platform created to the face side so that it can influence their stability.

7 PHOTOS



Photo No.6: Preparation of the support base



Photo No. 7 Start working with the first mesh of 300 kN.

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Photo No. 8 Contribution of land in the layers.

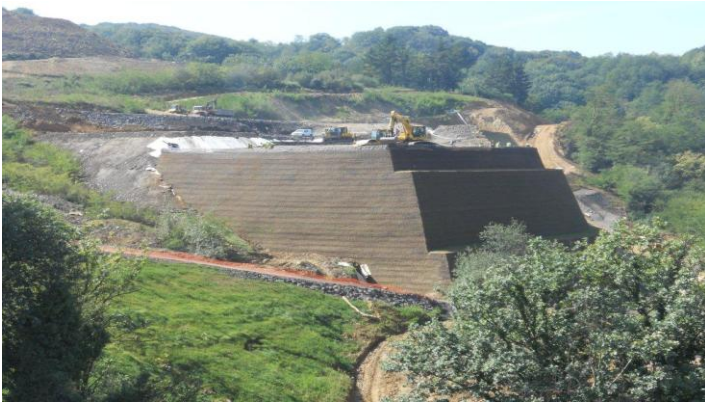


Photo No.11 Partial execution en Nov/11



Photo No. 12: Finished Dic./11



Photo No. 13: Overview