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UNPAVED ROAD DISTRESS EVALUATION USING URDE®

Julián Andrés Pulecio Díaz[1], Oscar Camilo Valderrama Riveros[1] and Myriam Rocío Pallares Muñoz[2]
[1]Civil Engineering Program, Faculty of Civil Engineering, Universidad Cooperativa de Colombia, Colombia
[2]Faculty of Engineering, Universidad Surcolombiana, Colombia
E-Mail: myriam.pallares@usco.edu.co

ABSTRACT

In this paper, URDE® software is introduced for the unpaved road distress evaluation using the VIZIRET method. This software is written in Hypertext Preprocessor and Php programming language, which allows multiplatform running, and since this is a Web application, it works on all operating systems. URDE® software helps estimate the viability index, road condition, and possible rehabilitation method on 100 m. URDE® is suitable for reducing the rehabilitation method's decision-times *in situ*, which is essential for government public dependencies who admins the unpaved roads. Besides, this software allows interaction with software DACE® and SDDRoads® to design unpaved roads and side drainage design for roads; the above, in case of count on the answer of reloading or rebuilding of roads. Finally, URDE® was demonstrated to be an interesting application for calculation road distress evaluation anywhere in the world with similar or equal criteria to the VIZIRET method.

Keywords: software, unpaved, road, distress, evaluation, viability index, rehabilitation, URDE®.

1. INTRODUCTION

This work has been done to improve the assessment of distress on unpaved roads, an activity required to estimate a road's condition and a possible rehabilitation method. For this purpose, the URDE® software [1] is presented to the academic community, which has easy access to and processing information derived from the field, according to a series of distresses typical of unpaved roads [2].

The software applies an international method of assessing distress, such as the VIZIRET [3], which is from France and belong to the Laboratoire Central des Ponts et Chaussées (LCPC), now the Institut Français des Sciences et Technologies des Transports, of L'Aménagement et des Réseaux (IFSTTAR) [4], a world-renowned research institution and leader in Europe.

The VIZIRET and other recognized trajectory methods are the results of arduous research developed according to conditions in several tropical countries in Africa [3], which allow it to be replicated in places in the world with the same or similar conditions.

Methods of assessing distress to unpaved roads such as the URCI [5] are available. These methods were developed by the United States Army's Cold Regions Research and Engineering Laboratory thanks to funding from the Federal Highway Administration (FHWA), but with a lower incidence of application in South America, specifically Colombia[6].

Unpaved roads are present all over the world, being more employed than the famous flexible [7] [8] [9] [10] and rigid [11] [12] [13] [14] [15] pavements. The first one is applied worldwide, and the last one with more influence in America. The most important unpaved roads are access roads to civil works or roads with low traffic volumes, compromising the agricultural and construction sectors on many occasions.

On the other hand, developing technologies that involve easy processing of information *in situ* in real-time and that allows the diagnosis of the condition of a road and possible rehabilitation would help to fulfill some of the goals of Sustainable Development Goals (SDG) recommendations related to: "the industry, innovation, and infrastructure"[16] and "no poverty, zero hunger, good health and well-being, quality education, decent work, and economic growth, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life on land, peace, justice, and strong institutions" [17]. The above is focused on improving access to territories, which involves communities [18].

For these reasons, the software URDE® was developed. The name of the program comes from Unpaved Road Distress Evaluation. It is a Web application (multiplatform) to be executed on a computer, tablet, or smartphone as long as you have internet access.

2. METHODS

2.1 Distress Evaluation Method in the Unpaved Road VIZIRET

VIZIRET [3] method was created for old Laboratoire Central des Ponts et Chaussées (LCPC) to describe and quantify distress to unpaved roads for scheduling and monitoring maintenance works.

VIZIRET has stood out for its application in tropical countries because its development took place in several African countries where that weather is present.

This method studies various types of structural distress and, in some cases, drainage, plus other causes. The distress is presented in Table-1, defining the reasons why they occur on unpaved roads.

Table-1. Distress in unpaved road according to the VIZIRET.

Distress	Definition
Deformation	The strains can have three origins: the tearing of the material under the traffic (a phenomenon known as "gravel loss" or loss of material, diminishing the structure), rutting, or sinking.
Potholes	Potholes are considered structural distress for unpaved roads because since the base layer and the wear layer are one, they spread quickly throughout the structure.
Corrugations	The corrugation is created by rearranging the material's surface in parallel waves perpendicular to the transit direction. Although its origin is linked to the nature of the material and not to thickness, the VIZIRET considers it a structural phenomenon because it affects the roadway's minimum thickness at the hollows' locations.
longitudinal erosion	Longitudinal erosion is linked to a flow of water in the middle or on the road's sides. This is a sanitation problem, not a structural problem. However, VIZIRET considers it a structural degradation because it can result in a deep erosion of the base layer. Its repair requires both a reworking of the ditches and the road's profile.
Lost material	This is originated from the formation of dust during the dry season due to the passage of vehicles.

Source: [3]

The distresses presented in Table-1 are quantified using a series of criteria (see Table-2), which depend on the type of impairment and the gravity level; the latter expressed as 1, 2, or 3, having a previous meaning of low to high gravity respectively.

Table-2. Distress vs. gravity levels, according to deformation, potholes, corrugation, and longitudinal erosion.

Distress	Level 1	Level 2	Level 3
Deformation	< 50mm	50 to 100 mm	>100 mm
Potholes	Few and small diameter	Quite a few or large	Numerous and of a size that justifies reconstruction
Corrugations (deflection)	< 20mm	20 to 50 mm	> 50 mm
longitudinal erosion (depth)	< 50mm	50 to 100 mm	> 100 mm
*The number and dimensions of the Potholes must be estimated rather than defined precisely. The following classification can serve as a basis for such an estimate: -Level 1: less than five potholes of diameter less than 0.50 m in a section of 100m -Level 2: between five and twenty potholes of diameter less than 0.50 m in a section of 100 m or less than 5 with a diameter greater than 1 m. -Level 3: more than twenty potholes of diameter less than 0.50 m in a section of 100 m or more than 5 with a diameter of more than 1 m.			

Source: [3]

On the other hand, the lost material distress depends on the following definitions according to the gravity level, see Table-3.

Tabla-3. Gravity levels of the lost material.

Level	Definition
1	Weak clouds of dust that dissipate quickly and do not cause discomfort to users of other vehicles.
2	Persistent dust clouds that reach the height of a person and obstruct the visibility of a pedestrian.
3	The total absence of visibility for the car drivers.

Source: [3]

The VIZIRET method from the definitions by distress related to a gravity level proposes determining the viability index per 100 m of road length related to the section's structural quality. This index corresponds to the highest level of distress detected in the section of the road evaluated. In other words, the viability index corresponds to the highest level at which the existence of deformation, potholes, corrugations, longitudinal erosion, and lost material occurs.

Finally, the VIZIRET method allows the viability index per 100 m of road length, the road condition, and the possible rehabilitation method (see Table-4).

Table-4. Road condition and possible rehabilitation method according to the levels.

Level	Road condition	Possible rehabilitation method
0	There is not distress	Monitoring and basic maintenance
1	Light degradation and little sensitive to the users	Light reprofiling with potholes or without potholes
2	Constant degradation and sensitive to the users	Hard reprofiling with potholes or without potholes
3	Degradation very important	Reloading or rebuilding

Source: [3]

For more information on VIZIRET, please consult the document "Qualification and quantification of the damages of an unpaved road for the planning and monitoring maintenance"[3].

2.2 URDE

URDE® is an application developed in the Hypertext Preprocessor (Php) programming language. According to a series of distressing unpaved roads, this application can process information in real-time, under the French VIZIRET criterion; this considers a series of distressed types, such as deformation and potholes corrugations, longitudinal erosion, and lost material. Distress identified according to condition and gravity levels,arriving at determining the viability index, road condition, and a possible rehabilitation method.

URDE® has two shared interfaces: One preprocessorand one postprocessor. The preprocessor uses data such as deformation in mm, number and average diameter of potholesin mm, deflection of the corrugation distress in mm, longitudinal erosion for the depth in mm, and lost material. For lost material, the software requires the shape of dust during the dry season. The preprocessor of URDE®in English and Spanish for computer and smartphone are shown in Figures 1 to 16. The second mentioned a postprocessor shows the viability index on 100 m, road condition on 100 m, and possible rehabilitation method on 100 m. But when a viability index on 100 m is 3, URDE® shows an additional option, called calculation options. In this case, the software displays the possibility to interact with the design conventional and special of unpaved roads and side drainage design for roads, because the road would be in a very important degradation condition, requiring reloading or rebuilding. The two software are DACE®and SDDRoads®, which can be review in [19][20][21][22]. Specifically, in papers-*Design of unpaved roads with DACE® software-* and -*Side drainage design for roads using SDDRoads®*-.

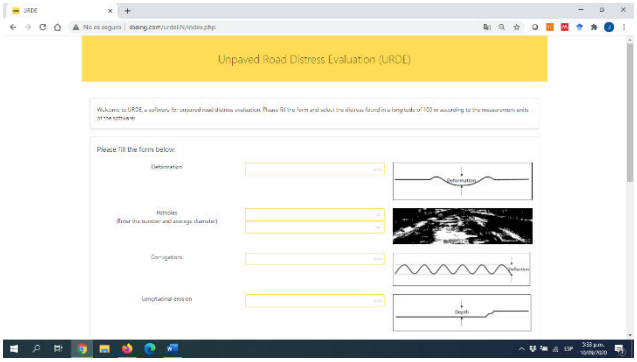

Figure-1. The first part of URDE® preprocess - English language (Computer).

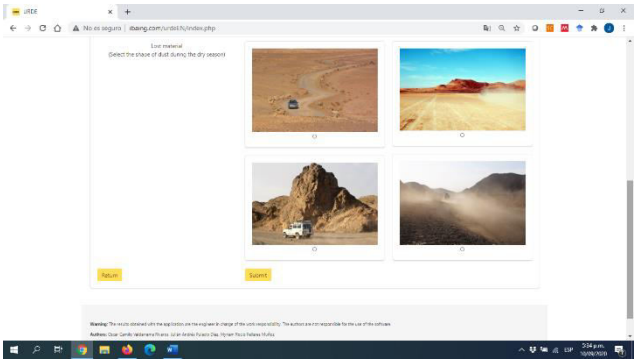

Figure-2. The second part of URDE® preprocess - English language (Computer).

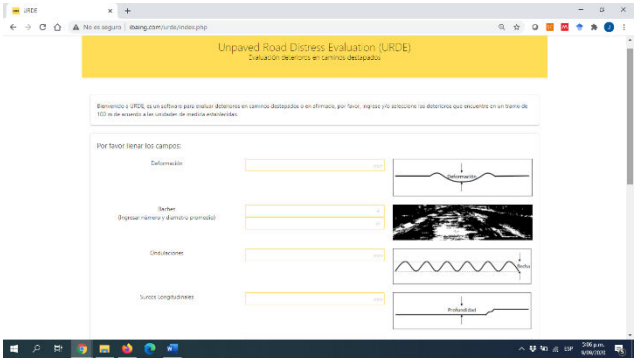

Figure-3. The third part of URDE® preprocess - Spanish language (Computer).

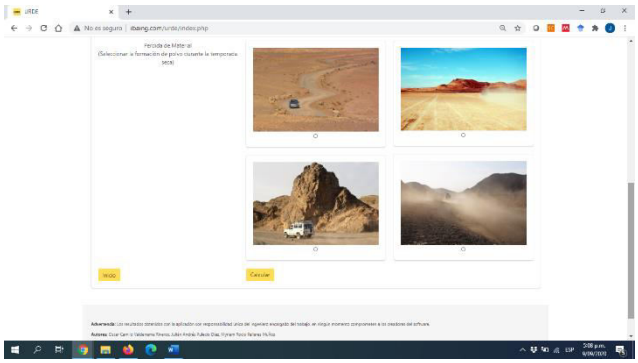

Figure-4. The fourth part of URDE® preprocess - Spanish language (Computer).

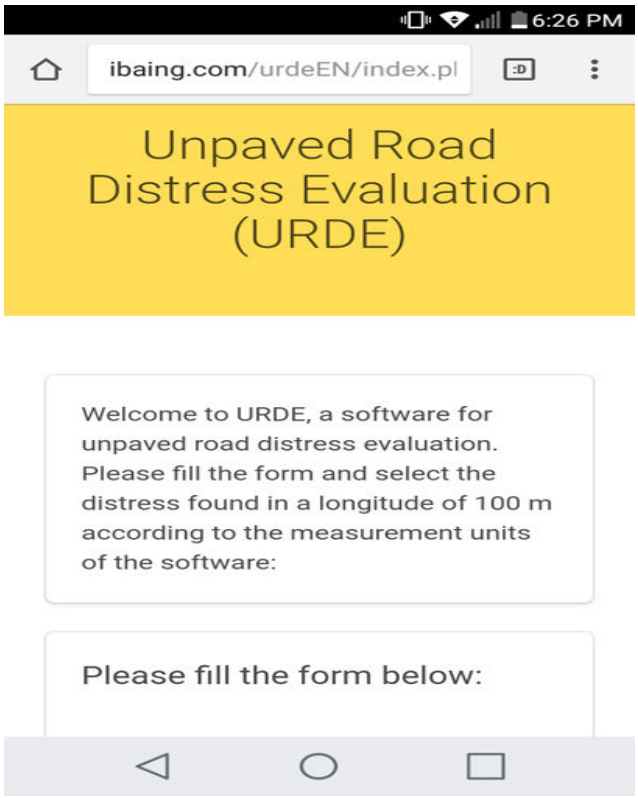

Figure-5. The first part of URDE® preprocess - English language (Smartphone).

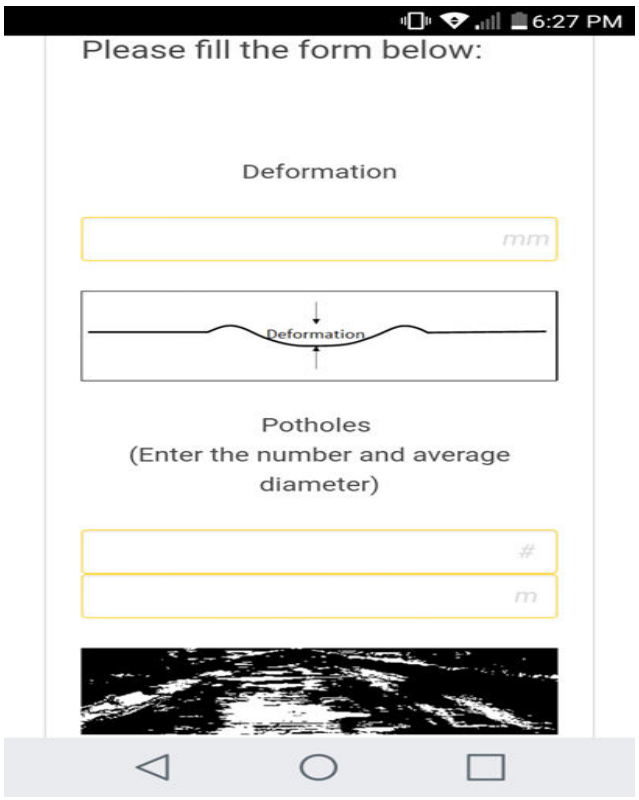

Figure-6. The second part of URDE® preprocess - English language (Smartphone).

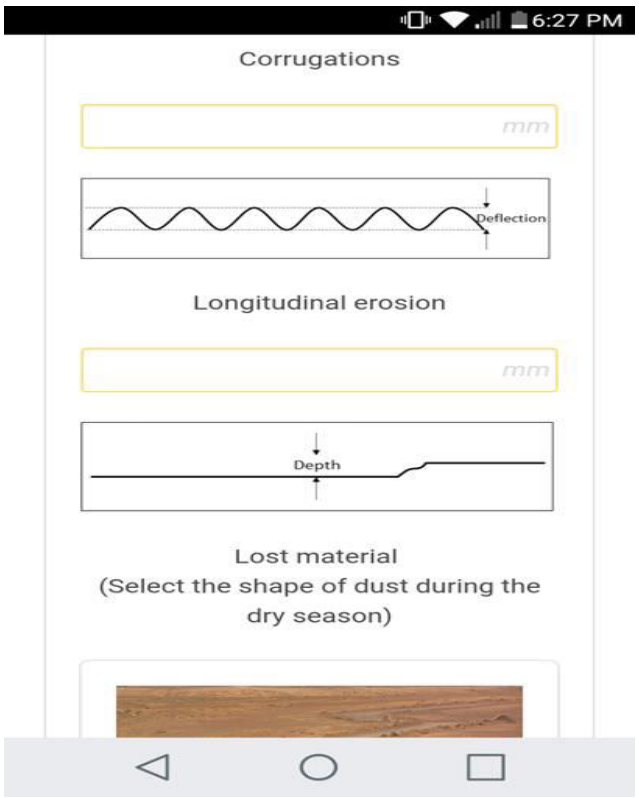

Figure-7. The third part of URDE® preprocess - English language (Smartphone).

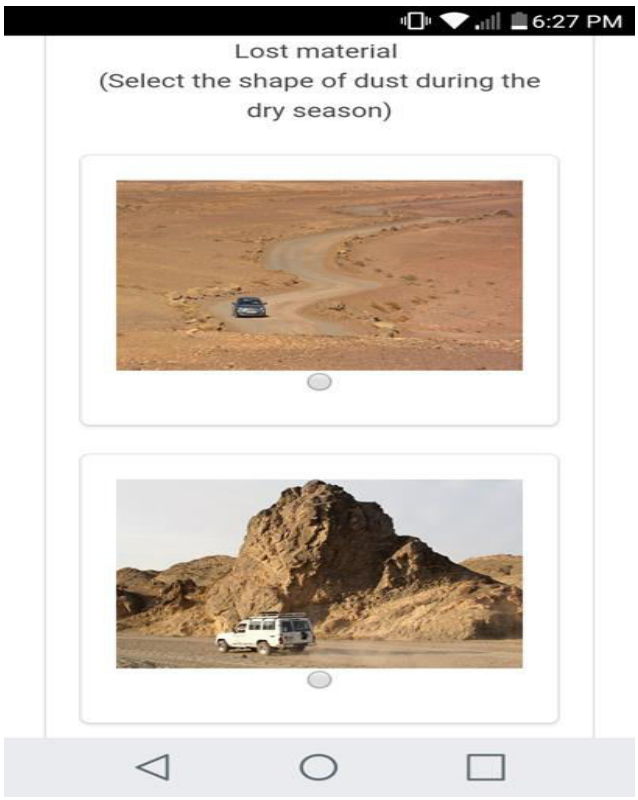

Figure-8. The fourth part of URDE® preprocess - English language (Smartphone).

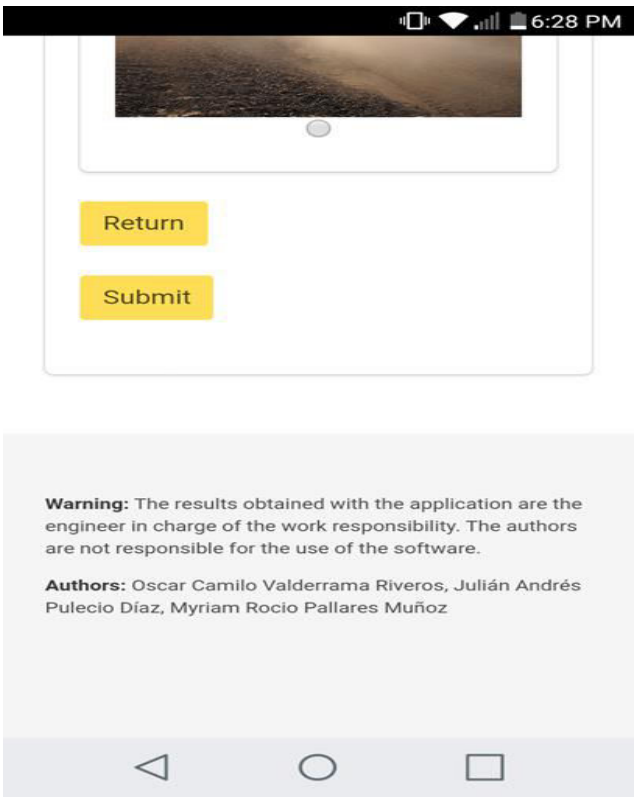

Figure-10. The sixth part of URDE® preprocess - English language (Smartphone).

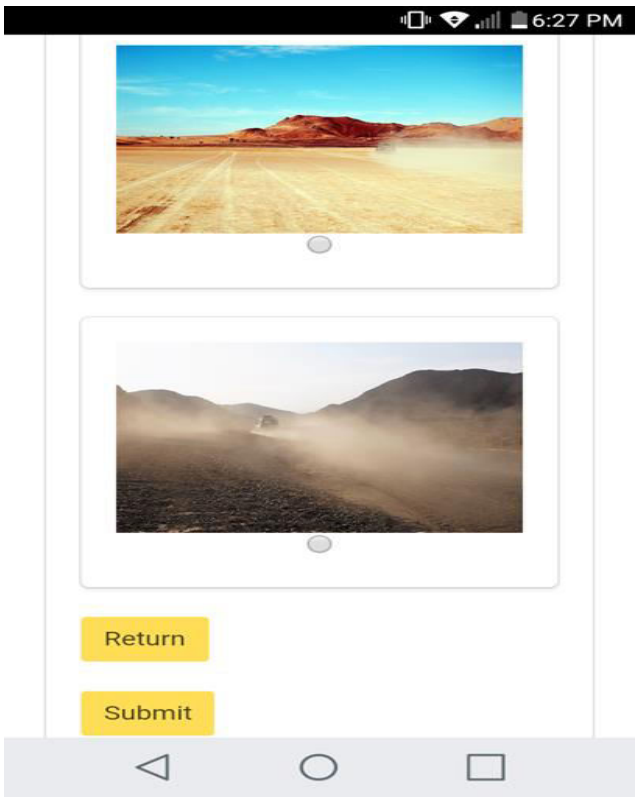

Figure-9. The fifth part of URDE® preprocess - English language (Smartphone).

Figure-11. The first part of URDE® preprocess - Spanish language (Smartphone).

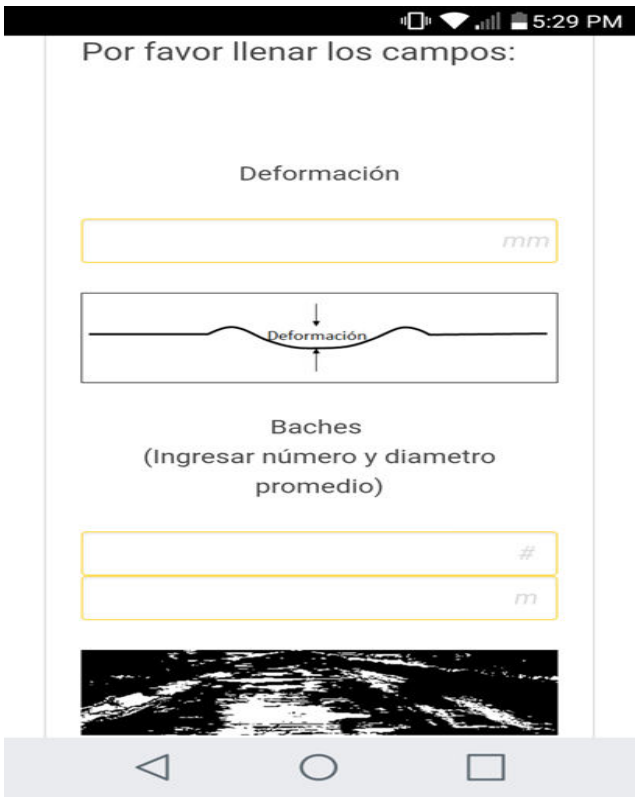

Figure-12. The second part of URDE® preprocess - Spanish language (Smartphone).

Figure-14. The fourth part of URDE® preprocess - Spanish language (Smartphone).

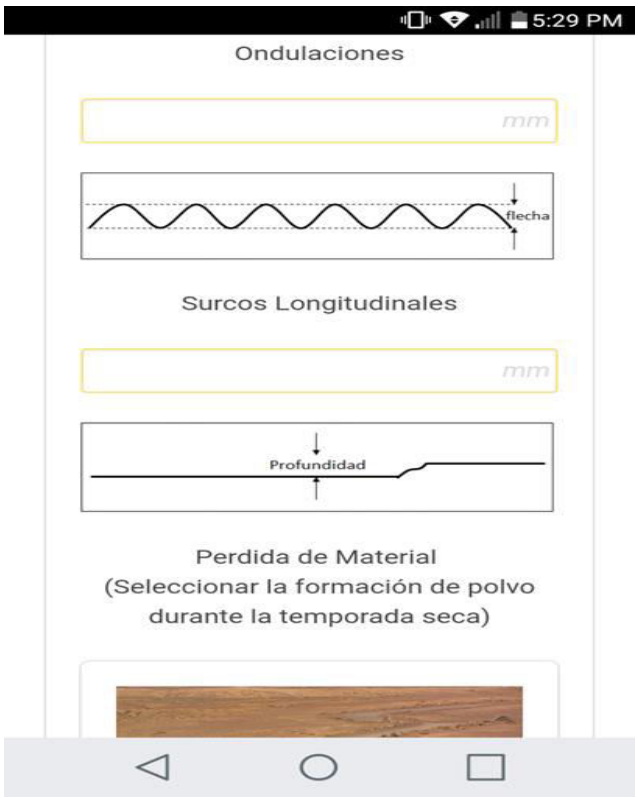

Figure-13. The third part of URDE® preprocess - Spanish language (Smartphone).

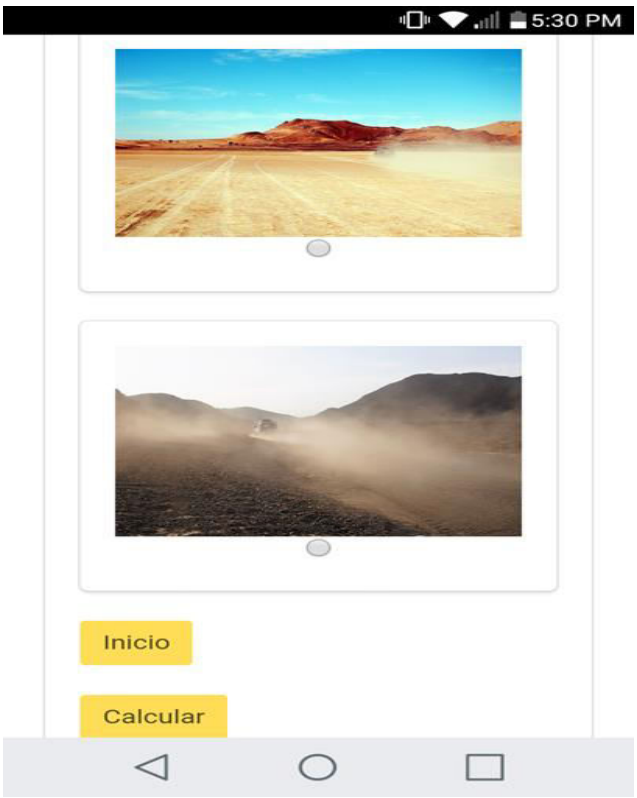

Figure-15. The fifth part of URDE® preprocess - Spanish language (Smartphone).

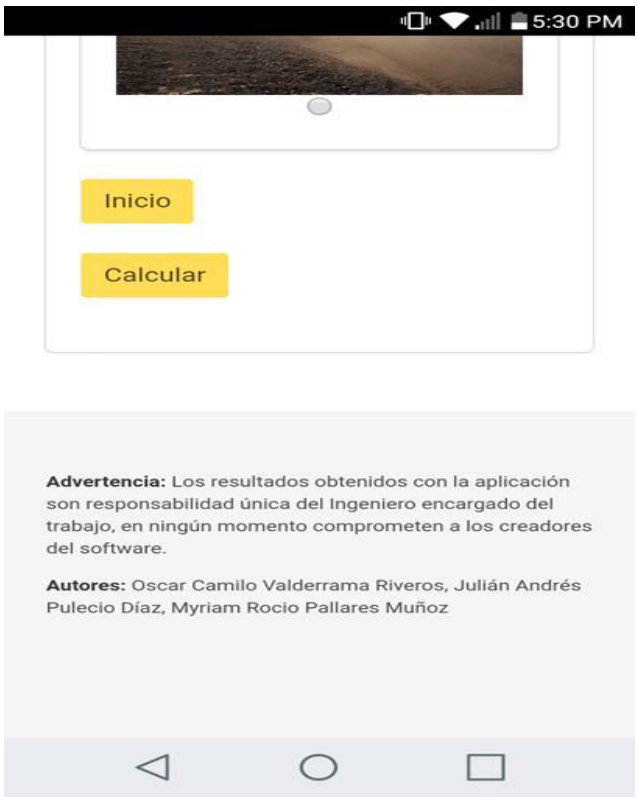

Figure-16. The sixth part of URDE® preprocess - Spanish language (Smartphone).

The English and Spanish computer URDE® preprocessor is shown in Figures 1 to 4.

The URDE® preprocessor in English and Spanish for smartphones is shown in Figures 5 to 16.

Currently, URDE®can be accessed on the Internet by typing in the URL ibaing.com/urdeEN/index.php for English ibaing.com/urde/index.php for Spanish [1]. Contact urdeengineering@gmail.com for more information.

2.3 Use of URDE

The URDE® verification was done with the following study cases according to the VIZIRET method [3]. These exercises estimate the viability index, road condition, and possible rehabilitation method on 100 m. The dataentries are presented in Table-5.

3. RESULTS AND DISCUSSIONS

Table-6 shows results según el VIZIRET method used for verification- and the results obtained with URDE®. The viability index of the road sections using URDE®is equal to the VIZIRET, which shows that URDE® is accurate. The results of URDE® are shown in Figures 17 to 32, both in English and Spanish, for computers and smartphones.

Table-5. Input data for each study case.

Study case	Deformation, mm	Potholes		Corrugations	Longitudinal erosion	Lost material during the dry season
		Number	Average diameter, m	Deflection, mm	Depth, mm	
A	0	0	0	0	0	No dust clouds when vehicles pass
B	40	0	0	19	0	Weak clouds of dust that dissipate quickly and do not cause discomfort to users of other vehicles.
C	0	10	0.45	0	0	Persistent dust clouds that reach the height of a person and obstruct the visibility of a pedestrian.
D	0	0	0	0	150	Weak clouds of dust that dissipate quickly and do not cause discomfort to users of other vehicles.

Table-6. Verification of the results - URDE®.

Study case	Viability index		Variation
	VIZIRET	URDE®	[%]
A	0	0	0 %
B	1	1	0 %
C	2	2	0 %
D	3	3	0 %

URDE® generates the results of the road condition and possible rehabilitation method. Table-7 shows the results of every study cases using URDE®.

URDE®, like many software, needs to be fed with consistent, field-based data to establish reliable results. So, I can suggest a possible rehabilitation method. That is, finally, the response required by the unpaved road management bodies [23].

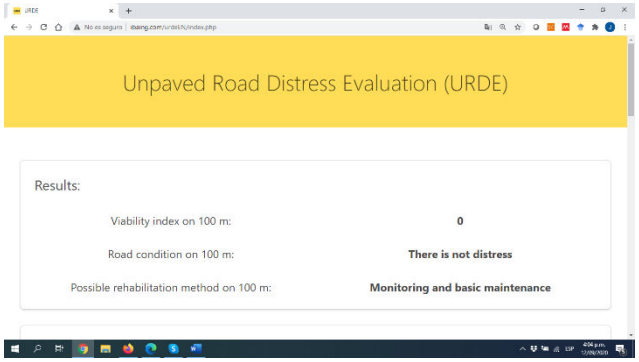

Figure-17. URDE® display output for study case A - English language (Computer).

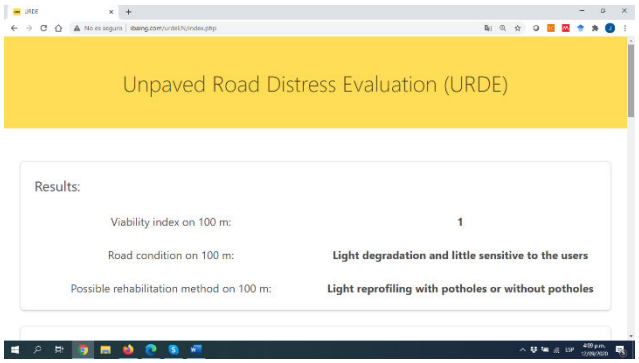

Figure-18. URDE® display output for study case B - English language (Computer).

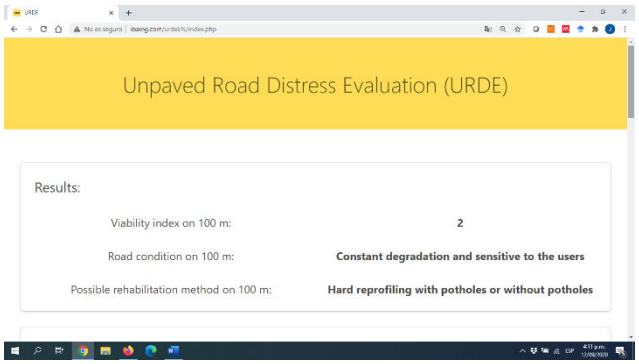

Figure-19. URDE® display output for study case C - English language (Computer).

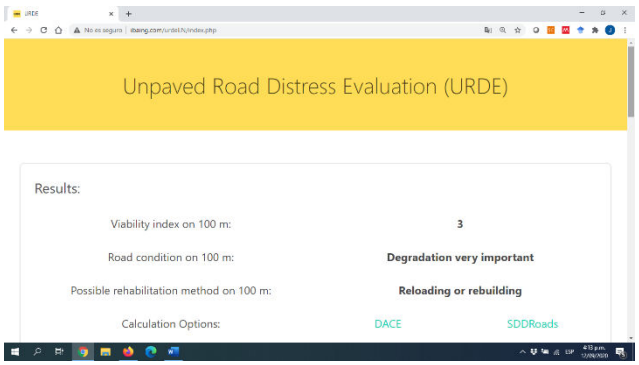

Figure-20. URDE® display output for study case D - English language (Computer)

Table-7. Road condition and possible rehabilitation method according to each study case - URDE®.

Study case	Road condition	Possible rehabilitation method
A	There is not distress	Monitoring and basic maintenance
B	Light degradation and little sensitive to the users	Light reprofiling with potholes or without potholes
C	Constant degradation and sensitive to the users	Hard reprofiling with potholes or without potholes
D	Degradation very important	Reloading or rebuilding

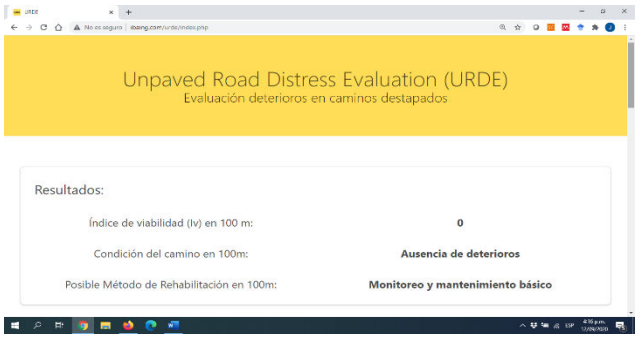

Figure-21. URDE® display output for study case A - Spanish language (Computer).

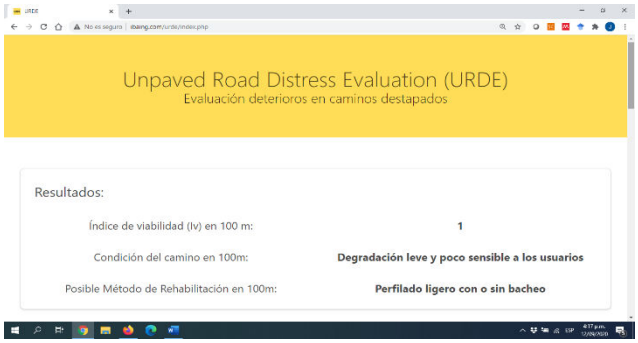

Figure-22. URDE® display output for study case B - Spanish language (Computer).

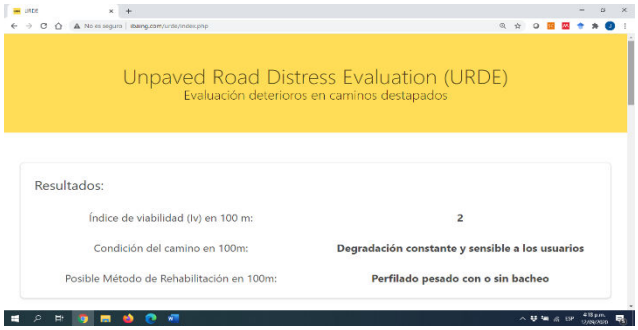

Figure-23. URDE® display output for study case C - Spanish language (Computer).

Figure-24. URDE® display output for study case D - Spanish language (Computer).

Figures 25 to 32 show one of the major contributions of the URDE®, which is observing the viability index results on 100 m of the road by smartphone with road condition, possible rehabilitation method, and calculation options. Finally, finding a compatible tool with any equipment, including a web browser and an internet connection, will reduce the time taken to make decisions in situ [24] [25].

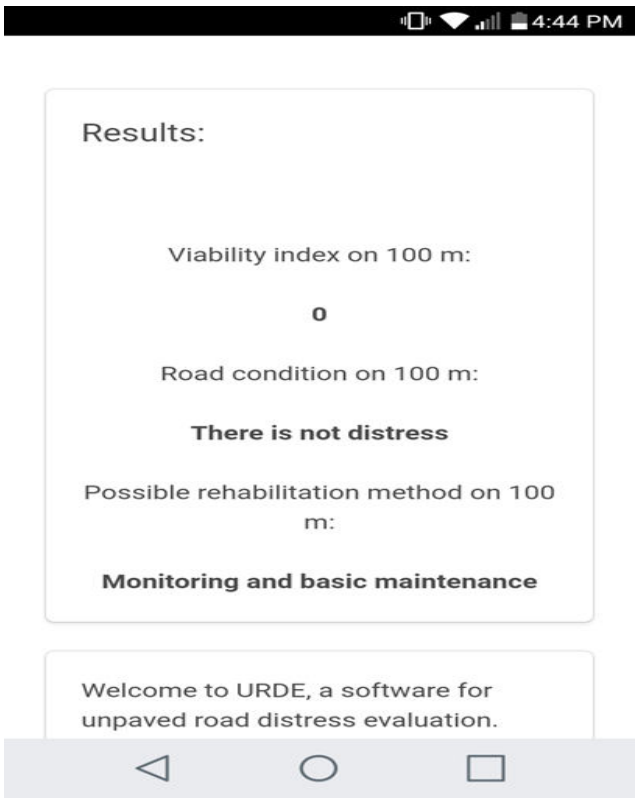

Figure-25. URDE® display output for study case A - English language (Smartphone).

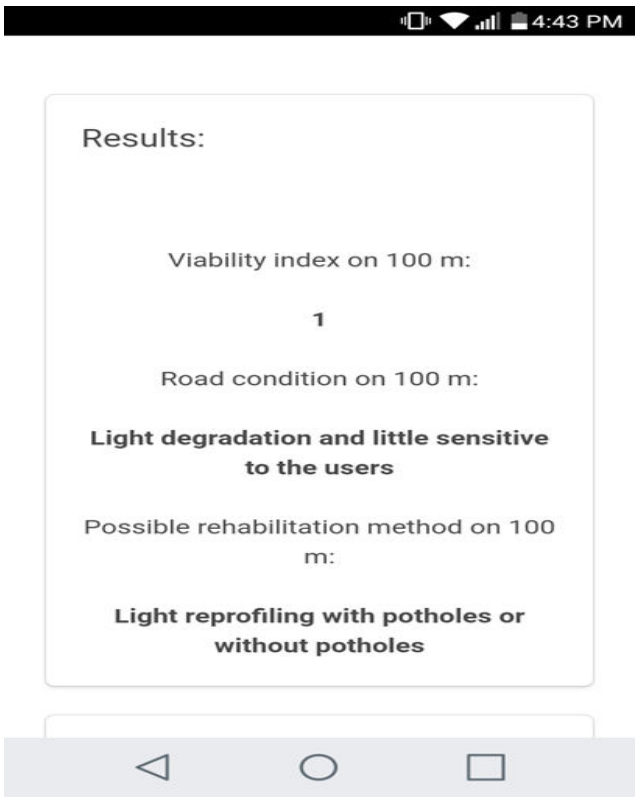

Figure-26. URDE® display output for study case B - English language (Smartphone).

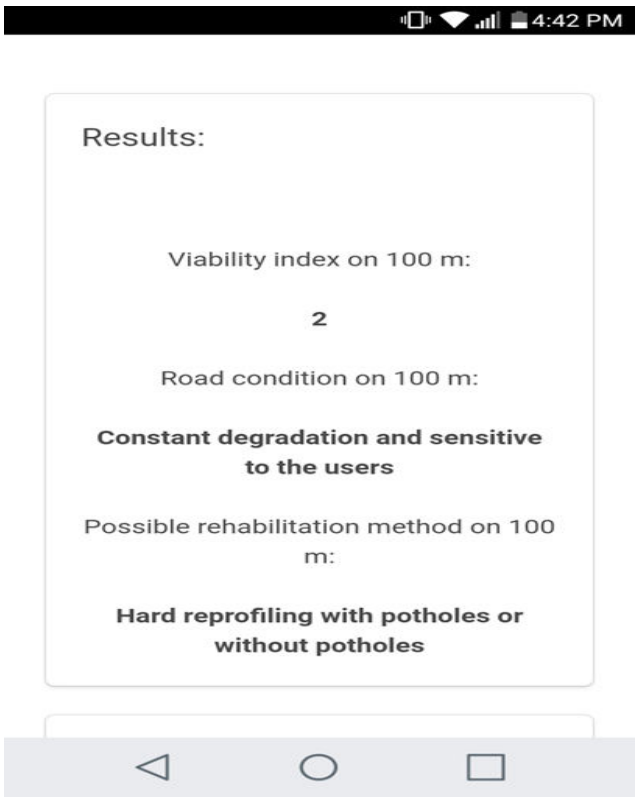

Figure-27. URDE® display output for study case C - English language (Smartphone).

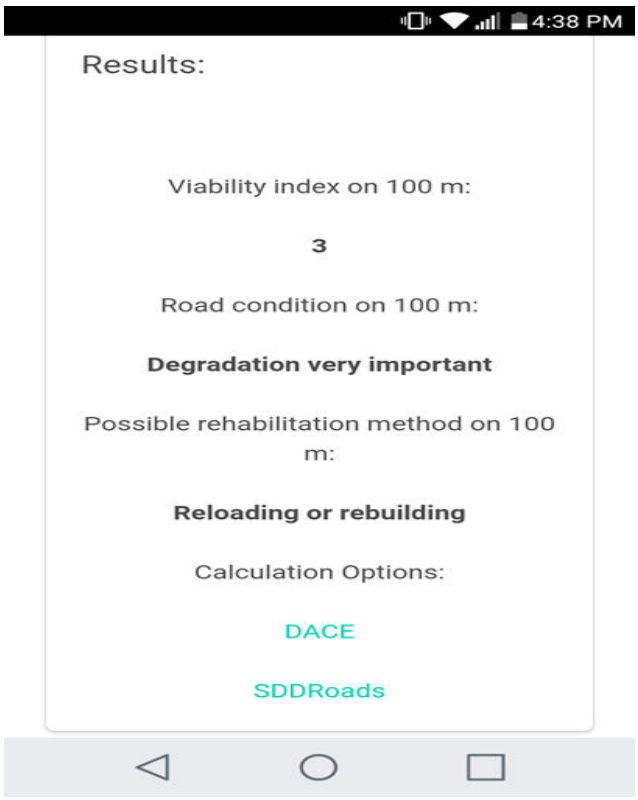

Figure-28. URDE® display output for study case D - English language (Smartphone).

Figure-29. URDE® display output for study case A - Spanish language (Smartphone).

Figure-30. URDE® display output for study case B - Spanish language (Smartphone).

Figure-31. URDE® display output for study case C - Spanish language (Smartphone).

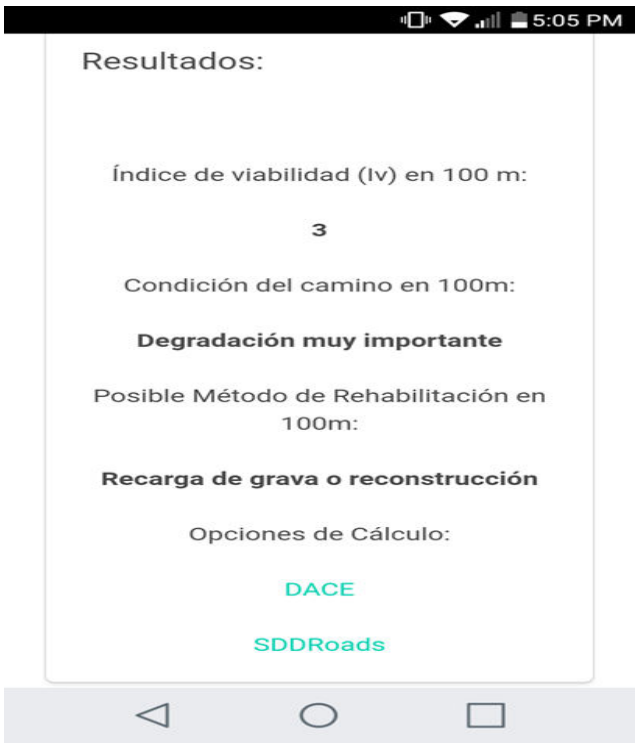

Figure-32. URDE® display output for study case D - Spanish language (Smartphone).

4. CONCLUSIONS

- The Hypertext Preprocessor (Php) as a programming language to develop URDE® lets software be cross-platform since it is a web application and works in all operating systems.
- The results obtained with URDE® were satisfactorily verified against the study cases formulated according to VIZIRET method.
- The viability index, road condition, and possible rehabilitation method on 100 m using URDE® are suitable for reducing the time taken to make decisions in situ.
- URDE®is software that interacts with software DACE® and SDDRoads® for design f unpaved roads and side drainage design for roads; the above, considering the answer of reloading or rebuilding.
- URDE® software demonstrated to be an interesting calculation application to have anywhere in the world where exist same or similar conditions to the VIZIRET method, for its versatility.

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