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FUNCTIONAL EVALUATION OF RURAL HOUSING BASED ON A SEISMICALLY OPTIMIZED PROPOSAL WITH RESPECT TO THE E-080 STANDARD, SHAULLO CHICO BAÑOS DEL INCA

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ABSTRACT: *The purpose of the research carried out is to evaluate the functional state of the houses built with adobe in the Shaullo Chico Village Center, Baños del Inca, Cajamarca, and to quantify the main internal and external deficiencies that may influence their behavior in the event of a seismic event. The methodology used is framed in a non-experimental descriptive approach, applied study design and the sample consisted of 20 houses built with adobe, for which a non-probabilistic sampling was used. Data collection was carried out through detailed observations of each household, and then the Shapiro-Wilk test was applied in the processing of the information. It is important to note that the registered homes were built by the inhabitants of the area themselves, who lacked exhaustive knowledge of building regulations and did not have technical advice during the design and construction process. The processed results reveal the deficiencies identified in the selected homes. Five percent (5%) of the houses showed a deficient condition, characterized by the absence of over foundation in accordance with the E-080 standard, as well as problems of settlement, deformation and cracking in the walls. On the contrary, 95% of the houses presented a regular state, in which some failures and cracks were observed that did not compromise the structural integrity. In particular, the houses in poor condition showed a lack of knowledge in the execution of the construction as established in the E-080 regulation. In conclusion, this study indicates that most of the dwellings in Shaullo Chico, Baños del Inca, Cajamarca, exhibit a functional state classified as regular, with certain deficiencies that do not seriously compromise their structural system.*

KEYWORDS: Functional, condition, adobe.

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INTRODUCTION

The continuous movement of tectonic plates generates seismic movements. Peru is located on one of the most important tectonic plates, Nazca. A constant accumulation of energy by the convergence of plates would generate what can be called telluric movements (Tavera, 2020).

According to Churchill, the activity in the Northern Block of Peru is related to the so-called "Seismic Cycles" given from 1985–2019, so it is expected to present the same deformation mechanisms in what refers to the Northern zone of Peru, which shows the notable risk of our region (Churchill, 2019). Not only does it have a climatologically varied system, it is influenced by different geological phenomena periodically.

Illustration 1: Vulnerability of the Main Cities of Northern Peru

Source: *IGP*

In 1977, under the investigation of the Office of Standardization together with USAID and the Ministry of Housing and Construction in Peru, a research program on stabilized adobe was obtained. It sought to obtain an improvement due to the fact of having an advantage in terms of economy and availability for our population.

The construction processes in our country are largely formulated without technical guidance or knowledge about it and it is precisely for this reason that it limits protection, making it insufficient or null, this generates vulnerability to a disaster. In Cajamarca, adobe constructions have been carried out for a long time, as can be seen in the large houses in the center of the city or in the rural area and surroundings.

Some of the cities in our country have suffered earthquakes that cause not only material losses, but human lives. As evidenced in the IGP (2021) Cajamarca had the most recent presence on July 21, 2021, where a telluric movement with a magnitude of 5.2 and a depth of 25 km was recorded—moderate movements in areas such as the provinces of Jaén, Chota and Cutervo, which indicate how harmful it could be not to foresee an event of greater magnitudes.

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LITERATURE/THEORETICAL UNDERPINNING

According to Peruvian regulations, the designs must be based on the behavior of the material, verifying its seismic behavior and based on the engineering principle, taking special care of the material used for construction (Ministry of Housing, 2017).

Especially in rural areas, houses that are highly vulnerable to earthquakes are built consecutively in adobe due to their low cost, on a soil with low load-bearing capacity and that is potentially slippery. According to the National Institute of Statistics and Informatics (INEI, 2021) with data from 2011 with 34.4%, the manufacture of adobe houses has been decreasing until 2021 with 31%, which may highlight a lag in construction techniques. However, it is important to recognize that the damage in the event of an earthquake could be irreparable, which is why the houses of the C.P Shaullo Chico are taken as research materials since the objective is to determine the functionality of each of them.

The main importance in the research is to guide and inform the population about the level of functionality of their homes, as it is a concern regarding their location, providing a preventive alternative for new constructions and measures for constructions already carried out.

METHODOLOGY

In the framework of this research, the sample will consist of a total of 20 homes located in Shaullo Chico, Baños del Inca, and will be selected through simple and probabilistic random sampling.

The confidentiality of the participants in this study will be strictly respected. The information collected from the 20 homes located in Shaullo Chico, Baños del Inca, will be treated anonymously and without revealing the identity of the owners or inhabitants of the homes. Any personal data or information that may identify the participants will be kept strictly confidential and will only be used for statistical and academic analysis purposes. The results will be presented in an aggregated and generalized manner to protect the privacy of those involved in this study.

Techniques/Instruments

The observation technique was used, which involves the perception of the properties and characteristics of the object of study, encouraging interaction between the observer and the object. To carry out this process, a form designed specifically for the purpose of collecting information on the functionality of the houses located in the Shaullo Chico Population Center, in its original context, was used.

Data Collection Procedures

The present study was carried out through the following phases:

Phase 1: First, an evaluation form for the functionality of the houses was developed, consisting of 11 items. Subsequently, this form was subjected to a validation process in which three experts in the field participated. The observations and suggestions provided by these experts were taken into account to improve the form.

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Phase 2: The evaluation form was used to analyze the functionality of 20 houses in the Shaullo Chico Population Center – Baños del Inca. During the data collection process, specific tools and procedures were applied. These procedures included the use of a topographic level to determine the height of the settlement, measuring each end and center of the houses to verify any differences. In addition, a hand level was used to assess the verticality of the walls and a ruler to measure the distance from the walls.

Regarding soil cohesion, a cohesion strength test was carried out to assess the adhesion of clays and silts. This test consisted of making three discs of 5 cm diameter and 2 cm thickness, which were left to dry for 48 hours and then tested using fingers.

Phase 3: The data collected in the field were subsequently analysed using SPSS version 21. Using this tool, the condition of the houses was examined and a statistical analysis was carried out that included frequency tables and bar graphs to effectively represent the results.

RESULTS/FINDINGS

Table 1: ***Pre-dimensioning According to the Regulations***

Standardized Dimensioning					
	Frequency		Percentage	Percentage valid	Percentage accumulated
Valid	Bad	1	5,0	5,0	5,0
	Regular	19	95,0	95,0	100,0
	Well	0	0,0	0,0	0,0
	Total	20	100,0	100,0	

Note: *Own elaboration in the SPSS program*

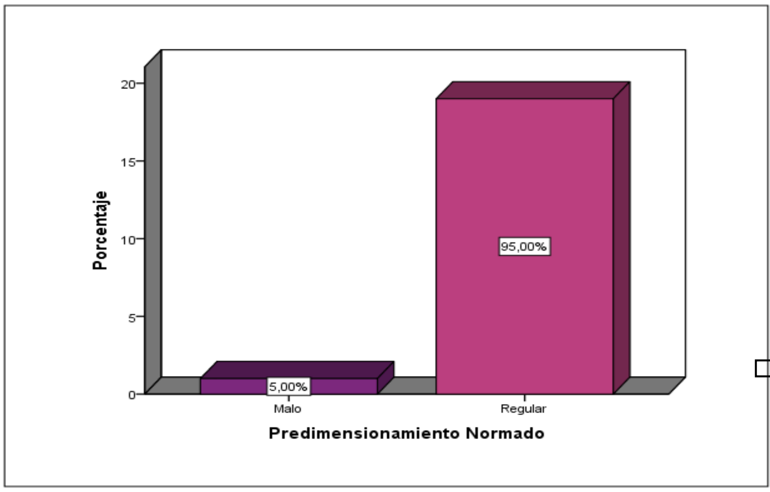

Figure 1: *Resizing According to the Regulation*

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Table 1 and Figure 1 provide a detailed overview of the evaluation of adobe housing in the Shaullo Chico Primary School. The results reveal that 5% of these homes obtained a rating of "bad" in terms of geometric pre-dimensioning, which indicates significant deficiencies in their structure. In contrast, 95% of the homes were classified as "fair," pointing out that most of them have deviations from the criteria of the E-080 regulation in this regard. Notably, no housing was classified as "good," suggesting that although some of them may maintain an acceptable functional state, they still have structural defects and do not fully meet regulatory standards. These results underscore the need to address deficiencies in geometric pre-dimensioning to improve the seismic resistance of homes in this area, where factors such as adobe durability and other construction aspects can also influence their functionality.

Table 2: *Overarching According to the Regulations*

Normative Overclogging					
	Frequency		Percentage	Percentage valid	Percentage accumulated
Valid	Bad	5	25,0	25,0	25,0
	Regular	15	75,0	75,0	100,0
	Well	0	0,0	0,0	0,0
Total		20	100,0	100,0	

Note: *Own elaboration in the SPSS program*

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Figure 2: *Overcrowding According to the Regulations*

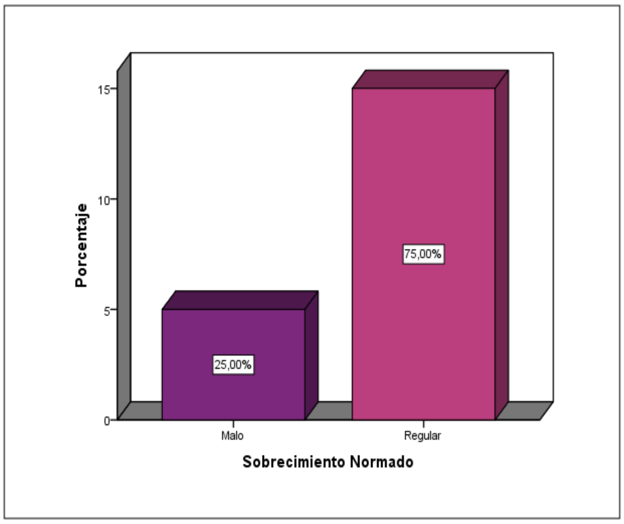

Table 2 and Figure 2 present the results of the evaluation of the over-foundation in adobe houses in the Shaullo Chico Primary School. The data reveals that 25% of the homes were rated as "poor" due to the absence of overhang, raising significant concerns in terms of safety and structural stability. On the other hand, 75% of the homes received a rating of "fair," which indicates that the vast majority have deviations from the dimensions of overhang required by the E-080 standard. Notably, no homes were found that fully met the "good" criteria. This situation represents a risk not only for the inhabitants of the area, but also for those who live in areas near the houses that do not meet the standards, since the lack of overhang and irregular dimensions can compromise seismic resistance and structural safety.

Table 3: ***Settlement of the House***

Settlement				
Frequency		Percentage	Percentage valid	Percentage accumulated
Bad	5	25,0	25,0	25,0
Regular Valid	15	75,0	75,0	100,0
Well	0	0,0	0,0	0,0
Total	20	100,0	100,0	

Note: *Own elaboration in the SPSS program*

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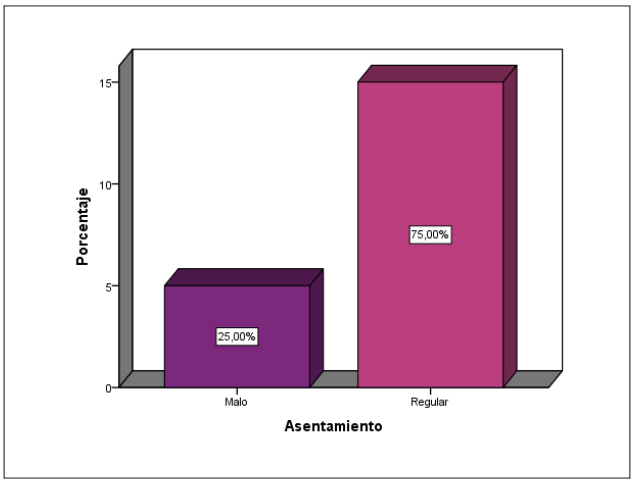

- **Figure 3:** *Settlement in housing*

In Table 3 and Figure 3, the results indicate that most of the dwellings experience moderate settlement, with 75% of them classified as "regular." Although 25% of the homes show a significant settlement and were rated as "bad," it is relevant to highlight the absence of homes with a rating of "good." These findings suggest that, despite the challenges inherent in the settlement in the area, most of the dwellings have maintained a stable structure and reasonable security, considering the forces exerted on the ground and compliance with the regulations of occupation of the territory. In summary, the benchmark-based assessment methodology has provided accurate data to record and understand the structural changes experienced by the majority of the assessed homes.

- **Table 4:** ***Material Quality***

Material Quality					
	Frequency		Percentage	Percentage valid	Percentage accumulated
Valid	Bad	0	0,0	0,0	0,0
	Regular	20	100,0	100,0	100,0
	Well	0	0,0	0,0	0,0

Note: *Own elaboration in the SPSS program*

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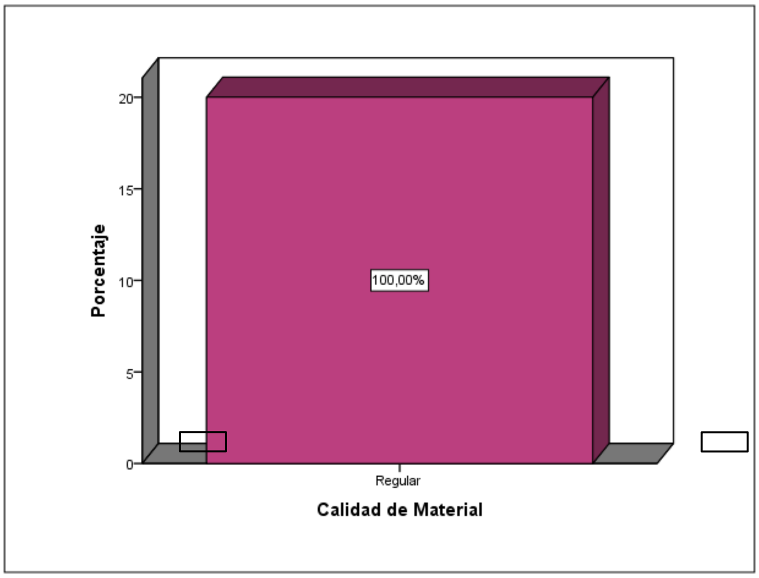

Figure 4: *Material Quality*

In Table 4 and Figure 4, we can observe and analyze that the adobe houses in the Shaullo Chico P.P. have been evaluated in terms of the quality of the material used. The results reflect a univocal trend, as 100% of the homes are in the 'fair' category, while none obtained a 'good' or 'bad' rating. This evaluation was based on a variety of parameters, including detailed visual inspection, tapping tests to assess hardness, water sensitivity to verify moisture resistance, color analysis for uniformity, and confirmation of the absence of contaminants. These results suggest that, although the quality of the material was considered acceptable, it did not reach the best quality standards. However, regarding the quality of the material of the houses, which are made up of adobe walls, sedimentation and other materials, it can be concluded that they provide a safe place to live, complying with the control points and acceptance criteria required by the regulations to guarantee their usefulness and useful life as time goes by.

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Table 5: ***Verticality of Walls***

Verticality of Walls				
Frequency		Percentage	Percentage valid	Percentage accumulated
Bad	5	25,0	25,0	25,0
Regular Valid	15	75,0	75,0	100,0
Well	0	0,0	0,0	0,0
Total	20	100,0	100,0	

Note: *Own elaboration in the SPSS program*

Figure 5: *Verticality of Walls*

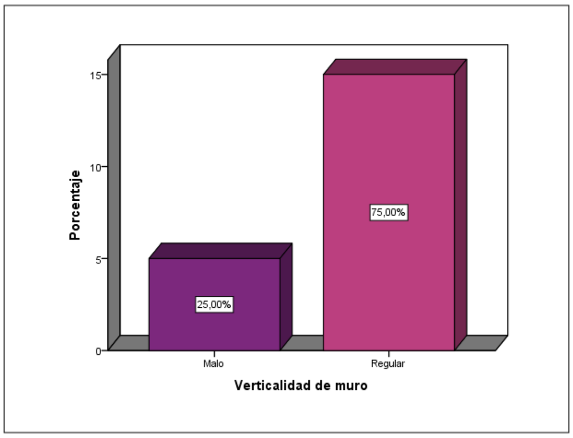

Table 5 and Figure 5 show the results of the evaluation of the verticality of the walls in the adobe houses in the Shaullo Chico Primary School. These results indicate that 25% of the houses evaluated presented a "bad" state in terms of the verticality of their walls, which suggests the existence of notable inclinations that represent a potential risk. On the other hand, 75% of the homes were rated as "fair," indicating a slight slope that does not significantly compromise the structure. It is important to note that no homes were found with walls rated as "good."The evaluation of verticality was carried out through detailed visual inspection and measurement tools, such as spirit levels, following specific qualification criteria based on construction and safety standards. These results reflect the presence of certain inclinations and cracks in the walls of adobe houses, possibly due to the lack of support in the foundation and the aging of the material since its construction, which underlines the importance of carrying out structural evaluations and corrective measures when necessary to guarantee the safety and stability of the buildings.

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Table 6: ***Quality of Joints in the Dwelling***

Gasket quality				
Frequency		Percentage	Percentage valid	Percentage accumulated
Bad	1	5,0	5,0	5,0
Regular Valid	19	95,0	95,0	100,0
Well	0	0,0	0,0	0,0
Total	20	100,0	100,0	

Note: *Own elaboration in the SPSS program*

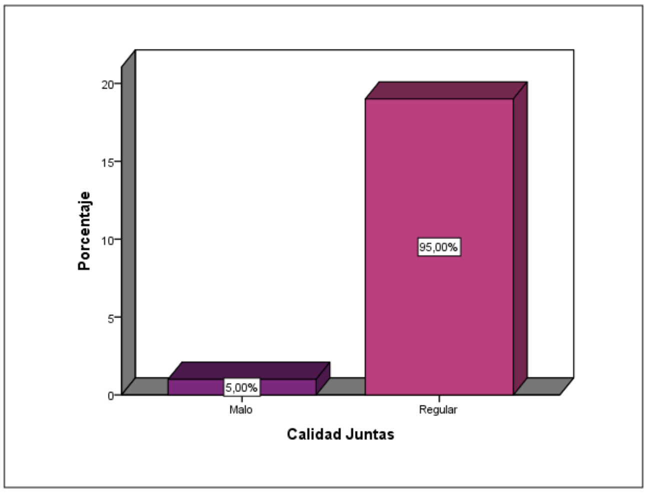

Figure 6: *Quality of Joints in Housing*

In the evaluation of the quality of the joints in the adobe houses in the Shaullo Chico Shopping Center, a rigorous process of visual inspection and detailed analysis of the characteristics of the joints was carried out. The results, as reflected in Table 6 and Figure 6, reveal a significant distribution in the quality of the joints. In this evaluation, 95% of the homes were classified as "fair" in terms of the quality of the joints, indicating the presence of some irregularities such as holes generated by the force that maintain stability and prevent the formation of cracks, crevices or significant spaces. However, 5% of homes received a "poor" rating in this category, pointing to weak joints that could put the stability of the structure at risk. Surprisingly, no homes were found with joints rated as "good," suggesting the need to implement better construction and maintenance practices to achieve solid, well-built joints. This evaluation was based on thorough visual inspection, joint consistency, pressure testing, and a detailed photographic record. These results emphasize the importance of addressing the joints between

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adobes to control deformations and maintain the safety and durability of adobe houses over time.

- **Table 7:** ***Collapse of Walls***

Wall collapse				
Frequency		Percentage	Percentage valid	Percentage accumulated
Bad	1	5,0	5,0	5,0
Regular Valid	19	95,0	95,0	100,0
Well	0	0,0	0,0	0,0
Total	20	100,0	100,0	

Note: *Own elaboration in the SPSS program*

- **Figure 7:** *Wall Collapse*

In Table 7 and Figure 7, it can be seen that the evaluation of the presence of collapse in the walls of the adobe houses in the Shaullo Chico P.P. revealed that 95% of the houses were classified as "regular," which indicates that there have been partial collapses in some walls without endangering the general integrity of the houses. In contrast, 5% of the homes were rated "poor," suggesting the occurrence of complete collapses in one or more walls, posing a significant risk to structural safety. No homes with a "good" rating were identified in this category. This assessment was based on a thorough visual observation of the presence or

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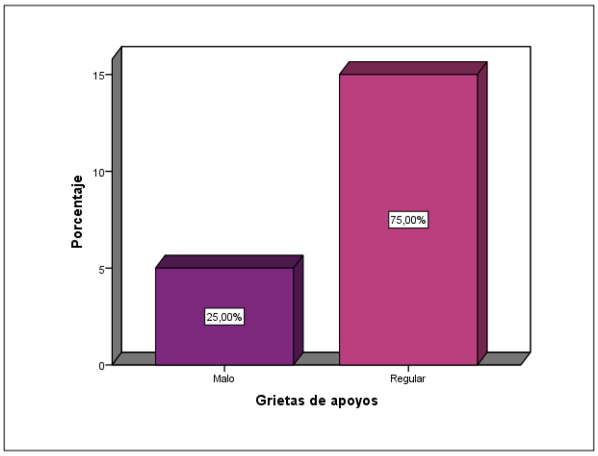
absence of collapse, together with an analysis of structural stability. These results indicate that most of the houses in the C.P. Shaullo Chico have maintained their structural integrity in terms of wall collapse, which is essential for the safety of the inhabitants and highlights the importance of implementing preventive measures to avoid future collapses.

Table 8: ***Cracks in Supports***

Cracks in Supports				
Frequency		Percentage	Percentage valid	Percentage accumulated
Bad	5	25,0	25,0	25,0
Regular Valid	15	75,0	75,0	100,0
Well	0	0,0	0,0	0,0
Total	20	100,0	100,0	

Note: *Own elaboration in the SPSS program*



- **Figure 8:** *Cracks in Supports*

In Table 8 and Figure 8, we can observe and analyze that the adobe houses in the Shaullo Chico P.P. present a worrying evaluation in terms of the presence of cracks in the support points. The results reveal that 25% of homes are rated as "poor" when it comes to cracks, indicating the presence of significant cracks that pose a potential risk to housing stability. On the other hand, 75% of the homes are rated as "fair," pointing to the existence of small cracks that, while not significantly compromising the structure at this time, could worsen over time if not properly addressed. No homes with a rating of "good" were found in this category. These findings highlight the importance of taking immediate action to address cracks in adobe housing support points and ensure the safety and durability of structures over time. The evaluation of the cracks was based on a rigorous visual inspection process and established criteria that distinguished

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between small and significant cracks, considering various causes such as expansion, dampness, quality of materials and project execution, among other factors that can affect the structural integrity of the homes.

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Table 9: ***Quality of Wood in the House***

Wood quality				
Frequency		Percentage	Percentage valid	Percentage accumulated
Bad	1	5,0	5,0	5,0
Regular Valid	19	95,0	95,0	100,0
Well	0	0,0	0,0	0,0
Total	20	100,0	100,0	

Note: *Own elaboration in the SPSS program*

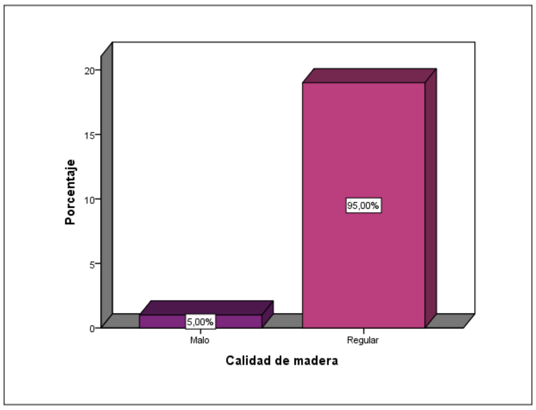

Figure 9: *Quality of Wood in the House*

In Table 9 and Figure 9, 95% of the dwellings were rated as "fair" in terms of the quality of the wood used, suggesting that the quality of the wood is acceptable but not optimal. However, 5% of the homes received a rating of "poor" in this category, noting the presence of low-quality or deteriorated wood in the beams, posing a significant risk to the safety and stability of the homes. Surprisingly, no homes with a "good" rating were found in this category. These results highlight the urgent need to address and improve the quality of the wood used in the beams of adobe houses in the area, since the current conditions expose the structures to humidity and deflections, which could be due to both the age and the quality of the material. This assessment was based on a detailed visual inspection of the timber components in the dwellings.

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Table 10: *Roof Collapse*

Roof collapse				
Frequency		Percentage	Percentage valid	Percentage accumulated
Bad	1	5,0	5,0	5,0
Regular Valid	19	95,0	95,0	100,0
Well	0	0,0	0,0	0,0
Total	20	100,0	100,0	

Note: *Own elaboration in the SPSS program*

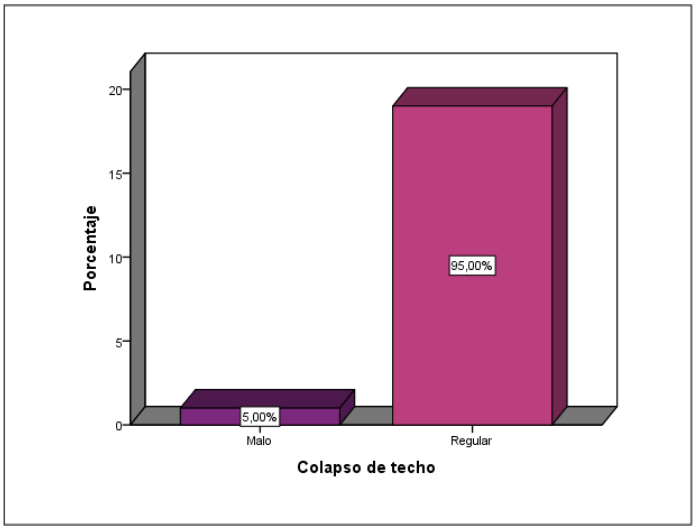

Figure 10: *Collapse in the Roof*

In Table 10 and Figure 10, the results indicate a generally positive situation. Most of the homes earned a rating of "fair" regarding the condition of the roofs, indicating the presence of some signs of displacement or minor damage to the roofs, although there were no cases of partial or complete collapse on any roof, accounting for 95% of the homes evaluated. These results are encouraging as they suggest that adobe dwellings in the area have largely withstood the challenges of weather and climatic conditions, with a minor damage that does not compromise their stability. However, the remaining 5% of the homes had collapses in their roofs, which can be attributed to factors such as abandonment, weather disasters, lack of maintenance actions due to economic limitations and the absence of previous studies to guarantee structural safety. These cases of roof collapse underscore the importance of prevention and proper maintenance

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of adobe housing in the area, as well as the need to consider restoration and structural reinforcement measures to ensure the safety of the inhabitants.

Data Normality Test

For the functional status of the homes that could be evaluated, the Shapiro Wilk test was performed, which is used for tests with a sample of less than 50.

Table 11: ***Data Normality Test***

	Shapiro-Wilk		
	Statistical	Gl	Gis.
Cracks supports	,544	20	,000
Wall collapse	,236	20	,000
Roof collapse	,236	20	,000
Standardized Dimensioning	,236	20	,000
Normative Overclogging	,544	20	,000
Settlement	,544	20	,000

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Vertical wall	,544	20	,000
Quality joints	,236	20	,000
Wood quality	,236	20	,000

For the Normality Test, the data collected to process it by Shapiro Wilk was taken into account, which is designed to analyze data < to 50 samples; we deduce that it does not have a normal distribution, so we used a non-parametric test.

According to the chi-square, our level of significance turns out to be p-value < 0.02, which leads us to conclude that the structural state of the adobe houses in Shaullo Chico, Baños del Inca is regular.

DISCUSSION

The results obtained in the present research support previous findings, such as those presented by Adriana Marcela Ríos Lázaro in her study entitled "El bahareque y el adobe como técnica constructiva sismo-resistente" (2021). In this study, the main objective was to analyze the effectiveness of adobe and bahareque as raw materials in earthquake-resistant construction. A descriptive-documentary methodology was used that involved comparisons with various earthquake-resistant materials. The conclusions highlighted aspects such as costs, utilities, durability, resistance and aesthetics, highlighting that these traditional techniques have evolved over time and remain a viable construction option due to their low cost.

Likewise, Ríos (2020) explored the process of improving common adobe in her study "Process for the Improvement of Adobe." The main objective of this work was to describe how common adobe can be improved physically and mechanically by adding sand, lime and cement. This is done with the purpose of obtaining a material that can be used to revitalize the traditional construction system of vernacular buildings.

Both investigations highlight the importance of factors such as the verticality of the walls and the quality of the material, crucial aspects for the houses studied in this research. The aim is to determine the safest form of construction, either using adobe or applying other techniques, such as bahareque, which are attractive options due to their affordable cost and the quality of the material, as evidenced in Table 4 of our study. It is highlighted that adobe is positioned as a high-quality material in 100% of the houses in the Shaullo Chico Population Center, as illustrated in Figure 4.

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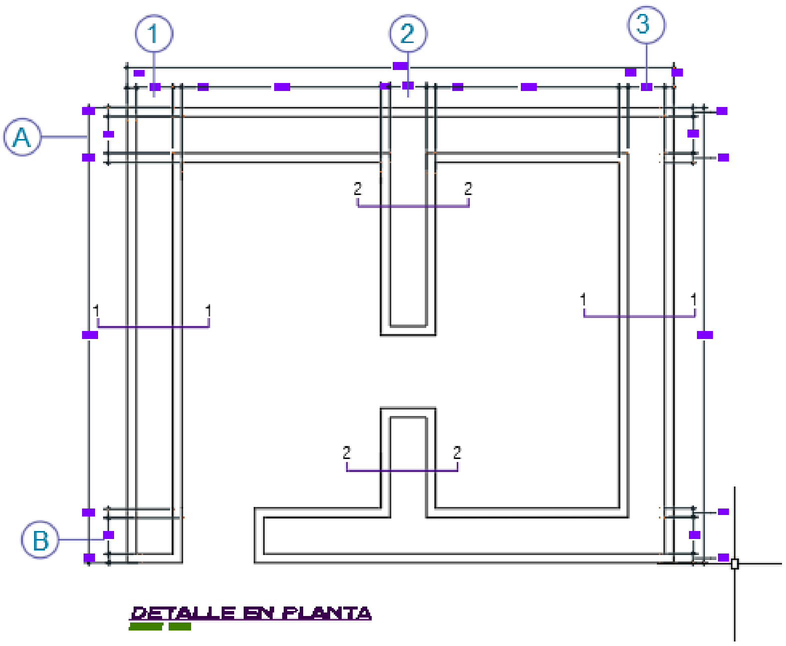
IMPLICATION TO RESEARCH AND PRACTICE

Resilient Seismic Module

The structure of the 30 m² housing for the Sierra focused on the rural area, considering a single level for its distribution since most of the houses observed had a single floor. Using an adobe of dimensions 0.4 x 0.4 x 0.1, Considering

From the analysis, we can conclude that adobe walls of 0.40 m x 0.40 m x 0.10 m thick of a single floor will withstand shear forces and vertical loads for the zoning to which Shaullo Chico Zone 3 belongs on the map, according to the E 0.80 standard.

- **Figure 11:** *Plan of the Model House*



Source: Own elaboration

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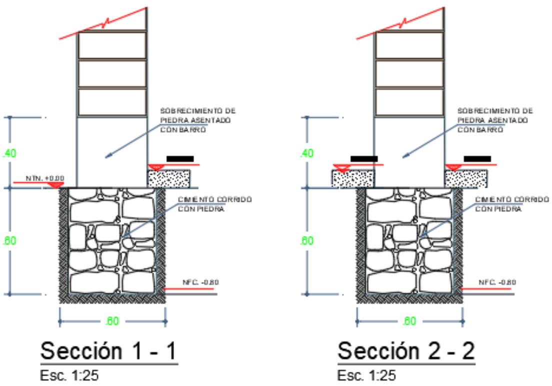
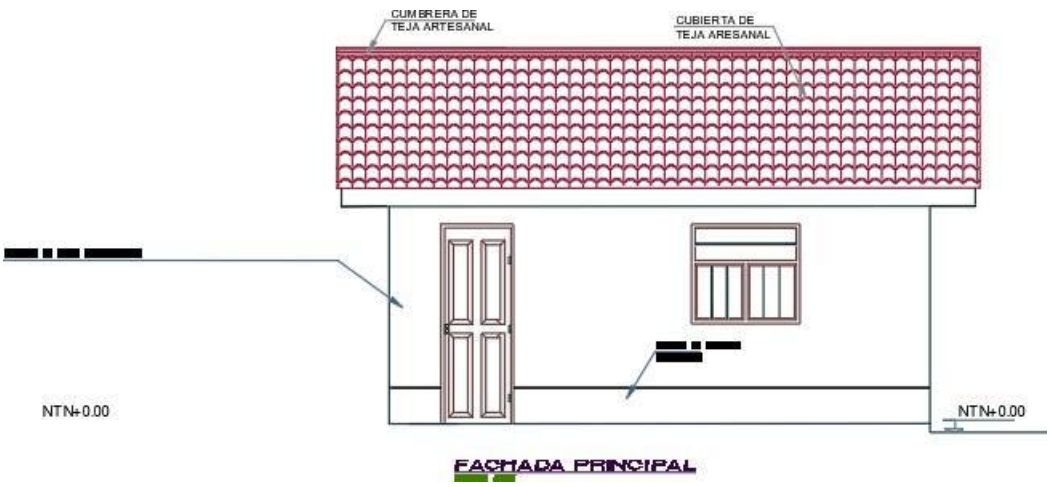


Illustration 3: *Overclogging Detail*

Source: Own elaboration

Figure 12: *Main Façade of the House*



Source: Own elaboration

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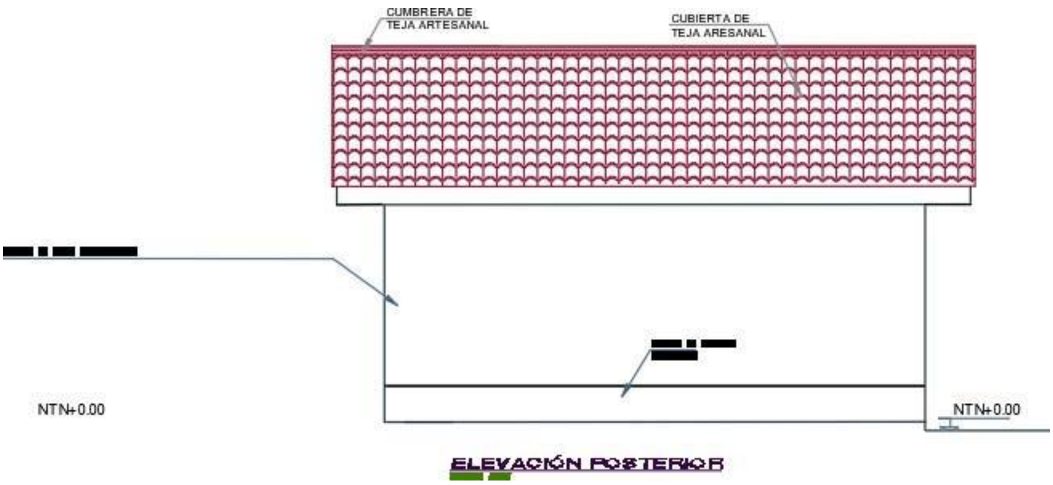
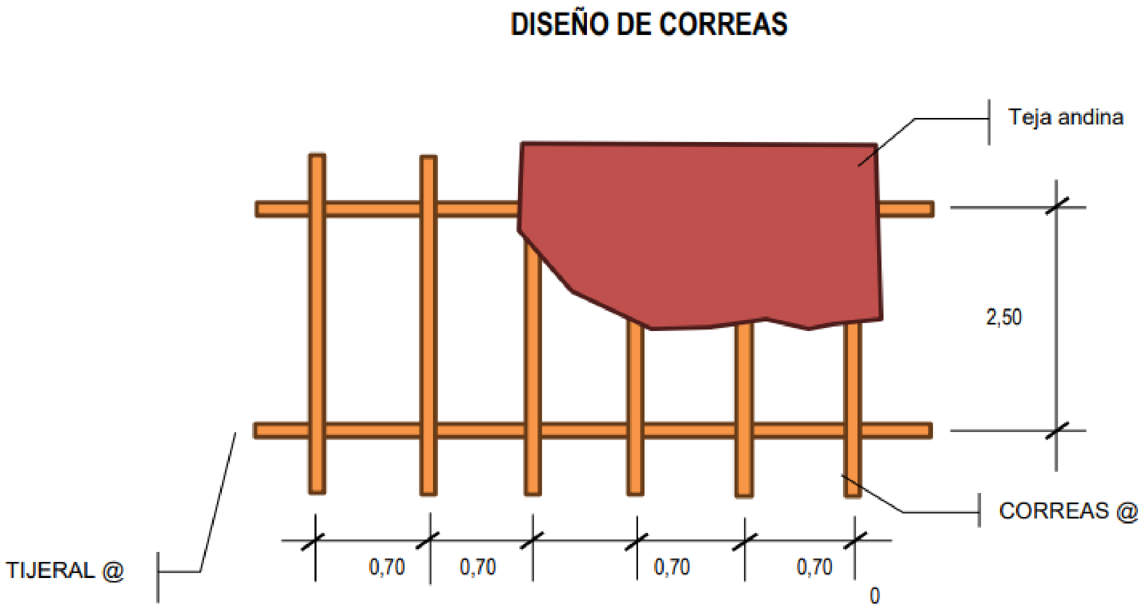
Figure 13: *Posterior Elevation*



Source: Own elaboration

Figure 14: *Strap Design*



Source: Own elaboration

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Figure 15: *Scissor's Design Details*

1.- BASES DE CALCULO

a). Se usará madera del grupo C, en estado seco

b(cm)=	6,40	Ancho de la correa	Peso espcif (gr/cm3)	0,45
h(cm)=	1,50	Peralte de la correa		
L(mt)=	2,50	Luz de cálculo		
S(mt)=	0,70	Separación de correas		

b). Deflexión máxima

Para carga total $\nabla max \leq \frac{L}{250}$ Admisible

Para sobrecarga solamente $\nabla max \leq \frac{L}{350}$

Se sabe:
deflexion por flexion
Δf = 5WL^4/(384EI)

deflexion por corte
Δc = 1.2WL^2/(8GA)

Δtotal = Δf + Δc

c). Esfuerzos admisibles

Eprom=	90000,00	kg/cm2
Fmadm=	110,00	kg/cm2
Fvadm=	8,80	kg/cm2
Fcadm=	10,00	kg/cm2

El G (modulo de corte) en direcciconde las fibras de la madera es

G = 1/16E a 1/25E

Source: Own elaboration

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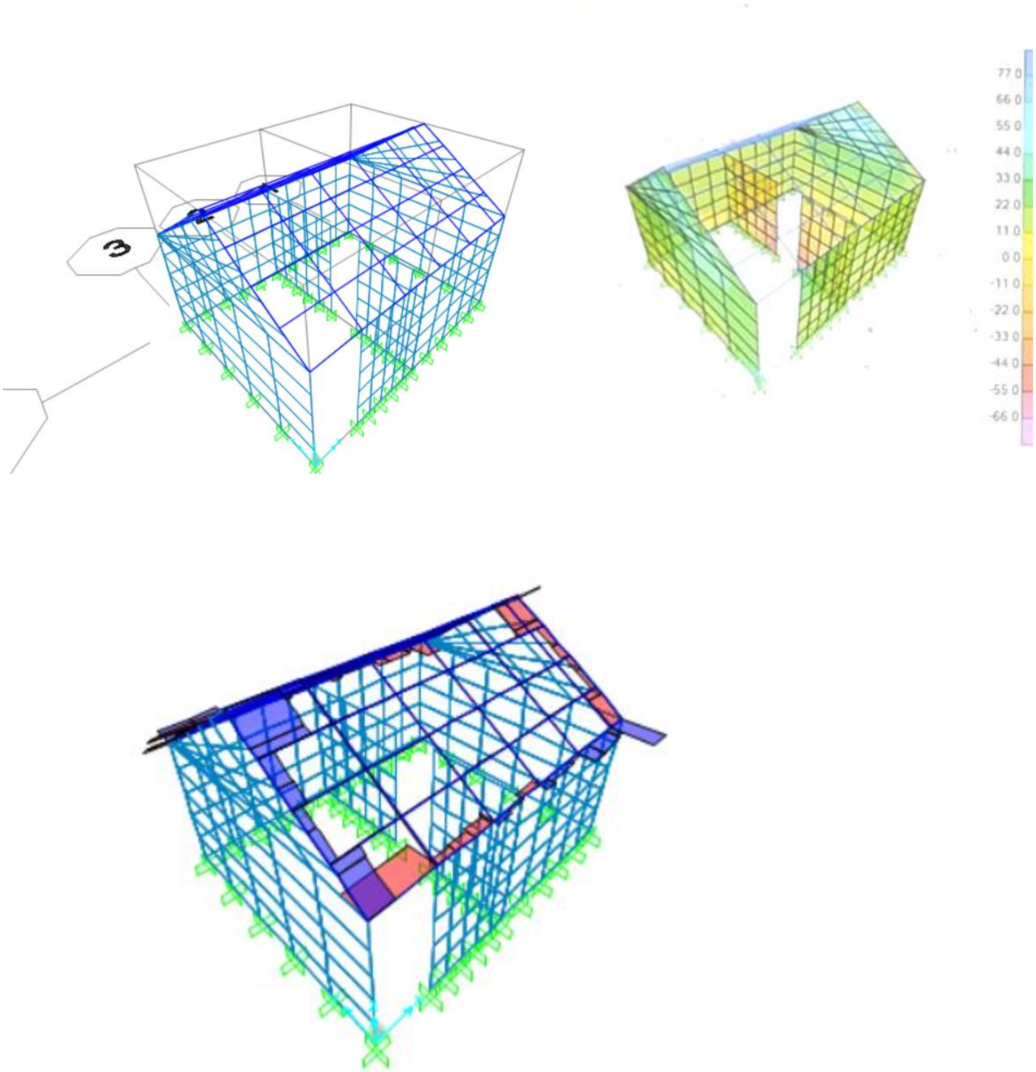

Illustration 4: *Wall Modeling In the SAP2000 Program*

Board 1: Comparative Results of the Analysis in SAP2000

VARIABLES	**MAXIMUM VALUES**	**RESISTANCES MAXIMUM**
SHEAR FORCES IN THE DIRECTION OF X-X	+/- 0.40kgf/cm2	Ultimate stress +/- 0.25 kgf/cm2
SHEAR FORCES IN THE Y-Y DIRECTION	+/- 0.40kgf/cm2	Ultimate Stress +/- 0.25kgf/cm2

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TENSILE EFFORTS IN THE DIRECTION OF X-X	+/- 1.0Ton/m	3.0Ton/m
TENSILE EFFORTS IN THE Y-Y DIRECTION	+/- 2.0Ton/m	3.0Ton/m

Description of the Comparison Table

After the modeling in the SAP 2000 program, the ranges of shear stresses were observed (Table 1); horizontal traction is also evidenced with a range of 2.0 Tons/m in the Y-Y direction and 1.0 in X-X respectively. This indicates that seismically it would resist a mild to moderate earthquake safely based on the principle of the E0.80 standard of designing with resistance and stability.± ±

Mechanical Characteristics of Materials (Ministry of Housing, 2017)

With regard to materials and their mechanical characteristics, the E 0.80 and E 0.10 standards are taken into consideration:

A. Adobe masonry (Ministry of Housing, 2017)

- Specific weight of Adobe Pe masonry = 1600.00 Kgf/m^3. 83
- Modulus of elasticity: Em = 4 000.00 Kgf/cm^2
- Ultimate compressive strength: f'm = 6.12 Kgf/cm^2
- Permissible compressive strength (E.080): [fadm = 0.40 f'm]

fa dm = 2.45 Kgf/cm^2

- Ultimate shear stress on unreinforced walls: = 0.25 Kgf/cm^2.

B. Wood (STANDARD E 0.10)

- Belongs to Group C according to the E 0.10 standard
- Specific Weight of Wood Pe wood = 900.00 Kgf/m^3.
- Modulus of elasticity E = 90000.00 Kgf/cm^2.
- Admissible tensile strength by bending f'm wood = 100.00 kgf/cm^2.
- Admissible cutting strength fv wood = 8.00 Kgf/cm^2.

C. Loads

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For the structural model carried out, the following were considered

Loads:

1. Dead Load

- Ceiling considered as a fiber cement plate and

= 4mm ef = 0.004 m.

- In accordance with the E.020 Standard Fiber Cement Loads 600 Kgf/m^3.
- Roof Load Dead Load = 10.00 Kgf/m^2.

2. Seismic Load

Based on the E.080 Reinforced Earth Standard, the horizontal seismic force in the structure is defined by:

H = SUCP

The values considered are shown below:

H = Horizontal Seismic Force

S = Soil factor as indicated in Table No. 1. (Ministry of Housing, 2017)

Or = Factor of use as indicated in Table No. 2. (Ministry housing, 2017)

C = Seismic coefficient as indicated in Table No. 3. (Ministry of Housing, 2017)

P = Total weight of the building, including dead load and 50 % of live load.

Model Description

The housing model has an area of approximately 30 m^2 under the guidelines of the Ministry of Construction and Housing Standard E 0.80 which will improve the quality of construction. Therefore, the quality of life of the population, especially to the dispersed rural population centers as well as takes advantage of the thermal quality that earth constructions provide us hand in hand with seismic safety, which is projected on a single level.

For the modeling, the seismic zone factor 3 was used; the properties of the material, such as the volumetric weight, the adobe modulus and the seismic load defined by the spectrum of the zone, the continuous foundation was analyzed as an embedded and our walls in a laminar shape.

As described through the SAP 2000 program, the adobe model, the most important objective

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was to reinforce the connection of the scissors and purlins to the wall since this helps us in the seismic condition, avoiding deformation; under dynamic excitations of mild to moderate, they were adequately protected in their dimensions and techniques according to regulations that verify their structural integrity and avoid their accelerated to excessive degradation, but, above all, the total collapse of its walls since it provides control in the displacement that is due to the dimensions established in the walls that were modeled in laminar dimension, and the wooden structure represented as linear elements carrying a concentrated load in their supports. The mass of the walls was distributed according to its geometry.

For the above reasons, this facilitates safe housing; therefore, there is confidence in the results presented to preserve the integrity of adobe construction since, due to its low cost, it is the most accessible way for low-income families.

CONCLUSION

In conclusion, this research evaluated the seismic functionality of adobe houses in Shaullo Chico Baños del Inca. It was concluded that 95% of them have a functional status rated as regular, although details were identified that require rehabilitation. The remaining 5% were rated as poor. The need for regular care to preserve the homes in a better state is emphasized.

In addition, a seismically optimized improvement was proposed for the adobe homes in Shaullo Chico Baños del Inca, ensuring safe components aligned with the E-080 standard. The housing model was analyzed seismically through the SAP2000 program, and it was concluded that there are shear stresses in the wall plane that exceed 0.25 kgf/cm², suggesting an inelastic range. It is recommended to improve aspects such as symmetry, distribution of masses and rigidities, minimum weight for roofs and proper use of construction materials. In addition, the need for better continuity in the walls in reference to the structure and meticulous supervision in accordance with

FUTURE RESEARCH

Project Vision Statement

A reconstruction and reinforcement approach is proposed using techniques and materials that comply with the E-080 standard. This includes restructuring the overhang, improvements in the verticality of the walls, and the use of better quality materials.

Project Program

Phase 1: Diagnosis and initial assessment of the homes.

Phase 2: Design and planning of structural improvements.

Phase 3: Implementation of improvements, with follow-up and adjustments.

Phase 4: Post-intervention evaluation and delivery of reports.

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Roles and Responsibilities

- Project Coordinator: General supervision and resource management.
- Engineers and Architects: Technical design and supervision of the works.
- Local Labor: Execution of improvements under supervision.
- Seismology Specialists: Technical advice and validation.
- Risk Register.
- Technical Risks: Mitigation through expert advice and pilot tests.
- Financial Risks: Diversification of sources of financing and controlled budget.
- Social Risks: Communication and work with the community to ensure acceptance and participation.

Improvement Project Deliverables:

▪ Reinforced housing in accordance with the E-080 standard.

▪ Progress reports and final evaluation.

▪ Long-term maintenance and prevention plan.

Reporting Tools:

- Project management software such as Microsoft Project will be used for progress tracking, along with structural analysis tools for technical evaluation.
- This approach ensures structured and safe progress towards improving the seismic resistance of housing in Shaullo Chico.

Improvement Project Deliverables

To define the deliverables and objectives of the seismic improvement project of houses in Shaullo Chico, Baños del Inca, we will consider the following points:

▪ Project Deliverables

▪ Initial Assessment Report: Detailed diagnosis of the current state of the homes.

▪ Structural Improvement Plan: Designs and technical specifications for improvements.

▪ Reinforced Housing: Houses rebuilt or reinforced according to the E-080 standard.

▪ Final Report and Maintenance Plan: Document that summarizes the activities carried out and provides a future maintenance plan.

Project Timeline

➢ **Phase 1** (Months 1–3): Evaluation and diagnosis.

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- **Phase 2** (Months 4–6): Development of the improvement plan.
- **Phase 3** (Months 7–12): Implementation of improvements.
- **Phase 4** (Month 13): Final evaluation and delivery of reports.

SMART Goals

- **Specific:** Improve the seismic resistance of 20 homes in Shaullo Chico.
- **Measurable:** Ensure that all homes comply with the E-080 standard.
- **Achievable:** Use local resources and seismic construction experts.
- **Relevant:** Increase the safety and durability of homes in an earthquake-prone area.
- **Temporary:** Complete the project within 13 months.

These deliverables and objectives provide a clear and measurable structure for the project, ensuring that resources are used efficiently to achieve the desired outcomes.

2. Resources Needed

A detailed budget will be required to cover the costs of materials, labor, and technical supervision. In addition, collaboration with seismic construction experts and the active participation of the local community will be needed.

To carry out the seismic improvement project of houses in Shaullo Chico, Baños del Inca, the following resources will be needed, according to the budget available to the municipality of Baños del Inca.

Budget of the Improvement Plan

- Construction Materials: These include adobe, cement, iron, wood, and other specific materials to comply with the E-080 standard.
- Labor: Labor costs for local workers and construction specialists.
- Engineering and Architectural Services: Fees for designers, engineers and architects.
- Equipment and Tools: Rental or purchase of equipment necessary for construction and evaluation.
- Administrative Expenses: These include logistics, permits, insurance, and other indirect expenses.
- Advertising and Communication: Costs associated with community outreach and participation.
- Cost Breakdown: Each element of the budget will be detailed to justify the need for resources and ensure efficient budget management.

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- Resource Allocation Plan: Funds will be allocated according to the phases of the project, ensuring that each stage has the necessary resources for its proper execution. Controls and monitoring will be established for the effective distribution and use of resources.

CONCLUSION

This project will not only improve the safety and durability of housing in Shaullo Chico, but will also raise awareness about the importance of earthquake-resistant construction in rural areas, contributing to a safer and more prepared community.

This plan is a general scheme that can be adapted and detailed according to the specific requirements and resources of the Municipality of Baños del Inca.

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