

ESTIMATING THE GLUED-LAMINATED TIMBER DEMAND IN NON-RESIDENTIAL BUILDINGS IN CHILE

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ABSTRACT: Glued laminated timber has taken center stage in recent years in Chile. The non-residential building sector is attracting the attention of local architects and builders, possibly due to the multiplicity of types of buildings, in which the attributes and advantages of this product are expressed. There is no record of the amount of glued laminated timber that is consumed annually in the country. The present study is a contribution to the knowledge of the demand, from the point of view of the potential that the non-residential construction market would offer. The main result indicates that, if all the potential non-residential area use glued laminated timber as a structural element, the associated demand would be in the range of 192 to 220 thousand cubic meters. This volume accounts for the enormous space that exists in the construction market to position this product, since production does not exceed 25,000 m³.

KEYWORDS: glued laminated timber, potential demand, non-residential building.

1 INTRODUCTION

In developed countries as Germany, Austria, and Japan, glued laminated timber (GLULAM) it is produced in large volumes, which is used in different types of residential, and non-residential building, usually found where large spans members are required [1].

In Chile, glulam has a vast history of usage since 1960's in the last century. The production is mainly oriented to internal market in architectural works with big spans, as warehouses, industrial plants, gyms, roofed sport centers, indoor swimming pools, pedestrian bridges, and other public infrastructure works. In Chile, there are different types of non-residential buildings which are highlighted by the use of glulam in wall, and roof structures. In general, this product operates as other materials complement which are more frequently found as concrete, or bricks. However, there are buildings whose wall, and roof structures are only composed by glulam. From some years now, glulam is drawing the attention of constructors, and architects to be used in non-residential building in the country [2].

In the present research, it was carried out an estimation of glulam cubic meter consumption that non-residential construction may reach in Chile, by means of potential demand.

In marketing, the potential demand is the maximum volume a product, or service can reach in a stablished time

horizon. The marketing potential demand is calculated from an estimation of potential buyers' number, which are assign with an individual consumption rate. The potential demand represents the superior limit reached by the sum of sales of all companies participating in the market for a determined product or service [3].

2 MATERIAL AND METHODS

In order to develop this research, the main input in the analysis was the information contained in the building database recorded by the National Statistics Institute (INE). This information contains, among other fields, the following: region, and commune where works will be located, the type of building permit (new works permit, or extension permit), the purpose of building (public building, commercial premises, kindergartens, hospitals, among many others), the total authorized area to build (in square meters), and total area distribution according to predominant material in wall structure. The purpose of building was based on a table of purposes INE has elaborated to fill the Single Building Form (FUE), adding a broader definition. On the other hand, the list of predominant materials in wall structure, also elaborated by INE for the same purpose, was used without any changes [4].

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Table 1: Purposes of non-residential buildings based on INE's table to fill the FUE

Purposes	Purposes
Customs (offices, and other similar constructions).	Leisure and amusement (sports centers, indoor pools, sports fields and other similar)
Agricultural (aviaries, yards, greenhouses, nurseries, fodder storage facilities, among others)	Financial institutions (banks, stockbrokers, and similar ones)
Storage (warehouses) y Transport (bus stations, air terminals, and similar ones)	Sheds (maintenance of several products)
Social assistance	Hotels, residences, cottages
Bars, restaurants, and coffee shops	Industry
Jails	Courts
Market (commercial premises, pharmacies, bakeries, others)	Mines and quarries
Communications, mail	Markets, and fairs
Cultural (theaters, cinemas, public libraries, and similar ones)	Offices
Public building (municipalities, ministries, and similar ones)	Religious organizations (churches, chapels, others)
Kindergartens	Fishing (roofed agricultural crops, and similar)
Basic education	Health (hospitals, clinics, and other healthcare facilities)
Secondary education	Public services
Professional institutes	Supermarkets
Universities	Technical agencies, Laboratories
Electricity, gas	Other non-residential buildings N.E.I not elsewhere identified

Source: Own elaboration, based on the INE, 2021
N.E.I not elsewhere identified

Table 2: Predominant materials in walls used by INE to fill the FUE

Wall material
Mud brick
Concrete block
Concrete
Brick
Wood
Preformed metal panel
Ferro-concrete panel
Expanded polystyrene reinforced Panel enabled for stucco
Stone

Source: INE, 2021

The database of building from INE do not allow to determine directly the cubic meters of predominant materials contained in wall structure, since, as stated before, it is only available the information on area built in each one of them. Another difficulty in regards of obtaining the volume of materials in a direct way, and, particularly in timber category, is that there is no specification on type of wood, or to which wood product it is referred.

The individual consumption is given by the glulam volume needed in a built area unit, that is to say, the usage factor. The non-residential authorized area in a certain year is the potential area. Thus, with the quantities of predominant materials in walls, and roofing the potential demand is estimated. The amount of glulam in potential area is the expression of the volume that may be consumed by construction of non-residential works if this structural material was used ("potential demand").

To obtain the maximum demand, in first place it was carried out an estimation of potential non-residential area using INE's database, and subsequently, a documentary inquiry of non-residential works tendered by the State, to obtain the usage factor ($\text{m}^3 \text{ glulam} / \text{m}^2 \text{ built}$).

3 RESULTS

3.1 ESTIMATING THE NON-RESIDENTIAL POTENTIAL AREA

The total of new non-residential works area, according to data published by INE, was $4.216.362 \text{ m}^2$ in 2019. INE obtained this area considering the total of building permits authorized by the different municipalities in the country during one year.

In order to express in a better way, the "potential" feature of area to the used of glulam, in this research, it was considered appropriate to make some adjustments (reduction) on INE's figure:

- It was eliminated non-residential buildings from the database that could be interpreted as of small spans. This criterion is supported in that glulam emerges as a construction material mainly to cover large distances between building supports. Clearly, the relation between square meters of a determined building, and the size proportion of it (large, or small) will depend on what it is being analyzed. In this research it was fixed arbitrarily a limit of 140 m^2 to establish non-residential building with large spans.
- From the remaining area, it was excluded works related to a mixed project, that is to say, building with more than one purpose. Among the most frequently found mixed constructions in urban areas are buildings with commercial premises in the first floor, and housing purpose from the second floor and up. According to INE's database, the majority of this mixed projects are characterized because of the predominant material in walls is concrete, and to a lesser extent, bricks, and metal, without the participation of wood in wall structures.



Figure 1: Buildings with mixed purposes, Housing, and Market (Located in Avenida Irarrázaval avenue, Nuñoa commune, Chile)

- It was excluded the number of non-residential corresponding to large area works recorded under the purpose of storage, and transport, and industry purpose. The first one corresponds to large goods storage warehouses, which are commonly rented by retail companies by means of storage, and product delivery. In industry purpose, it is common that the extensions of roof coating under product processing plants, as well as the structural walls that support them, are made with predominant materials different from wood [5]. While the structures, and roof of both types of buildings (Storage, and transport, and industry) are a potential market for glulam use, so far it is thought that this may not bring positive results, due to that the alternative materials already being used, as steel, and concrete, have more competitive costs [6].



Figure 2: Non-residential building, Industry purposes (Wood pellet plant, Biobío region, Chile)



Figure 3: Non-residential building, Industry purposes (Sawmill, Biobío region, Chile)

The resulting area, after applying the previous three points, it was reduced due to not executed buildings. The municipal permit grant to build lasts for three years; in practice, this permit represents an intention of building on behalf of the architect, since the construction may not be finally carried out for various reasons. Given it was no found an official data on numbers of not executed building permits, nor the area involved, in this research it was considered that 5% of the building permits are not finally executed.

Table 3: Total and potential area by purpose, for the estimation of glulam potential demand

Categories of Construction purposes	Total area (m ²)*		Potential area (m ²)*	
	2019	2020	2019	2020
Agriculture and fishing (aviaries, yards, animal fodder storage facilities)	134,74	244,94	126,8	210,523
Storage and transport (product storage warehouses, bus stations, others)	570,033	462,544	164,67	140,348
Market (commercial premises, supermarkets, pharmacies, bakeries, others)	901,042	562,889	653,081	446,412
Public buildings (custom, courts, mail, cultural centers, others)	102,081	42,177	92,162	37,336
Education (kindergartens, basic, and secondary education, professional institutes, universities, others)	162,231	107,028	152,55	100,677
Leisure and amusement (sports centers, roofed yards, indoor pools, museums, theaters, cinemas, others)	151,52	114,093	108,256	80,266
Hotels, residences, cottages and others	322,583	96,694	162,208	73,902
Religious organizations (churches, chapels, others)	24,701	13,049	20,755	11,726
Industry	706,549	411,06	179,979	179,117
Offices	250,333	391,532	181,07	306,907
Health (hospitals, clinics, family healthcare centers, others)	300,744	225,574	283,148	211,11
Other non-residential buildings N.E.I	589,805	443,748	380,92	377,466
TOTAL	4,216,362	3,115,328	2,505,599	2,175,790

Source: (*) INE, 2022; (**): Own elaboration, N.E.I not elsewhere identified.

3.2 GLULAM USAGE FACTOR

Once the potential area is defined, the usage factors were calculated for different purposes categories of non-residential buildings. In order to do this, it was used information available in different public tenders of the state in the website www.mercadopublico.cl [7] systemizing the documentation presented by tenderers adjudicated. It was analyzed nearly 80 public tenders to several works' constructions, among these: kindergartens, sports centers, public indoor pools, schools, universities, hospitals, family healthcare centers, primary health clinics, fire stations, civil registration offices, police stations, town halls, and others. From these, 20 that use glulam as a structural material were selected.

Table 4: Public tender selection for calculation of glulam usage factor.

Year	: 2020
Project Name	: Héroes de la Concepción high school
Purpose Assigned	: Secondary education
Region	: Biobío
Commune	: Laja
Tender N	: 3735-57-LR20
Authorized Area	: 3,570 m ²
Glulam Volume	: 45 m ³
Factor	: 0.013 m ³ MLE / m ²
Year	: 2016
Project Name	: Huechuraba Semi-Olympic Swimming Pool
Purpose Assigned	: Leisure and amusement
Region	: Metropolitan
Commune	: Huechuraba
Tender N	: 2793-113-LR16
Authorized Area	: 2,120 m ²
Glulam Volume	: 167 m ³
Factor	: 0.079 m ³ MLE / m ²
Year	: 2018
Project Name	: Consistorial Llanquihue Building
Purpose Assigned	: Public Buildings
Region	: Los Ríos
Commune	: Llanquihue
Tender N	: 1437-9-LR18
Authorized Area	: 2,243 m ²
Glulam Volume	: 81 m ³
Factor	: 0.036 m ³ MLE / m ²
Year	: 2019
Project Name	: Municipal Market Temuco
Purpose Assigned	: Markets and Fairs
Region	: La Araucanía
Commune	: Temuco
Tender N	: 1658-321-LR19
Authorized Area	: 12,000 m ²
Glulam Volume	: 1,010 m ³
Factor	: 0.084 m ³ MLE / m ²
Year	: 2020
Project Name	: Muñequitos Kindergarten
Purpose Assigned	: Kindergarten
Region	: Maule
Commune	: Cauquenes
Tender N	: 848-94-LR20
Authorized Area	: 946 m ²
Glulam Volume	: 17 m ³
Factor	: 0.018 m ³ MLE / m ²

The selected tenders that use glulam were assigned to one of the construction purpose categories from the table of purposes. Those containing information on the use of glulam as a structural material in walls, and roofs were revised in more detail, particularly the itemized budget, the unitary price analyses (APU), elevation planes, and building technical specifications. Thus, it was obtained the volume (in m³) of glulam used. With this data, in addition to the area built recorded in the building permit, it was obtained the usage factor for each construction work expressed in m³ of glulam per unit of area built.

For each resulting purpose category, it was averaged the usage factors of assigned tenders in each one of them. The average factor was multiplied by the potential area of each construction typology. In table N°4 it is presented 5 of the 20 projects where glulam was used as a structural material, the project area, glulam volume, and usage factor.

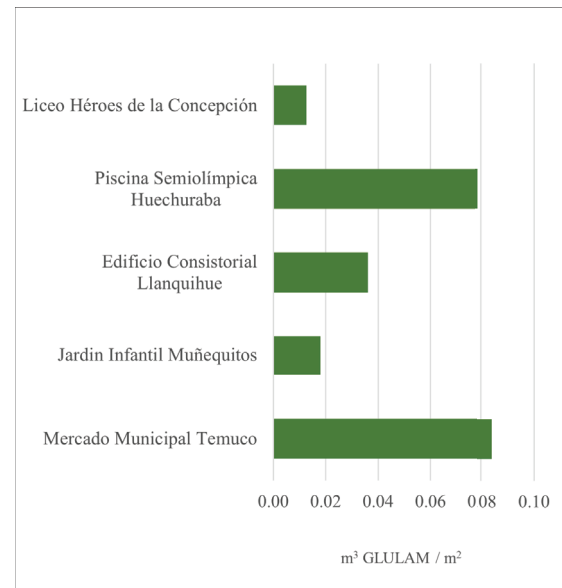


Figure 4: Glulam usage factors expressed in cubic meters by square meter built

Table 5: *Glulam usage factor by construction purpose*

Categories of Construction purposes	Volume (m ³)
Agriculture and fishing (aviaries, yards, animal fodder storage facilities)	0.107
Storage and transport (product storage warehouses, bus stations, others)	0.101
Market (commercial premises, supermarkets, pharmacies, bakeries, others)	0.102
Public buildings (custom, courts, mail, cultural centers, others)	0.063
Education (kindergartens, basic, and secondary education, professional institutes, universities, others)	0.104
Leisure and amusement (sports centers, roofed yards, indoor pools, museums, theaters, cinemas, others)	0.074
Hotels, residences, cottages and others	0.074
Religious organizations (churches, chapels, others)	0.088
Industry	0.051
Offices	0.088
Health (hospitals, clinics, family healthcare centers, others)	0.074
Other non-residential buildings N.E.I	0.088
TOTAL	0.085

Source: Own elaboration

The resulting potential volume of glulam demand of the estimation it is presented in Table N°5. At country level, this estimation presents a potential glulam demand of 219,839 m³, and 192,552 m³ for 2019, and 2020, respectively.

Table 6: *Demand volume of glulam in Chile*

Categories of Construction purposes	Volume (m ³)	
	2019	2020
Agriculture and fishing (aviaries, yards, animal fodder storage facilities)	13,542	22,483
Storage and transport (product storage warehouses, bus stations, others)	16,605	14,153
Market (commercial premises, supermarkets, pharmacies, bakeries, others)	66,288	45,311
Public buildings (custom, courts, mail, cultural centers, others)	5,783	2,343
Education (kindergartens, basic, and secondary education, professional institutes, universities, others)	15,884	10,483
Leisure and amusement (sports centers, roofed yards, indoor pools, museums, theaters, cinemas, others)	7,991	5,925
Hotels, residences, cottages and others	12,015	5,474
Religious organizations (churches, chapels, others)	1,837	1,038
Industry	9,19	9,146
Offices	16,022	27,157
Health (hospitals, clinics, family healthcare centers, others)	20,974	15,638
Other non-residential buildings N.E.I	33,706	33,401
TOTAL	219,837	192,552

Source: Own elaboration

4. CONCLUSIONS

The production of Glulam in Chile in 2019 reached 23,034 m³. This figure is only 10.5% of the potential volume of laminated timber that could be demanded in the country, therefore existing wide range to increase the use of this material in the national market.

A possible explanation of this gaps between supply, and demand of glulam, is the timber industry limited perception in terms of the remarkable market potential this product has. Certainly, the availability of the raw material to increase glulam production can be limiting; in this sense, sawmills play a very important role as suppliers of structural sawn wood (MAE) of companies producing glulam.

Regarding 2020, this estimation exercise shows that the potential area calculated decreased in 15.2%, and the potential demand volume in 12.4% in respect of the previous year. This drop it is attributed to less construction activity in 2020 due to COVID-19 pandemic effects.

While the research considered only the non-residential building segment, the gap between supply, and demand presented in this research may be higher, that is to say, the percentage of potential volume covered by the current supply could be lower than 10.5%, since the housing sector has not been included.

Moreover, there is a glulam demand volume which has not been evaluated in this research, that it would be determined by the structural reparations market in the existing buildings, that may contemplate a partial, or total reposition of glulam volume currently in operation.

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