



**HOW VARIABLES ON THE MORPHOLOGY OF AN INDIVISIBLE LOAD
PLAYS AN IMPORTANT ROLE ON THE CHOICE OF THE SET OF
CARRIERS AND TRANSPORT ROUTES. THE TRANSPORTATION OF
AN ELECTRIC CAPACITOR IN CITY AREAS**

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ABSTRACT

The transportation of an indivisible load also bears the core definition of load transportation in logistics - delivering a load, considering its starting point as far as its destination, the decision upon the best set of carriers and the best transportation route to minimize final transportation costs. This research aimed at describing the issue regarding transportation of indivisible loads in urban areas where the road system might have limited transportation conditions depending on the complexity of the load. All researched books have come up with a number of situations regarding this type of transportation. From the information collected, it was observed that the transportation scenario and its difficulties were similar; a study has been suggested in order to give examples of how this type of transportation works. Results have shown that height, width, length and weight parameters should consider the transportation infrastructure offered, the appropriate set of carriers and the compliance with all legislations.

Keywords: Logistics; Indivisible loads; Route; Urban; Traffic



1. INTRODUCTION

Studies in the field of transportation are essential in today's globalized reality. Logistics, the study where transport is the leading component, is seen as the last resort for cost reduction to companies. The transportation of an indivisible load also bears the core definition of load transportation in logistics - delivering a load, considering its starting point as far as its destination, the decision on the best set of carriers and the best transportation route (considering how complex the load is, its height, width, length and weight, not meeting regulatory dimensions) and, even so, optimizing transportation final costs.

The issue on loads in urban areas dates to the history of urbanization, when goods to be consumed had to have access to, enter and move around the space provided, causing high density levels, and keeping narrow ways and access with low moving capacity, which were conditions driven by the development of infrastructure and transportation.

As we are discussing a great core city like São Paulo and we are aware of its characteristics as to urban growth and unplanned and ungoverned regional development. It is impossible to discuss urban loads and not relate them to urban policies, city transport, traffic engineering and all issues regarding urban loads.

As to the city of São Paulo, the São Paulo Traffic Engineering Company (CETSP) controls load transportation considering load data, the road system, the ground use and the busiest time (rush hour).

As to the transportation of indivisible loads, likewise, there are some regulations issued by CETSP which - owing to all circumstances and complexity of the transportation - state the responsibility to follow up whenever necessary, issue authorizations, choose the best routes managing all risks related to traffic engineering and road safety.

In this scenario, we have three types of indivisible loads:

- **En-route Load Profile:** The city of São Paulo, which is privileged for its location, is the core of a sound road network. The main Brazilian roads converge to the city of São Paulo: Régis Bittencourt, which links the southern states; Raposo Tavares and Presidente Castelo Branco both lead to the western part of the



state; Bandeirantes and Anhanguera, which lead to the northern part of the state; Fernão Dias, which leads to southern Minas Gerais state and interconnects the center states in the country; Presidente Dutra and Ayrton Senna highways are connected to Vale do Paraíba, Rio de Janeiro and the northeastern Brazil; still, there are Anchieta and Imigrantes highways, which lead to Port of Santos. Nowadays, almost all highways are interconnected through Rodoanel Mario Covas, even though the transportation company might choose to go through the city as an itinerary option.

- Origin Load Profile: The city hosts some manufacturers of industrial parts and can serve as the “Starting Point” of the itinerary.
- Target Load Profile: Power Substations and large-scaled constructions (Subway Lines) are the destinations for this load type.

Therefore, it is most likely that the origin or the destination be inside an urban area, in either São Paulo or any other city in Brazil. This article, thus, aims at dealing with the hard task of adjusting the load size with possible urban interventions (narrow streets, maneuvers in turns, yardstick heights of bridges and footbridges, road sign/lights, phone/energy cables) and, from this point, we offer a solution to the issue Origin/Target logistics of the transportation which must be safe and efficient, meeting the current legislation demands. Considering the point of view of all those involved in the process: transportation company, shipper, transit authority, concessionaires, users and the end user.

2. BIBLIOGRAPHY

2.1. Initial considerations

Resolution 01/16 (DNIT, 2015) regulates the transportation of loads that are indivisible and exceed weight and dimensions permitted by the effective law for the set comprised by vehicle and load carried, as well as by special vehicles and shows some important concepts and definitions designed to be understood:

- Indivisible Load: Indivisible Load is the single load bearing excess dimensions and weight in comparison to the regulatory limits, which transport requires the use of special vehicles with load capacity, dimensions, structure, wheel suspension and a suitable steering wheel. Examples of indivisible load - among



others - are: machinery, equipment, parts, wind shovels, wagons, transformers, reactors, hoisters, machinery for factory and construction use, agriculture machinery, metal structures, silos, etc.

Figure1 shows an example of indivisible load.



Figure 1: an example of indivisible load.

- Tractor or traction vehicle: the motor vehicle designed and made to pull or drag trailers and semi-trailers;
- Trailers and Semi-trailers: vehicles bearing one or more axles to be connected to a tractor vehicle or one that leans against the vehicle or is connected to it through an articulation.
- Special Vehicle: bearing specific characteristics, it is a custom-made vehicle designed to transport indivisible loads that exceed in weight and/or dimensions.
- Self-Propelled Modular Transport: the modular vehicle with its own load platform, with wheel suspension, power steering, and a set of steering axles with a driving force that enables moving by its own means;
- Gondola, Beam, Intermediate Platform, bearing or not bearing articulation: parts used in the transport of indivisible load that are oversized and extremely heavy;
- Axles Line: a modular vehicle bearing two or more pendulum axles, with wheel suspension and power steering, made of four, eight, twelve or sixteen tires in the same transverse alignment as to that of the chassis.

- Power Module: it is the vehicle made of two or more lines of directional axles, fixed on the same chassis of the load platform, with its own means of joining itself to other modules or parts;
- Belt Carriers Set: the vehicle or set of vehicles, bearing a load.
- Excess Dimension (length, width and height): these are the excess dimension, over the top limit allowed by the ruling traffic laws;
- Geometric Feasibility Study - (EVG in Portuguese) - the study on vertical and horizontal yardsticks and interventions, such as bridges, footbridges, tunnels, gantries, curves and intersections;
- Weight Excess; it is the total weight per axle, or set of axles, or even Gross Combined Weight (GCW), transferred to the pavement.
- Structure Feasibility Study: the study of the carrying capacity of Special Structures, present along the itinerary, in order to enable or not the passing of the Set of Carriers with Gross Combined Weight over certain limits. This study comprises the analysis of the details of the structure and how good the state of repair of the Special Structure is and, if appropriate, its project and Calculation Report. In the final report, it is important to state all measures that must be taken in order to enable transportation;
- Technical Report and Follow-up - it is the document that states that the company is liable for the Structure Feasibility Study, drafted after following up on the transportation, reporting how the recommendations for the passing of the set of Carriers for Special Structures were met, the state of the structures during the passing and if there were any problems with the carrying capacity of the Special Structures, accompanied by the Instrumentation Technical Report when necessary measures are listed, thus suggesting that Structures be open for the traffic of vehicles with the same carrying characteristics as those of the transportation studied;
- Instrumentation Technical Report: it is the study of the structure of Special Structures made by instrumentation, designed to measure tensions and deformations;

- Escort: Escorting carried out by accredited companies or by the Federal Highway Police, in a determined car or set of cars, when dimension and weight limits go beyond what is established by law.
- Accredited Escort Company: is the company duly accredited by the Federal Highway Police to execute escort services to vehicles carrying excess indivisible load, be they in weight or dimension.

Resolution 210/06 (CONTRAN, 2006) establishes the limits for the Set of Carriers, loaded or not, by the following:

Height: 4.40m;

Width: 2.60m;

Length:

- Ordinary Vehicle: 14,00m; Articulated Vehicle: 18.60m;
- Trailers: 19,80m.

Total Weight: 45t.

Figure 2 shows an example of a Loaded Set of Carriers, made by two pulling units, two axle lines that distribute the load weight along the floor, and a gondola that sits the load in a balanced way - center.

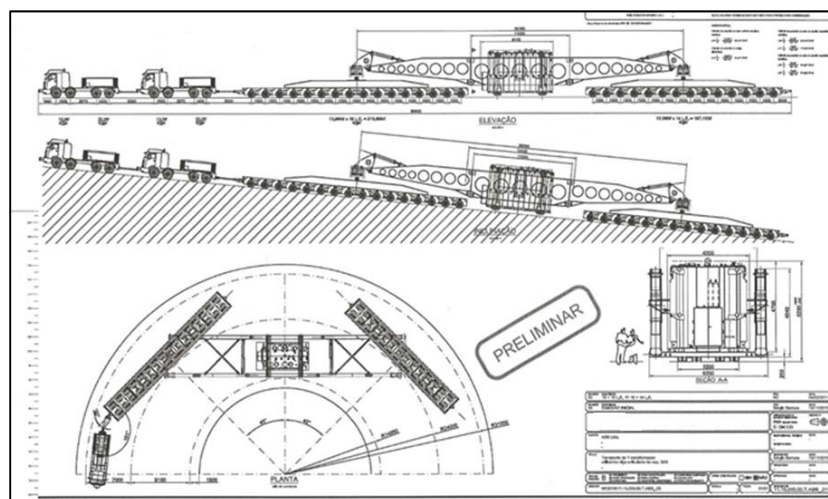


Figure 2: Example of a Set of Carriers

Source: CETSP Files (2018)

As per the Brazilian Traffic Regulations, article 101, (CONTRAN, 2008) from the moment a set of carriers goes over the dimension or weight limits established by Resolution 210/06, it is required that a Special Authorization be issued by the Transit

authority responsible for that part of the road. In Brazil, the work involving assessment, follow-up and monitoring of indivisible load transportation is divided into three domains:

- Federal: The National Transport Infrastructure Department (DNIT) is responsible for all distances comprising federal roads;
- State: State Highway Department (DER) in each state is responsible for all state highways in their state, accordingly.
- Municipal: The local transit authority is responsible for the local streets.

Figure 3 is a sample of a Special Authorization issued by CETSP containing important information, such as: Transport Company data; Source of the load; Place of Origin and Destination; Information of the Tractor and the Pulled Vehicle; Dimension and Weight of the Load and of the Loaded Set of Carriers; Validity; Escort and Support Company; Route and Technical Requirements:

REQUERIMENTO DE AUTORIZAÇÃO ESPECIAL DE TRÁNSITO - AET

A TRANSPORTADORA

Nome: _____ Endereço: _____ Cidade/Estado: _____ CEP: _____
 Telefone/E-mail/Contato: _____ Inscrição Estadual: _____ CNPJ: _____
 Responsável Técnico: _____ CREA: _____

Solicita: *AUTORIZAÇÃO ESPECIAL DE TRÁNSITO* para a carga e o(s) veículo(s) abaixo discriminado(s)

UNIDADE TRATORA

MARCA	TIPO	PLACA	PESO
MANITEX	FH 520		10.00 t

UNIDADE TRACIONADA

TIPO	PLACA	PESO
MOD. 6 E.E. C7	SÃO PAULO	26.00 t

CARGA

COMPRIMENTO	LARGURA	PESO
8.00 m	5.80 m	60.00 t

CONJUNTO TRANSPORTADOR CARREGADO

COMPRIMENTO	LARGURA TOTAL	ALTURA TOTAL	PESO TOTAL
23.00 m	5.80 m	3.60 m	96.00 t

CONFIGURAÇÃO

nº de eixos = 6

TON / EIXO: 7.0, 22.0, 67.00
 RODA / EIXO: 2, 4, 4, 8
 DIST ENTRE EIXOS: 2.00, 3.60, 1.40, 6.25, 1.55, 2.00

TERMO DE RESPONSABILIDADE

DECLARAMOS estar cientes que a concessão desta Autorização não exime o beneficiário quanto a eventuais danos que o veículo vier causar à via, equipamentos, instalações públicas e obras de arte.

São Paulo, 26/07/2018

VALIDADE: Do dia 26/07/2018 ao dia 28/07/2018 das 23:00hs as 05:00hs.

O DEPARTAMENTO DE OPERAÇÃO DO SISTEMA VIÁRIO - DSV, nos termos da Lei Federal nº 9503/97, combinado com a Resolução 210/99 do Conselho e da Legislação Municipal vigente, autoriza o conjunto transportador descrito a transitar com a carga excedente, desde que cumprida as seguintes condições:

1 - ESCOLTA E EQUIPE DE APOIO:

CREDENCIADA 03 - CET / TE TELEFONIA TRÔLEBUS
 GATA FIO CET / SIN ELETROPAULO CET / SEMCO

2 - ITINERÁRIO E REQUISITOS TÉCNICOS

INÍCIO: AV. PROF. ABRÃO DE MORAIS/RUA PEDROSO LOUSANO/COMPLEXO VIÁRIO MARIA MALUF/TUNEL MARIA MALUF/VD. D'AM VIL ARÉS/AV. PRES. TANCREDO NEVES/COMPLEXO VIÁRIO ESCOLA DE ENGº MACKENZIE/RUA CIPRIANO SIQUEIRA/RUA DAS JUNTAS PROVISÓRIAS/AV. DOS ESTADOS/VD. GRANDE SÃO PAULO/AV. DR. FRANCISCO DE MESQUITA.

FINAL: DIV. COM. MUN. DE SÃO CAETANO.

Atender resolução contran 168/04 e suas atualizações.

Obs: EM CASO DE CONDIÇÕES CLIMÁTICAS ADVERSAS, ESTA AET ESTARÁ AUTOMATICAMENTE CANCELADA. PROIBIDO TRÁFEGO EM COMBÓIO.

EMITENTE

DATA: _____ NOME: _____ CARGO E ASSINATURA: _____

Figure 1: Example of Traffic Special Authorization
 Source: CETSP Files (2018)

2.2. International scenario

In Ohio, the Transport Department requires very similar actions regarding vehicles classified as oversized. All structures the vehicles shall pass under demand that a structural assessment be made to ensure a safe passage for the vehicle and the integrity of all structure along the chosen route. The number of authorization requests has increased tremendously in the past years and the transportation of oversized load vehicles along state highways has become more and more popular, owing to an improvement in production in industries (WAHEED; ADELI, 2000).

In Delaware, vehicles and assembled vehicles that exceed permitted limits for height, length or weight are considered oversized, needing authorizations issued by their State Transport Department. These authorizations aim at managing oversized vehicles, limiting them to specific routes that can support their sizes and weight, thus reducing potential damages to roads and bridges (RAY, 2007).

In Holland, the transportation of oversized loads of Special Vehicles on roads is also carried out after an authorization is issued, stating the time and previously established route according to the size and weight of the set of carriers (FEDDES, 2012).

The Road Department in England is also concerned about the management of indivisible load transportation along the highways, so they have established policies and measures in order to reduce impacts on the environment and on traffic, such as clearance and authorization for transit at night, due to the conflict between transportation and day traffic (ALONSO; PLAZA, 2010).

Czech Republic has a long-time tradition regarding engineering and industry. Industrial sectors make products which dimensions and weight can be considered above standard. Many problems have occurred as a result of the transport of such products due to the yardstick of the bridges and the turning radius of cars in curves. Therefore, it is necessary to transport loads on previously established routes, based on the size of the set of carriers and the infrastructure of the transportation offered (PETRU; KRIVDA, 2017).

In Lithuania, the demand for indivisible and oversized loads is increasing, which is a bit of a trouble because, in many cases, it is not easy to follow standards for this

kind of transport; it is important to make decisions in order to benefit from the best performance involving costs and the available infrastructure (PETRAŠKA et al., 2018).

In Europe, a managing committee has been put up to handle loads that exceed permitted limits - which specialists call "Special Loads"; economically, they are part of an important segment in commercial road transportation. These loads vary from mobile homes and cranes to indivisible loads of extremely large dimension and weight, such as electric transformers, tubs for chemical reactors, fuselage or airplane wings. Special road vehicles must travel long distances; in many cases, they must cross country borders.

If Special road vehicles do not comply with European regulations regarding dimension and weight, they must hold an exemption document or a license prior to proceeding with a special road transport operation. Authorities must check whether bridge structures on the route can support the passing of such vehicles - which are usually heavier than ordinary cars - and whether the streets can bear the dimension of the load being carried along. (COMISSÃO EUROPEIA DIRECÇÃO-GERAL DA ENERGIA E DOS TRANSPORTES, 2006)

2.3. Transportation management

Restrictions in the transportation of indivisible loads involve physical restrictions regarding the route, specific legislation, the need of operational infrastructure and business relationships with a number of bodies. These restrictions demand for a study in the various technical and institutional aspects in that this type of transportation is well regulated.

In order to benefit from the best performance of the transportation of indivisible loads, special transportation equipment is used, as well as tools that lead to a decision-making process considering a complex set of variables (origin/destination and variables related to the main interferences along the route), resulting in a detailed program of activities (MELO et al., 2010).

As to transport engineering and planning, it is important to have a connecting system among the development centers; i.e., the way through which they are connected, as well as the outline of simple transport routes that can ensure the efficiency of the transportation network (KRPAN; MILKOVIĆ; HESS, 2014).



The criteria used to plan the transportation route of indivisible loads should offer choices, considering the load size and the transportation infrastructure available. We can also compare the available routes within the same stretch to select the best one according to some interference criteria related to height/width/length of the load (BAZARAS et al., 2013).

The transit of indivisible load at night might bring benefits regarding road safety and traffic flow, reducing transit time (BOURNE et al., 2008).

The most important factor that harms the quality in the transportation of indivisible loads is safety. One of the key issues to be considered when planning the route is the risk assessment. Throughout the transportation itself, it is important to manage the previously assessed risks during the planning phase. The purpose of assessing risks during the planning phase and managing them during transportation is to keep the infrastructure intact and protect the load and everyone involved in the transportation (PALŠAITIS; PETRAŠKA, 2012).

3. METHODOLOGY

This study aims to conduct an Exploratory Analysis of a Case, exploring and describing objects (in this case, transportation of indivisible load - how it works and what its main difficulties are) which, due to previously gathered information (origin and destination of the indivisible load, how it will be carried, Transport Route) seems to be the best choice for the type of category. (The best Transport Route, based on the complexity of the Load and the infrastructure offered, to benefit from the best performance in the duration of the transport as well as costs).

All researched books have come up with several situations regarding this type of transportation. From the information collected, it was observed that the transportation scenario and its difficulties were similar; a study has been suggested in order to give examples of how this type of transportation works. Based on data collection and documentation regarding the Transportation Operational Process, Engineering, Projects and Licenses/Authorizations - mainly in the urban area, highlighting the complexity in the transportation system in the city of São Paulo.

4. CASE STUDY

A certain customer places an order for an electric capacitor to be used at a certain hydroelectric power plant in the far north of the country. This customer, then,



hires a transportation company to do their work from and to the extreme spots. As the capacitor manufacturer is placed in the metropolitan area of São Paulo, there is a complex urban area in the route that will be highlighted in the study.

In São Paulo, CET is the organization responsible for managing traffic engineering, and CETSP is the managing body that accounts for the transportation of Special Loads. CETSP is the body that provides the Special Transit Authorization, to whom the transportation company should provide all technical information of the load, the set of carriers to be transported and the route to be followed.

Below is some important information to help understand and set up the scenario for the case study.

Origin of the Load: Rua Friedrich Von Voith, São Paulo - SP.

Destination: Avenida Educador Paulo Freire, São Paulo - SP.

Load details: A rectangular volume bearing the following measures:

- 5.55m wide, 4.73m high and 5.35m deep:
- Weight: 130 ton.

Having these measures, knowing all conditions of the road system (Transport route) and meeting the legislation requirements for the transport of indivisible loads, the transportation company has drafted a project of a set of Carriers with the following information:

- 5.55m wide, 5.50m high and 48m deep:
- Total Gross Weight: 227t.

Figure 4: Set of Carriers made of one tractor unit, one 4-line axle, one platform sitting the load in the middle and a 10-line axle in the rear part of the set.

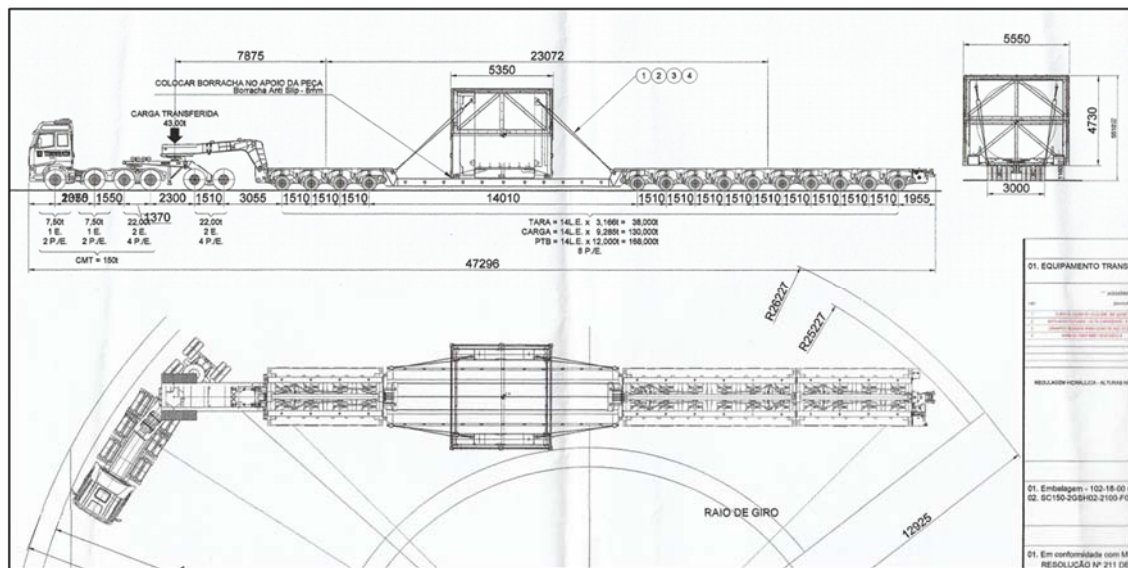


Figure 4: Set of Carriers
 Source: CETSP Files (2018)

4.1. Transportation management

A transport planning for indivisible load is present in the draft phase of the construction (for example, the construction of a hydroelectric power plant, where the main indivisible loads are the Turbine and the Power Transformers). At this point, we already know the place where loads are made and the construction site. Then, we must adjust the load in the set of carriers capable of meeting the requirement established by the main legislation and the characteristics of the transportation route.

In this case study, considering Cost x Time and safety - among other factors - the transportation company has chosen to follow the first route suggested - by driving through São Paulo urban area. It is worth remembering that the part covered in this study refers to the transportation only in the city of São Paulo, although the load will cross the states of São Paulo, Minas Gerais, Goiás, Tocantins, and finally reach Belém (in the state of Pará) covering about 2,800km in 60 days); after that, the load travels on a ferry to Santarém for 4 more days, reaching Rurópolis (covering 250km in 2 days).

From the initial information aforementioned (Place of Origin, destination, details of the load and set of carriers), the transportation company has conducted a Geometric Feasibility Study (aligning issues related to width, height and weight of the set with the route details, street widths, bridge and footbridge heights, low-voltage cables, radius

of turn) and a Structural Feasibility Report (assessing conditions of the pavement and support of the bridges).

Once these studies are concluded and the transportation route is decided upon, the transportation company must engage with the traffic authorities and phone and electricity companies who will make all the load transportation viable.

4.2. 4.2 TRANSPORTATION MANAGEMENT

Considering that the route is 31km long, it is estimated that the transportation operation shall take 3 nights. Due to the type of load and its adjustment to follow the route, this procedure can be only executed in the city of São Paulo during the night period.

The route comprises all parts listed below:

- Part 1 (First night): R. Friedrich Von Voith, Estrada do Corredor, Av. Amador Aguiar, Av. Nelson de Palma Travassos, Av. Raimundo Pereira de Magalhães, R. Com. Feiz Zarzur (Opposite way to the regular), R. Cabo Adão Pereira, Av. Benedito de Andrade, R. Manoel Barbosa (PARKING 1);
- Part 2 (Second night): Av. Fuad Luftala, Av. Gal. Edgar Facó, Pte. Piqueri, Av. Ermano Marchetti, Pca. Pedro Corazza, Av. Com. Martinelli, R. Barão de Pombalinho (PARKING 2);
- Part 3 (Third night): Av. Pres. Castelo Branco, Av. do estado, Av. Santos Dumont (BACKING MANEUVER AS FAR AS AV. TIRADENTES; ACCESS R PEDRO VICENTE - MANEUVER 1), Av. Cruzeiro do Sul, R. Joaquim José Moredo, Av. Pres. Castelo Branco (ACCESS TO THE CENTRAL LANE ON MARGINAL TIETÊ, PASSING UNDER BRIDGE VILA GUILHERME, ENTERING THE LOCAL LANE, AV PRES CASTELO BRANCO, PASSING UNDER BRIDGE VILA MARIA - MANEUVER 2), Access to Av. Salim Farah Maluf, (TRANSFER CENTRAL RESERVATION AREA - MANEUVER 3), Access to Av. Condessa Elizabeth de Robiano, R. Helly Lopes Meireles, Pte. Aricanduva and Av. Educador Paulo Freire.

Figure 5 show the route in detail, also highlighting the parking places and the main maneuver detour from interferences regarding bridge yardstick heights and the best maneuver of road geometry due to load length and width.

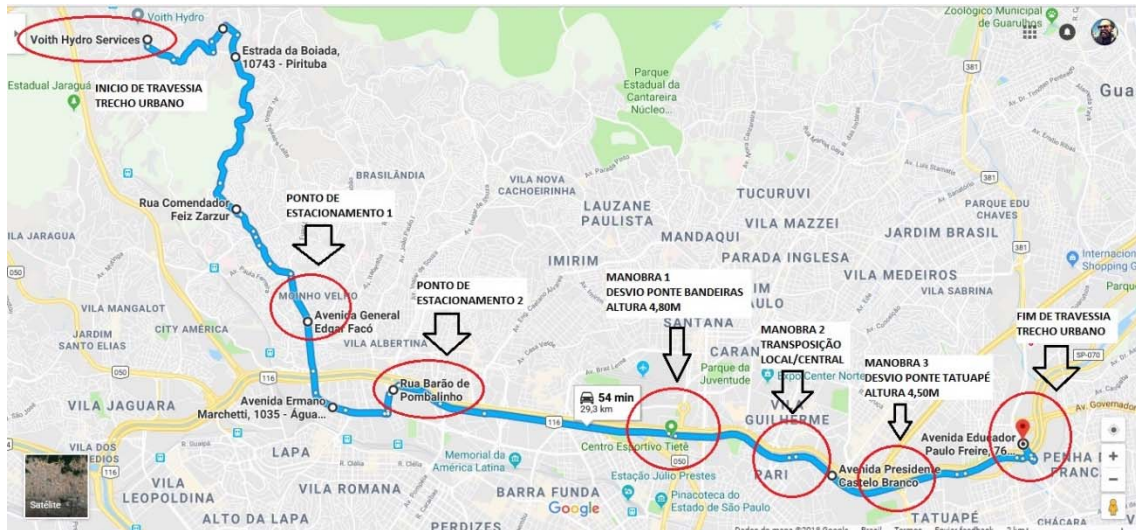


Figure 5: Transportation Route

Therefore, the transportation operation shall proceed as follows:

- First Part, (9Km) Departure at 11:30PM, R. Friedrich Von Voith;

There will be a number of traffic lights throughout Av. Raimundo Pereira de Magalhães. Reverse maneuver on R. Com. Feiz Zarzur owing to road geometrics and a number of interferences caused by phone and electric cables.

- Arrival at 4AM on R. Dr. Ferreira da Luz, near Av. Fuad Luftala.
- Second Part (6Km), departure at 11:30PM. Dr. Ferreira da Luz;

Best part, having few interferences and maneuvers owing to the road geometrics, bearing the size of the set of carriers.

- Arrival at 3AM on R. Barão de Pombalinho.
- Third Part, (16Km) Departure at 11:30PM, R. Barão de Pombalinho;

Maneuver 1; Detour on Bridge Bandeiras due to height 4.80m;

Maneuver 2; Detour on Bridge V. Guilherme, Main road, Bridge V. Maria, Side track;

Maneuver 3; Detour on Bridge Tatuapé, due to height 4.50m;

- Arrival at 5AM Av. Educador Paulo Freire.

5. RESULTS - STUDY AND DISCUSSION

The main talking point on results must deal with safety; regarding this type of transportation, the load must be intact and in its full form upon arrival at the destination point. There are several risk factors to be tackled in many of the transportation phases. The transportation company is responsible for looking after the load, staff and equipment involved in the transportation operation.

The transit authority, in turn, must monitor the compliance with the regulations in order to preserve the transport infrastructure, road safety during the operation, and reestablish all system after the load transportation has been concluded.

Even though the scenario in which the case study was based on is predominantly urban - bearing characteristics like those of a road system (narrow or low) that enables transportation - it does not mean that on highways, where characteristics are those of being wide and tall, it can be more favorable. What will lead to success is the combination of Load Complexity and Transportation Infrastructure offered. Another key factor that might as well contribute to the success of the transportation operation is the interconnection of all parts involved in the process.

6. CONCLUSION

The most important factor that harms the quality in the transportation of indivisible loads is safety. It is up to the transportation company to assess risks and manage the transportation throughout the operation, being it the key to the success of load delivery at its destination. The regulatory bodies demand that transportation company comply with the legislation in order to preserve the infrastructure of the road and ensure that it can be used again.

This research aimed at describing the issue regarding transportation of indivisible loads in urban areas, where the road system might have limited transport conditions depending on the complexity of the load.

Some parameters regarding load height, width, length and weight should be followed in line with the transportation infrastructure offered and all regulation terms must be met, having the appropriate set of Carriers.

The books used have shown that, broadly speaking, the set “parameters x available infrastructure x legislation” is faced in many countries that are under development, or even those that require such kind of load transportation through their

logistics network. Another point worth considering is to beat the Origin-and-Destination-of-the-load challenge; whatever the scenario these two extremes are located under, we must develop projects to meet such demand.

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