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STUDY OF EXPENDITURE IN CONSTRUCTION OF TRAM IN ENCLOSED AREA

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Abstract - A tram (also known as tram car), is a rail vehicle which runs on tracks along public urban streets street running, and also sometimes on a segregated right of way. The lines or networks operated by tramcars are called tramways. Tramways powered by electricity, the most common type historically, were once called electric street railways. However, trams were widely used in urban areas before the universal adoption of electrification.

Tram lines may also run between cities and towns, Very occasionally, trams also carry freight. Tram vehicles are usually lighter and shorter than conventional trains and rapid transit trains, but the size of trams (particularly light rail vehicles) is rapidly increasing. Some trams may also run on ordinary railway tracks, a tramway may be upgraded to a light rail or a rapid transit line; two urban tramways may be connected to an interurban, etc.

(i)

For all these reasons, the differences between the various modes of rail transportation are often indistinct.

Today, most trams use electrical power, usually fed by an overhead pantograph; in some cases by a sliding shoe on a third rail, trolley pole or bow collector. If necessary, they (ii) may have dual power systems — electricity in city streets, and diesel in more rural environments.

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Key Words: planning of tram, tram, bill of quantities, electric tram

1. INTRODUCTION

Tramways or light rail transit (LRT) is a medium capacity mode of mass rapid transport which straddles between the heavy capacity Metro rail and the low capacity bus services. It is a form of rail transit that utilizes equipment and infrastructure that is typically less massive than that used for heavy rail modes i.e. commuter/regional, and metro rail/subway. A few modes such as people movers and personal rapid transit could be considered as even "lighter". Tram may be at grade, partially grade-separated or completely elevated.

Worldwide data (2013) shows that tram has been adopted in 436 cities (includes 39 under construction and 30 under planning). Some of the countries are; Algeria, Argentina, Armenia, Australia, Brazil, China, Colombia, Denmark, Finland, France, India, Indonesia, Iran, Iraq, Israel, Italy, Japan, Korea South, Morocco, Netherlands, New Zealand, Norway, Panama, Romania, Russian Federation, Saudi Arabia, South Africa, Spain, Switzerland, Taiwan, Turkey, United Arab Emirates, United Kingdom, United States, Viet Nam. International experience of 436 LRT(Tramways) systems worldwide confirms that LRT is the most successful medium capacity mode, with over 100 years of development behind it, yet incorporating the latest technology for the future.

In India Tram is currently operating in Kolkata and also in few more cities around the World. However most tram systems operating around the World are the upgraded version of tram. Salient features of Tram are as follows:-

In the traditional tram, the tracks and trains run along the streets and share space with road traffic. Stops tend to be very frequent and use roads as platform for the purpose. Because road space is shared, the tracks are usually visually unobtrusive and paved in the road surface.

But now days, the trams run along their own right-of-way and are often separated from road traffic. Stops are generally less frequent, and the vehicles are boarded from a platform.

Many tram systems have a combination of the two, with both mixed and segregated right of way.
(iv) The traditional tram is often less expensive by a factor of two or more. Despite the increased cost, modern tramway or LRT is the current dominant form of urban rail transit development.

2. HISTORY

Tram, streetcar or trolley systems were common throughout the industrialized world in the late 19th and early 20th centuries, but they disappeared from many cities in the mid-20th century. In recent years, they have made a comeback. Many newer light rail systems share features with (or utilize) trams, although a distinction is often drawn between the two, especially if the line has significant off-street running.

The first tram was on the Swansea and Mumbles Railway in south Wales, United Kingdom. Horse-drawn at first, it was later powered by steam and electricity. In 1804, the Mumbles Railway Act was passed by the British Parliament, and the first tram (similar to streetcars in the US some 30 years later) was established and started operating in 1807.

The first streetcars, also known as horse cars in North America, were built in the United States and developed from city stagecoach and omnibus lines that picked up and dropped off passengers on a regular route without the need to be pre-hired. These trams were an animal railway, usually using horses and sometimes mules to haul the cars, usually two as a team. Occasionally other animals were put to use, or humans in emergencies.[citation needed] The first streetcar line, developed by Irish-American John Stephenson, was the Fourth Avenue Line of the New York and Harlem Railroad, which began operation in 1832 along Bowery and Fourth Avenue in New York City. A streetcar line was established in New Orleans, Louisiana in 1835, which is the oldest continuously operating street railway system in the world according to the American Society of Mechanical Engineers.

In India, horse-drawn tram service was begun on 24 February 1873 between Sealdah and Armenian Ghat Street; due to inadequate ridership, the service ended on November 20 of that year. The British registered the Calcutta Tramways Company, Limited as a joint stock company in London in 1880. Before 1900, the trams were horse-drawn; that year, the process of electrification began.

In 1951 the government of West Bengal entered into an agreement with the CTC, and the Calcutta Tramways Act was enacted. The government took over all rights regarding the tramways; it reserved the right to purchase the system on 1 January 1972 or any time thereafter, with two years' notice. In 1967 the government of West Bengal passed the Calcutta Tramways Company (Taking Over of Management) Act, and assumed its management on 19 July 1967. On 8 November 1976 the Calcutta Tramways (Acquisition of Undertaking) Ordinance was enacted, under which the company vested all its assets with the government; it is now a public-sector undertaking.

3. FEATURE OF TRAMWAY

Tramway is a low cost, low axle load, eco-friendly, electrically propelled system with no local pollution and low noise and vibrations. Light rail vehicles (LRV) generally have a top speed of around 100 km/h though mostly operating at much lower speeds, more akin to road vehicles. Tramway features include: Steel wheel vehicles operating on steel rails and are almost universally operated by electricity delivered through overhead lines or by ground level power supply. Electric power provides greater acceleration, making it suitable for operation with closely-spaced stations.

- Grooved steel rails laid flush with road surface or ballasted like normal railway track, making light rail the only system which can operate on both city roads and jointly with conventional rail services.

- Sharp road bends up to 25m radius, minimizing need for property acquisition and hence ideal for urban environment. Steeper inclines than heavy rail.

- Shares its operational space with other road vehicles (e.g. automobiles) and often runs on, across or down the center of city roads.

- Grade separation only in exceptional circumstances

4. PLANNING AND DESIGN OF TRAM

- For an economic transport network, it is necessary that capacity of the chosen mode matches the future projected demand level in a corridor. Over-provision in a corridor will be uneconomic

- Tramway offers the best safety, minimum pollution, conservation of fossil fuel and minimum land requirement

- The system design includes arrangement of Power Supply, Overhead traction or ground level power supply equipment, Fare Collection system, Articulated Rolling Stock for negotiation of sharp curves (each about 40m long), Depot & Workshop requirements and Track structure. One centralized maintenance and overhaul Depot for Rolling Stock, Signaling, Communication & other equipment is required. Approximately 1 hectare of land is required for the Depot.

- Different sources can be used to power the Tram. Some can be used individually or can be integrated with each other (i.e., hybrid). The sources are as shown in table 1

Table-1 Classification of tram

Automotive engine	Diesel engine
Other Systems	Electricity (DC)
	Solar
	Gasoline (LPG, Hydrogen, etc.)
	Electromagnetic
Hybrid	Electric-solar
	Electric-diesel
	Gasoline-electric

5. STAFF REPORT

A Working committee consisting of the coordinator heritage site, Transport Engineer, Park Planner, engineering cost Estimator and two representatives.

A Market Review including a stakeholder survey and public opinion survey were conducted with the majority of respondents very supportive of the project. Engineering and transportation requirement were and criteria for route alignment and building location were established while still adhering to the provincial operating rules that govern student railway. We have provided the cost estimation to establish the tram in our campus. Preliminary Capital cost was established and very rough estimates for operating cost and potential revenue were projected.

6. ROUTE OPERATIONAL REQUIREMENT

Specific requirement for right of way, crossings etc. are outline in operating rules that governs railways.

1. Alignment- the following criteria for route alignment were established:-

(a). Adequate space for track and overhead trolley right of way.

(b) For visibility and therefore market viability.

(c) Owned land or existing road right of way.

(d) Adequate space available.

(e) Surrounding area, including built and landscape environment.

(f) Cost

2. Geotechnical- Further geotechnical studies are not required at this time as all proposed routes are within existing or new roadways or along reinforced dyke.

3. Track work- The tram runs on standard gauge track 85lbs rails that are 4' 81/2" apart supported by an 8' tie every 18". A right of way approximate 20' is required. The tram can turn within radii of approximately 30' if necessary and much more easily within a 90' radius.

4. Electrical- The power supply required to operate the tram is 600 volt direct current, therefore a rectifier station is required to convert BC hydro's alternating current power supply to DC. Trolley poles are also required every 100' along the track to carry the wires that supply the tram.

5. Support Building and Stations- Workshop is needed to house the tram and provide space for regular maintenance of vehicle. An office for administration associated with operating the tram. A Station which is raised of platform and shelter is required at each stop along the proposed routes to accommodate passengers loading and unloading.

7. VARIOUS SYSTEMS FOR TRAMS

1. Diesel Tram: The attraction of diesel trams does not merely lie in their ability to operate as urban street vehicles. A standard diesel locomotive presents a very low fire risk but "flame proofing" can reduce the risk even further. This involves fitting a water-filled box to the exhaust pipe to quench any red-hot carbon particles that may be emitted. Diesel has an energy density of 37.3 MJ/L. So we can say that, Trams can move a ton of freight over 480 miles (772.49 km) on a single gallon (3.8 liters) of fuel. A standard weight of fully loaded tram is about 40 tones. Therefore, on calculating (772.49/(40*3.8)) gives 5km, which means a tram will give a mileage of 5 km/1 liter of diesel. Hence, a diesel tram will consume 7.46 MJ/km.

2. Electric Tram Trams operating at various voltages all over world:-

400-600 V DC (This voltage is mostly used by older tram systems worldwide but countries like Australia, Belgium, Canada, Japan, India, England, Poland are still using it).

600-750 V DC (This voltage is used for most modern tram systems like in countries India, Japan, Germany, Norway, Switzerland, UK, US).

1000-1,200 V DC (In countries like Cuba, Germany, Hungary, Spain)

According to an analysis on tramways by an agency following data is collected in table no 2

Table:2 Chronological order of tram construction

Tram Delivered in year	1965-1967	1969-1972	1998-2002	2004-2012
Weight (ton)	16.8	17.0	34.5	38.9
Length (m)	15.1	15.1	30.7	29.6
Sitting capacity	38	36	81	82
Standing capacity	78	82	109	104
Nominal power (kW)	176	200-250	300-400	420-550

Various tram systems in various countries are operating at different power of electric voltages. We can use any range of voltage to power our tram by considering various factors like efficiency, economy, etc.

Electricity can be provided to trams by various methods, such as:-

A. Overhead power supply

Overhead line is designed on the principle of one or more overhead wires (or rails, particularly in tunnels) situated over rail tracks, raised to a high electrical potential by connection to feeder stations at regular intervals. The feeder stationsare usually fed from a high-voltage electrical grid.

Electric trains that collect their current from overhead line use a device such as a pantograph, bow collector or trolley pole. It presses against the underside of the lowest overhead wire, the contact wire. Current collectors are electrically conductive and allow current to flow through to the train or tram and back to the feeder station through the steel wheels on one or both running rails.

Overhead power supply can be done by various methods some of them are:-

- Overhead contact system (OCS)
- Overhead line equipment (OLE or OHLE)
- Overhead equipment (OHE)
- Overhead wiring (OHW) or overhead lines (OHL)
- Catenary
- Trolley wire

B. Conduit current collection

The power rails for conduit are contained in a vault between and underneath the running rails, in much the same fashion as the cable for cable cars. The vault contains two "T" section steel power rails of opposite polarity facing each other, about 12 inches (30.5 cm) apart and about 18 inches (45.7 cm) below the street surface. Conduit current collection was one of the first ways of supplying power to trams but it proved to be much more expensive, complicated and trouble-prone than overhead wires. When electric street railways became ubiquitous, it was only used in those cities that did not permit overhead wires, including London, Paris, Berlin, Marseilles, Budapest and Prague in Europe and parts of New York City and Washington DC in the United States.

A. Ground-level power supply

It is also known as APS (Aesthetic Power Supply) or Wireless Tram. It is a modern method of third-rail electrical pick-up for street trams. It was invented for the Bordeaux tramway (Tramway de Bordeaux), which was constructed from 2000 and opened in 2003. Until 2011, this was the only place it was used, with proposals to install it elsewhere. Reims has adopted this technology for its new Reims Tramway (Tramway de Reims), which was opened in 2011, as have Angers (Tramway d'Angers) and Dubai (Al Sufouh Tram).Ground-level power supply is used, primarily for aesthetic reasons, as an alternative to overhead lines. It is different from the conduit current collection system which was one of the first ways of supplying power to a tram system by burying a third and fourth rail in an underground conduit between running rails.

Benefits of Ground level Power Supply

•Elimination of catenaries

•Preservation of historic sites, trees along the track and the overall urban environment

•Unlimited power supply (as opposed to power storage systems)

•Compatibility with all types of road surfaces

•Elimination of wayside masts, limiting footprint and allowing wider tram vehicles to circulate

•Easy extension of the system if the line is extended

•High availability for optimum operational performance due to the simplicity of the concept, inspired by power supply rails used in metros

•Proven resilience, both in degraded mode and disrupted conditions of service (traffic jam at intersection for instance)

•Total safety for passengers, pedestrians and road traffic

So, it is concluded by the above discussed different ways of power supply that power will be supplied through the ground level.

Table 3: Electric tramcars characteristics:

Length	29.40 m (96.5 ft)
width	2.30 m (7 ft 7 in)
height	3.36 m (11.0 ft)
Gross weight	44.2 tonnes
Power	550 kW
Speed	70 km/h (43 mph)
Passenger capacity	52/125

According to Wikipedia a standard electric tram consumes 1.649 MJ/km which is less than diesel tram. So here electric tram is more efficient.

a. a. Solar Tram

In several cases, this is one chiefly powered by fossil fuels. However, an ambitious blueprint for an entirely solar-powered tram network has been revealed for Melbourne, the capital city of Victoria, Australia. The Australian Solar Group (ASG), the company behind this proposal, has been in negotiation with various state (Victorian) government bodies for the past four years about establishing this project. Progress appears to have been made and is one step closer towards gaining approval form the Victorian Government. Solar power has grown exponentially in its potential to provide power not just to stationary homes and businesses, but various modes of transportation as well. A solar-powered car built by Australian engineering students just drove over 300 miles on a single charge, rivaling even the mighty Tesla Model S for EV range.

Solar tram is fitted with an array of photovoltaic panels, which are mounted on the roof and cover an area of about 106 square feet. The panels feed batteries installed under the seats, which also are powered by a regenerative braking system. This means that tram can be operated exclusively using onboard solar power, although the batteries also can be charged from external power sources (which, in turn, may be fed by local solar cells).

b. 4. Gas Tram

The tramcar 'exactly similar in size, shape, and capacity to a cable grip car' had the 'motive power' of gas 'with which the reservoir is to be charged once a day at power stations by means of a rubber hose'. The car also carried an electricity generator for 'lighting up the tram and also for driving the engine on steep grades and affecting a start'.

Comparatively little has been published about gas trams. However, research on the subject was carried out for an article in the October 2011 edition of "The Times", the historical journal of the Australian Association of Timetable Collectors, now the Australian Timetable Association. A tram system powered by compressed natural gas was due to open in Malaysia in 2012, but as of June 2015 there was no evidence of anything having happened; news about the project appears to have dried up.

8. DETAILED ESTIMATE OF TRAM

Table no 4. Detailed estimate of tram

Sr No.	Description of work	L (m)	W (m)	H (m)	Qty (m3) / No.	Rate/ m3	Price (Rs)
(i)	MATERIALS						
	Excavation	1	1.48	0.73	1.08	70	75
1.	Aggregates (40mm)	1	1.48	0.3	0.44	1000	440
2.	PCC Work (1:5:10)	1	1.48	0.18	0.26	3000	780
3.	RCC Work (1:1.5:3) @ 1% steel	1	1.05	0.15	0.157	4000	628
5.	G.I/C.I Sheet				8 kg	100/kg	800
6.	Rail Section				2	105/m	210
7.	Central Rail				1	180/m	180
Total							3113

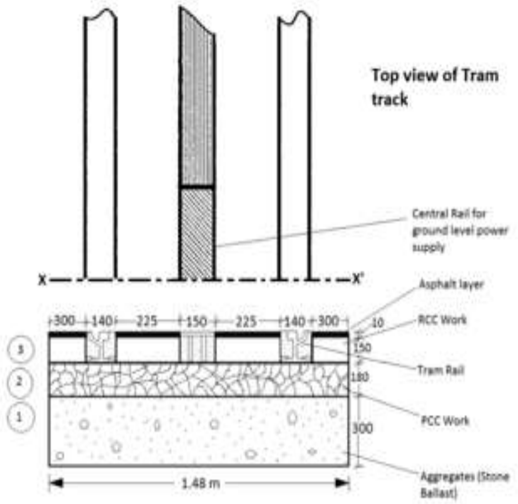

Figure:1

(ii)	LABOUR	Qty	/ Day	Price (Rs)
	Head Mason	1	400	400
	Mason	2	350	700
	Mazdoor	6	300	1800
	Coolie	8	250	2000
	Bhisti	2	200	400
	Sundries (T & P)	Lump Sump	150	150
Total				5450

9. CONCLUSION

For an economic transport network, it is necessary that capacity of the chosen mode matches the future projected demand level in a corridor. In our university right now there are more the 20,000 students and few thousands faculty members (including teaching and non- teaching staff). And as we know that our university is fastest growing in Asia, so our university campus area will keep increasing in future and no of students will also increase.

Many of us are facing a problem that we have to walk from one building to another for many works. This problem can be solved by introducing a Light Rail Transit System (i.e., TRAM)

Trams offer the best safety, minimum pollution, conservation of fossil fuel and minimum land requirement. These Trams will run on electric power, which can be provided either by overhead supply or by ground level power supply (APS-Aesthetic Power Supply). Its capacity would be 200 persons per buggy on a trip and could be increased on demand.

This Tramway will provide a unique identity to our university, not only in India but overseas also. Because this system is operates only in few universities in the world.

By considering all types of trams, we will choose electric trams with ground level power supply because it is the most efficient, economical, ecofriendly to our university campus.

This project can be completed in 4 to 6 months and estimated cost for track formation is 66.71 lacs rupees. And other charges will tram itself which could cost about 20 lacs per wagon (buggy). So, according to our report analysis we can operate 3 pairs of tram on our routes.

Hence the total cost of tram project would be 186 lacs (i.e. 1.86 crores rupees)

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