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Analysis On the Deteriorated Road Drainage System in the City of Srinagar

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ABSTRACT- A study was conducted in the city of Srinagar India to find out the possible causes of poor drainage in the city. Preliminary surveys and various tests were conducted to find out the possible cause of the poor drains in the city. Every year during the monsoon season the drains get clogged and water level rises and the condition of roads become worse and commuters are unable to walk on them. In 2014 the drastic floods lashed out the whole city of Srinagar and caused social and economic problems. Every year the Government spends a huge amount of funds to repair the road infrastructure of the city but at the end of the year the condition of roads remains still deplorable. Study revealed that use of poor construction materials, improper engineering practices and corruption leads to all this. Solutions to curb this menace were forwarded at the end.

KEYWORDS- Srinagar, Roads, Poor Drainage, Early Failure, Deterioration.

I. INTRODUCTION

Roads play an important role in the country's overall economy. Roads are one of the most important factors that contribute to a country's growth. Aside from that, highways employ thousands of young people in one way or another. Roads led to the inauguration of numerous projects that aid in the development of an area's infrastructure. According to surveys, effectively maintaining road infrastructure is critical to preserving and enhancing such advantages. However, a backlog of unfinished maintenance has resulted in permanent degradation of the road network. If roads are not properly maintained, they may require replacement or substantial repairs after only a few years. This degradation quickly spreads over a road system, resulting in skyrocketing costs and a significant financial effect on the economy and residents. The main reason for the frequent maintenance arises as the material that has to be used during the construction is usually of very poor quality. Apart from this, overloading on the roads of India has been a common problem from the past. A pavement is designed to withstand a particular load but when overloaded trucks run on these low specification roads the roads fail and lead to the mess. Further in some cases the climatic conditions are such that lead to the damage of the road pavement.

Roads are a vital means of transportation in India. As of March 31, 2017, India had a road network of over 5,897,6719 kilometers (3,664,643 miles). The Road and transport Wing of the Ministry is in charge of developing broad policies for the management of road transport in the nation, as well as arranging provisions for the flow of motor traffic with surrounding countries. Enhancing the country's road safety situation is one of the Road Transport Wing's most critical and difficult tasks. Driving over most Road networks, in general, means dealing with inadequate construction and traffic congestion, which has a negative impact on travel time and road safety. It does not speak well for the country's brisk business growth and demonstrates inefficiencies in the movement of products and services throughout the country.

A. Necessity of Road Drainage

Although virtual connectedness is becoming increasingly crucial with the advent of new communication routes, a robust and dependable transportation network remains critical. The necessity of good road drainage arises as:

A.1. The road network is very essential for a nation so the road network must be properly maintained.

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A.2. The moisture in the base of the pavement can pose a number of problems thus adequate precautions must be taken to curb it.

A.3. Proper design of the pavement is very much necessary as it plays a pivotal role in the draining of water.

A.4. Roads need to be well drained so that excessive water does not get accumulated on the surface of pavement.

A.5. The pavement damage can be minimized to a great extent if proper engineering is done for the road construction.

B. Roads in Srinagar City

Every year the Government is trying its best to construct more and more roads in the valley of Kashmir. But soon after a year the conditions of roads become such that a person will not acknowledge that the roads might have been repaired or constructed. Notwithstanding the fact that the government spends a large amount of money on the macadamization process every year throughout the

season, the decrepit roads throughout Srinagar and elsewhere in the Valley provide a negative image to tourists. This year to the government intends to macadamize the Valley's roadways. There are some roads where macadamization becomes increasingly important with each passing year due to their poor state. After a few weeks of macadamization, the roads become bumpy adding to the commuters' misery. However, inadequate drainage is the major reason for the poor state of roads in Srinagar [3]. Apart from this there are many factors that are responsible for the cause. In Kashmir all the roads are constructed without any proper drainage system. No super- elevation and no camber is provided to the roads as per the IS Codal specifications.

Every year a few centimeters of rainfall in the city causes chaos. Government has to shut down the institutions as the roads become non motorable.

The Public Works department usually constructs the roads in the vicinity of Srinagar which is the capital of J&K. But most of the roads are usually choked and are not cleaned on a regular basis. Srinagar Municipal Corporation also shows their negligence towards the proper maintenance and hygiene of these drains. Thus from the reasons it is obvious that the improper engineering practices are responsible for the poor drainage of roads in the city of Srinagar.

The 2014 floodwaters devastated the city, and the major cause was a weak drainage system and insufficient maintenance. Recently, in March 2021, a small amount of rainfall clogged all of the drains, causing major water logging throughout the city.

Figure 1: City Centre Lal Chowk

Figure 2: City Hub Karan Nagar Srinagar

Figure 3: Batamaloo to Bemina

Figure 4: Pantha Chowk to Sonwar

Figure 5: Foreshore Road Srinagar

The above images clearly speak a lot about the roads of the Srinagar city.

The main objectives of the study are:

- Identifying the primary causes of Srinagar's inadequate water drainage system.
- Factors influencing the structural and functional performance of these roadways and drains.
- Best practices for corrective procedures for these issues.
- To analyze the impacts of environmental and social change caused by a faulty drainage system.

- To provide recommendations after examining the entire circumstance.

II. LITERATURE REVIEW

- Amit (2016) A study on highway surface drainage systems and water logging problems was conducted substandard highway alignment, absence of shoulders and shoulder problems, absent or inadequate pedestrian facilities, small and faulty lanes, roadside hazards, and ambiguous pavement were determined to be undesirable roadway characteristics leading to traffic accidents [8]
- According to the findings of this study, effective drainage is a vital concern in roadway design. Inadequate drainage systems can cause the roadway to degrade prematurely and the emergence of dangerous safety circumstances like hydroplaning [1]
- Muhammad (2014), Another researcher investigated road drainage systems and discovered that drainage is critical for removing water from the road surface, preventing water ingress into the pavement, passing water across the road, either under or over, and preventing scour and/or washout of the pavement, shoulder, batter slopes, water courses, and drainage structures.This is significant because water damages roadway structures in a variety of ways. Waters that are hazardous to pavements include: Rainwater can cause surface erosion or seep downward and harm pavement.
- Navpreet (2014) According to Navpreet's research on road drainage, well-designed and well- maintained road drainage is essential in order to: minimize the ecological footprint of road runoff just on receiving water environment, ensure the expeditious removal of groundwater to enhance safety and minimize disruption to drivers on the road, and to maximize the longevity of the road surface and associated infiltration.Water in the pavement system can cause moisture damage, modulus decrease, and strength loss. It is critical to ensure appropriate road drainage in order to prevent such pavement degradation. They claimed that the presence of water in a roadway layer lowers beeriness [7]
- Rokade et al., 2015, According to him inadequate drainage is a primary cause of pavement distress since it necessitates a high number of costly repairs before the pavement reaches its intended life. He discovered that if water can be evacuated without delay, pavement service life may be improved by 50 percent [4]
- Similarly, pavement systems with adequate drainage may be anticipated to last two to three times as long as undrained pavement portions. He then calculated that a flooded, undrained pavement suffers 10 to 70,000 times the damage from a load incident as a drained pavement. He proposed that a un - drained pavement sustains 150 times the damage as a well-drained pavement.
- Bath and North East Somerset Council (2016), According to them highway drainage should achieve the following goals: prevent flooding, ponding, and seepage, and keep the carriageway, cycleway, and footway as free of standing water as possible; ensure surface water falling on the highway enters the drainage system or natural watercourse as quickly as possible; and keep the underlying road structure as dry as possible. The council argued that roadway drainage requires periodic maintenance in order to function properly.
- Magdi (2014), A versatile researcher, investigated the effects of inadequate drainage on road performance in Khartoum, Sudan; efforts were made to determine the causes of road failure during the first five years as a result of bad drainage.In this regard, it was discovered that four basic reasons contribute to the early worsening of pavement layers in the study. These factors include, according to the research, improper drainage engineering and implementation, a poorly maintained structure, the use of poor materials, and the lack of a native practice standards [5]

III. RESEARCH METHODOLOGY

I examined the important and oldest areas of the city of Srinagar, such as Lal Chowk, Batamaloo, and the Foreshore. During the rainy season, these locations frequently experience water logging.

A. Identification of study sections

- ***Lal Chowk to Karanagar***

Lal Chowk to Karanagar is one of Srinagar's oldest roads, as well as the city's market center (Figure 1 & 2 respectively). The road has a single lane with a length of 2 kilometers and a width of 20 feet. A 0.75 km section was chosen for research purposes. The road had been repaired numerous times in the previous ten years, yet it still suffered from significant distress.

- ***Foreshore Road Srinagar***

Foreshore Road is one of the most prominent roads in Srinagar (Figure 5). The road's significance stems from the fact that it runs entirely along the shores of Dal Lake. The route begins in Hazratbal and finishes at Nishat. It is around 5 kilometers long and suffers from water logging during the wet season. For research purposes, a length of around 1 km was chosen.

- ***Batamaloo to Bemina Road***

It is also an important route and is just around 2.5 kilometers from Lal Chowk, the city center (Figure 3). This specific road is in poor shape. It expresses the ugliness of administration and engineering. During the course of the investigation, this route was also investigated.

- ***Pantha Chowk to Sonawar***

This is also an important road section of Srinagar that acts as an alternate way for all the vehicles that come from the Southern part of the valley (Figure 4). It is around 5 Km in length and usually remains jammed as a number of important institutions lie on this road

IV. EXPERIMENTAL STUDY AND RESULT

The strategy followed in this research was first started with problem identification which has been done through literature review, study and informal discussion with

colleagues and professionals in the sector; and then the research design was formulated.

A. Laboratory Studies

Samples were gathered from all sites by digging test pits and packing them in airtight plastic bags to keep the moisture in while transferring them to the laboratory. For both WBM and GSB materials, multiple samples were obtained for each test, and the results were averaged. WBM and GSB Grading Samples were taken to determine if the proportion of material passing through a certain sieve size is within the MoRTH limitations [6]. The particle size distribution, or gradation, of an aggregate is a critical aggregate property in determining pavement performance. Some of the essential qualities regulated by aggregate gradation include permeability, moisture susceptibility, stability, stiffness, and durability. Gradation of screens ensures that the proportion of fines in the mix is not too high, preventing the layer's drainage ability.Apart from this various tests were done on the aggregates to find the relation between the early damage of pavements due to poor aggregates and drainage.

B. Granular Sub Base (GSB)

It is a natural or engineered building material used as a sub-base layer in road construction. Granular Sub Base is a road foundation layer that sits just above the compacted subgrade layer.In this study firstly Gradation of Granular Sub Base component layer material for Km 1 and then Km 2 from Lal chowk to Karanagar was conducted as shown in the Table 1 and Table 4 respectively to assess the particle size distribution of a granular material by allowing the material to pass through a series of sieves The granular sub-base, or GSB, inhibits capillary water from rising; its particle size is chosen in such a way that capillary action ceases and cannot proceed beyond the GSB layer. Second, it acts as a drainage layer, allowing water to move through without harming other road layers. It should adhere to Grading-I of MORTH standard Table 400-1, with the proportion passing 0.075mm size limited to 5%.

C. Water Bound Macadam (WBM)

WBM road is an abbreviation for water-bound macadam road. The WBM road wearing surface is made up of clean and crushed stones that are mechanically linked by rolling. The material is bonded with filler material (also known as screens) and water before being put on a prepared foundation course.Here the Gradation of WBM component layer material from Lal chowk to Karanagar was also conducted as shown in the Table 2 and Table 5 in order to see whether the results are as per the IS Code standards. Binding material which is going to be used for the construction of WBM road should be properly approved by engineers and it should have a plasticity index value less than 6. Also the Gradation of screening material of WBM component layer for the same place mentioned above was conducted as shown in the Table 3 and Table 6 in order to see whether the proper engineering practices that are vital in the field of construction are really considered and taken care of.

D. Sieve Analysis Test

- Step 1: Collect a typical oven-dried sample weighing around 500g.
- Step 2: If the particles are clustered or consolidated, use the spatula to smash the lumps but not the granules.
- Step 3: Accurately determine the mass of the sample — (g).
- Step 4: Make a test sieve stack. The sieves are piled in ascending order, with the greatest aperture size on top and the smallest at the bottom. To gather samples, a receiver is put beneath each sieve.
- Step 5: Separately weigh all of the sieves and the pan.
- Step 6: Pour the samples from step 3 over the top of the sieve stack and secure the lid, then place the stack in the sieve shaker and tighten the clamps, adjusting the timer to between 10 to 15 minutes, and then turn on the shaker.
- Step 7: Turn off the sieve shaker and weigh each sieve and retain soil/material.

After the experiment, the beginning sample weight must be observed and compared to the total weight of the sample retained on the sieves. If the value of the completed sample deviates from the beginning weight by more than 2%, the analysis and sample should be rejected. Technically, sample losses can lead to analytical errors and inaccuracies.

Laboratory Studies:

Granular Sub Base (GSB)

E. Crushing Test

It is an important laboratory test which gives us ideas about the strength of an aggregate to be used for the construction. The aggregate crushing value is indeed a relative measure of crushing resistance under a progressively applied compressive stress. To achieve a high level of pavement quality, aggregate with a higher crushing strength, i.e. a lower crushing value, should be selected. Smaller crushing value implies stronger strength since it represents a lower crushed percentage under load. This results in a longer service life and a more cost-effective performance. As per Codal provisions Crushing value should not exceed 30 % for an aggregate to be used in construction purposes.

F. Impact Test

Water bound Macadam (WBM)

The crushing value of aggregates is calculated as (W2/W1) × 100 and value is expressed in %.

During and after construction, aggregate may be exposed to a violent shock or impact. These loads are distinct from the compressive loads that are progressively imposed. Aggregate breaks down into smaller pieces as a result of such stresses. The aggregate impact test is used to measure the impact resistance of aggregate. The aggregate impact value indicates how much impact load the aggregate can withstand. Actually, aggregate should be strong enough to withstand impact disintegration. The impact value test is used to assess this distinguishing characteristic.

The aggregate impact value equals the abrasion test result. The impact value of aggregate should not exceed 30% when used for a surface wearing course and should not exceed 45 percent when used for a surface other than a wearing course.

SIEVE ANALYSIS TEST

- ***Apparatus***
  - Aggregate impact apparatus,
  - IS sieves (12.5 mm, 10.0 mm and 2.36 mm),
  - Cylindrical measure and cylindrical cup,
  - Weighing balance,
  - Tamping rod.
- ***Procedure***
  - Take a sample of aggregate that has passed through a 12.5 mm sieve but has been kept on a 10 mm sieve.
  - Fill a cylindrical cup halfway with sieved aggregates.
  - Place the mold in the aggregate impact testing equipment and give it 15 hits with a metal hammer.
  - The crushed material should then be removed and seized using a 2.36mm sieve
  - The aggregate impact value is calculated by dividing the total weight of the sample by the percentage of aggregate passing through the 2.36 mm seize (W2) (W1).

G. Soundness Test

A soundness test on aggregate is performed to determine aggregate resilience to weathering action. Aggregates are susceptible to the physical and chemical impact of rainwater, groundwater, and other atmospheric pollutants. This might result in a change in volume, which is undesirable and poor for the durability of the building. The ability of aggregates to tolerate the detrimental effects of weather is referred to as aggregate soundness.
The soundness test is carried out to learn the resistance of aggregates to weathering actions like thawing, freezing, alternate wetting and drying in normal condition and variation in temperature in salt water. When aggregates fail to resist such conditions, then it is said to be unsound. Recommended results of the soundness test should not be more than 12 % and 18 % after 10 cycles when tested with sodium sulphate and magnesium sulphate respectively.

- ***Apparatus***
  - Sodium Sulphate or Magnesium Sulphate Solution,
  - Oven,
  - Weighing Balance,
  - IS Sieves,
  - Weight Balance.
- ***Procedure***
  - Take a weighted sample with some well aggregate.
  - For 16 to 18 hours, immerse the specimen in a solution of sodium sulphate or magnesium sulphate.
  - Place the aggregates in the oven to dry after soaking.
  - Follow this cycle as needed, and then weigh to see how much weight has got lost.

H. Road 1: Lal Chowk to Karanagar

- ***Results of Sieve Analysis***

Table 1: Gradation of GSB Component Layer Material (Km 1)

Sieve Size (mm)	Amount that passed %	Limit of Passing as per IS Code
75	94	100
53	82.57	80-100
26.5	76.21	55-90
9.5	64.30	35-65
4.75	46.46	25-55
2.36	42.18	20-40
0.425	25.15	10-25
0.075	12.48	3-10

IS sieves (12.5 mm, 10.0 mm and 2.36 mm),

Table 2: Gradation of WBM Component Layer Material (Km 1)

Sieve Size (mm)	Amount that passed %	Limit of Passing as per IS Code
90	95.76	100
63	83.75	80-100
53	76.31	55-90
45	65.45	35-65
22.4	46.79	25-55

Cylindrical measure and cylindrical cup,

Table 3: Gradation of Screening Material of WBM Component Layer (Km 1)

Sieve Size (mm)	Amount that passed %	Limit of Passing as per IS Code
13.2	99.19	100
11.2	94.26	95-100
5.6	24.45	15-35
180µ	11.25	0-10

Weighing balance,

Table 4: Gradation of GSB Component Layer Material (Km 2)

Sieve Size (mm)	Amount that passed %	Limit of Passing as per IS Code
75	92	100
53	81.56	80-100
26.5	75.15	55-90
9.5	62.95	35-65
4.75	45.15	25-55
2.36	43.66	20-40
0.425	25.10	10-25
0.075	12.29	3-10

Tamping rod

Table 5: Gradation of WBM Component Layer Material

Sieve Size (mm)	Amount that passed %	Limit of Passing as per IS Code
90	93.65	100
63	83.56	80-100
53	76.52	55-90
45	65.23	35-65
22.4	46.85	25-55

Take a sample of aggregate that has passed through a 12.5 mm sieve but has been kept on a 10 mm sieve.

Table 6: Gradation of Screening Material of WBM Component Layer

Sieve Size (mm)	Amount that passed %	Limit of Passing as per IS Code
13.2	99.78	100
11.2	94.65	95-100
5.6	24.45	15-35
180μ	11.56	0-10

Fill a cylindrical cup halfway with sieved aggregates.
The crushed material should then be removed and sieved using a 2.36 mm sieve.
From the Tables (1,2,3,4,5 & 6) mentioned above, it is clear that materials used for the pavement were weak and not suitable to resist the loads as they did not meet the standard criteria set as per the IS Code, which implies the roads were not durable enough and thus lead to the early failure. Therefore, it clearly means that the department doesn't take care of the proper engineering practices that are vital for the construction.

III. RESULT AND DISCUSSION

The city of Srinagar's roadways is in disarray. There are several reasons for this, but one of the primary causes is inadequate drainage. The following are the key observations made over the course of the research:

A. Poor Construction

Poorly executed building works are a significant element that contributes to poor road drainage in Srinagar. The major cause is a failure to use suitable engineering and construction procedures. According to the findings of the investigation, roads were built without adequate camber. Drains were built with an upward slope. To avoid a similar scenario in the future, engineers in charge of building works should strictly stick to the plans for that specific job.

B. Poor Maintenance

According to the research, it was apparent in the degradation of drainages and resulting pavement surface conditions, which are visibly noticeable in the form of road pavement edge breakdowns, pot holes along the motorway of road pavements, stripping of bitumen off the surface of road pavements, and obstruction of drainage channels such as storm drains and underground drainage networks. Furthermore, inadequate maintenance culture causes gullies and gratings to get clogged with mud, weed, silt, and sand build up over time, as well as the growth of vegetation inside and all around the side drains, resulting in the ultimate failure of the side drain structures.

C. Role of Residents

The attitude of people in the areas where these drainage channels are built and placed has a role in deciding the service life of these drainage systems. According to the report, homeowners have transformed drains into rubbish dumps, thereby transforming drains into dustbins. As a result, these drains become clogged.

D. Non-compliance with the town's current master plan

Prospective town developers who deviate from the original master plan cause drainage to deteriorate, which has a negative impact on road pavement quality. Many of the residences and retail complexes developed now in Srinagar are built on natural drainage ditches, which are frequently sand filled by property developers prior to the construction of their constructions.
As a result of the rising population and the carelessness of relevant departments in charge of town planning and development, such as the Srinagar Municipal Corporation and the LAWDA, property developers began constructing structures on natural drainage channels/courses, leading to reduced drainage life span and total collapse of the designed drainage structures and facilities. To halt this obnoxious trend, relevant government agencies in charge of town planning and development, such as the Ministries of Housing and Urban Development, should wake up to their responsibilities of ensuring that Very government-approved structures in accordance with the local planning master plan are erected on government-owned land.

Place the mold in the aggregate impac
The aggregate impact value is calcula

E. Poor Construction Material

Also the results done on aggregates showed that the quality of aggregates that were used during the construction of the road were not of good quality. All the main tests that are being done on the aggregates showed abnormal values for the above mentioned roads.

IV. CONCLUSION AND FUTURE SCOPE

Drainage is an essential aspect in evaluating a road pavement's capacity to survive the effects of traffic and the environment.

- Poor drainage conditions on road pavements have negative consequences and cause failures in a variety of ways.
- Proper and well-kept drainage systems for road pavements improve their life duration, but incorrect and poorly maintained drainage systems cause road pavement failure at an early age, significantly lowering their service lifespan.
- The real cause of the pavement section's reduced strength was discovered to be poor subsurface drainage caused by water entering the pavement

surface through cracks, rising ground water, seepage water through shoulders, and a huge proportion of fines in the GSB layer stopping effective pavement surface drainage.

- A pavement portion with adequate drainage requires thin overlay treatment just once in a design term of 10 years [2], but a roadway section with poor drainage requires thin overlay treatment repeatedly in the same design period.
- It was discovered that a big number of everyday commuter's experience significant challenges as a result of the inadequate drainage system.
- It was observed that the Vehicles were also requiring higher maintenance due to water logging problems.
- Materials that were used in the pavement were of poor quality and needed frequent maintenance which added burden to the government chequer.

Throughout pavement design, proper attention should be paid to the surface and sub-surface drainage of the pavement.

- A pavement degradation model, including the permeability factor, should be created.
- The ground drainage system should be maintained and inspected on a regular basis.
- The government should impose harsh penalties on individuals who block these drains.
- Roads and drains must be appropriately designed in accordance with engineering requirements.
- Proper Aggregate testings must be done on all the construction material that is to be used.

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