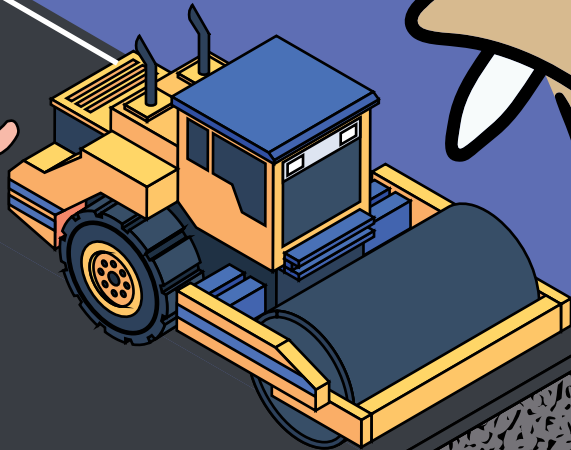
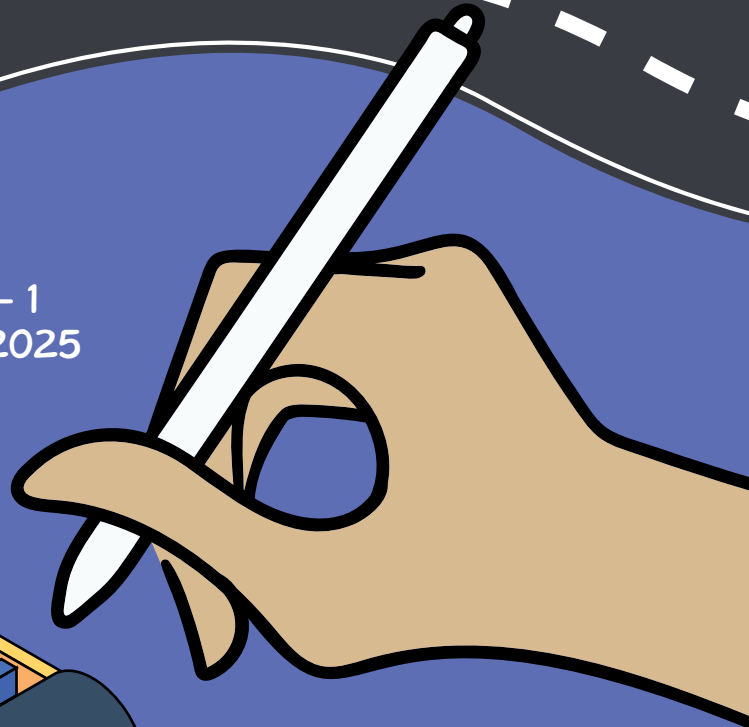


AN ILLUSTRATED
HANDBOOK FOR STANDARD
OPERATING PROCEDURES
FOR BENGALURU'S ROADS

NAMMA RASTE KAIPIDI



VERSION - 1
FEBRUARY 2025



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AN ILLUSTRATED HANDBOOK FOR STANDARD
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TITLE

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PUBLISHER

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MOD FOUNDATION

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WORLD RESOURCE INSTITUTE INDIA (WRI)

DATE OF PUBLICATION

FEBRUARY 2025

ILLUSTRATED, DESIGNED AND PUBLISHED BY



BRUHAT BENGALURU
MAHANAGARA PALIKE

SUPPORTED BY



WRI INDIA

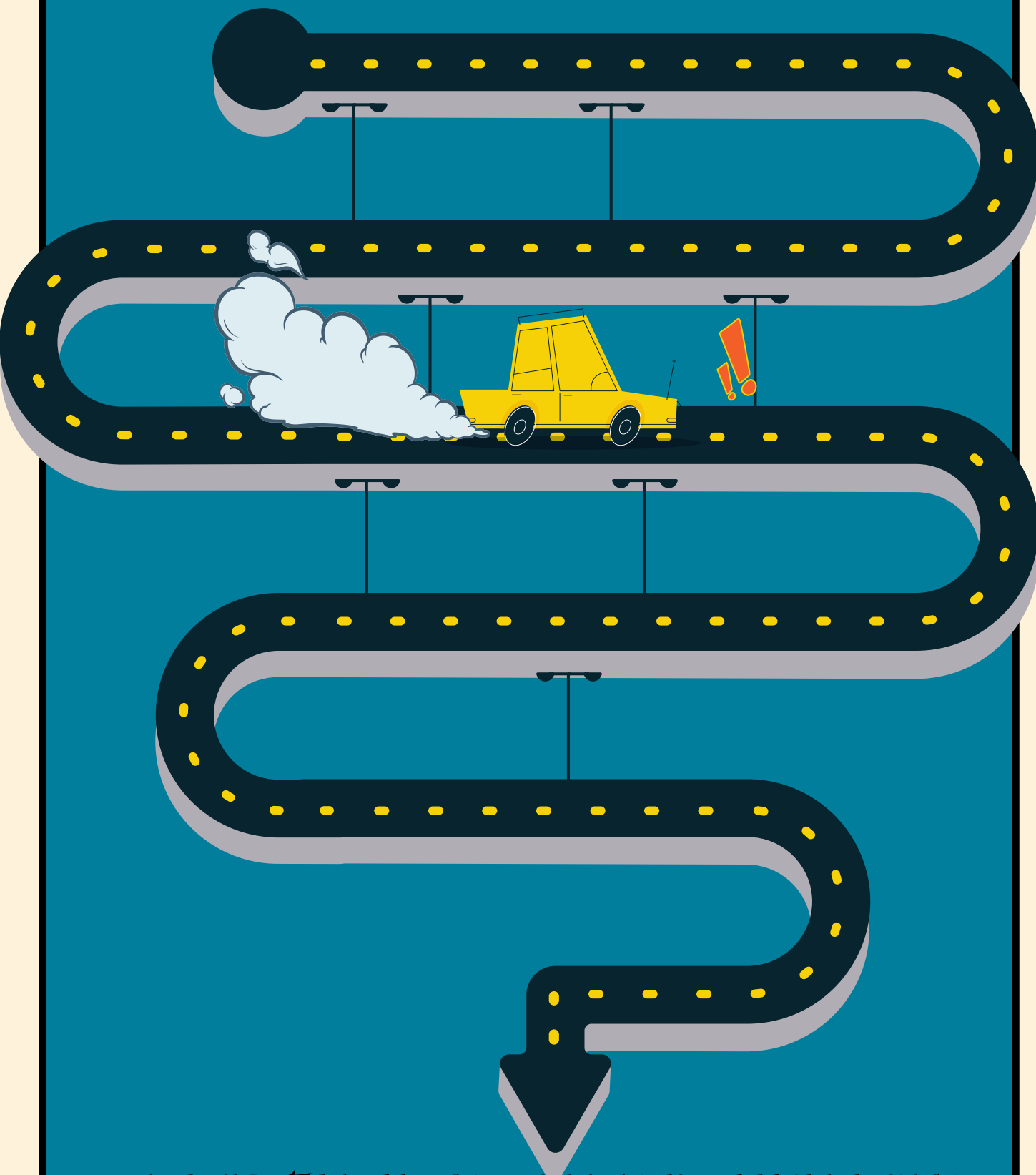


DISCLAIMER

THIS ILLUSTRATED HANDBOOK CONVEYS THE CITY'S ROAD DESIGN THROUGH CLEAR VISUALS, MAKING THEM ACCESSIBLE TO URBAN PLANNERS, ENGINEERS, GOVERNMENT OFFICIALS, AND THE PUBLIC. IT HAS BEEN ADAPTED FROM THE NAMMA RASTE KAIPIDI (MANUAL) PRODUCED BY WRI INDIA AND INCORPORATES RECOMMENDATIONS FROM THE EXPERT COMMITTEE ON THE PREPARATION OF THE MANUAL FOR ROAD DESIGN AND STANDARD OPERATING PROCEDURE.

NO PART OF THIS ILLUSTRATED HANDBOOK MAY BE REPRODUCED, STORED, OR TRANSMITTED IN ANY FORM (ELECTRONIC OR MECHANICAL) WITHOUT PRIOR PERMISSION FROM OR INTIMATION TO BBMP AND MOD FOUNDATION.

NANMA RASTE KAIPIDI



IN A TIME WHEN SAFETY, EFFICIENCY, AND SUSTAINABILITY ARE CRUCIAL, THIS VISUAL GUIDE IS AN ESSENTIAL RESOURCE FOR RESHAPING BENGALURU'S STREETS INTO SAFER, MORE INTELLIGENT, AND EASILY NAVIGABLE SPACES FOR EVERYONE.

AN ILLUSTRATED GUIDE FOR STANDARD OPERATING PROCEDURES OF BENGALURU'S ROADS (SOP).

A VISUAL HANDBOOK IS ESSENTIAL FOR EFFECTIVELY COMMUNICATING COMPLEX ROAD DESIGN PRINCIPLES AND STANDARDS TO A DIVERSE AUDIENCE, INCLUDING **URBAN PLANNERS, ENGINEERS, GOVERNMENT OFFICIALS, AND THE GENERAL PUBLIC.**

ROAD DESIGN STANDARD OPERATING PROCEDURES (SOPS) ARE OFTEN HIGHLY DETAILED AND TECHNICAL, MAKING THEM DIFFICULT FOR NON-EXPERTS TO UNDERSTAND. THIS GUIDE SIMPLIFIES THESE CONCEPTS THROUGH ILLUSTRATIONS, DIAGRAMS, AND VISUAL AIDS, MAKING THEM MORE ACCESSIBLE AND EASIER TO APPLY IN REAL-WORLD SCENARIOS. **FOCUSING ON THE UNIQUE CONTEXT OF BENGALURU, THIS ILLUSTRATED GUIDE PROVIDES CLEAR VISUAL REPRESENTATIONS OF THE CITY'S ROAD DESIGN AND UTILITY PLANNING STANDARDS.**

IT EMPOWERS STAKEHOLDERS TO CREATE **SAFER, MORE EFFICIENT STREETS** BY HIGHLIGHTING KEY PRINCIPLES SUCH AS **PEDESTRIAN-FRIENDLY INFRASTRUCTURE, ROAD CONSTRUCTION, AND INTEGRATED UTILITY PLANNING.** PROPER UTILITY DESIGN—COVERING ELEMENTS LIKE **DRAINAGE, STREET LIGHTING, UNDERGROUND UTILITIES, AND SIGNAGE**—ENSURES THAT BENGALURU'S ROADS ARE NOT ONLY WELL-CONSTRUCTED BUT ALSO **FUNCTIONAL, RESILIENT, AND FUTURE-READY.**

THIS HANDBOOK BRIDGES THE GAP **BETWEEN TECHNICAL EXPERTISE AND PRACTICAL IMPLEMENTATION,** ENSURING THAT ROAD DESIGN IS NOT ONLY EFFECTIVE BUT ALSO INCLUSIVE AND RESPONSIVE TO THE NEEDS OF ALL ROAD USERS.



MEET THE HEROES!

YOU GIVE ME THE **BLUEPRINT**, I'LL **BUILD THE ROAD** – BUT I'VE GOT QUESTIONS ALONG THE WAY!

GOOD ROADS DON'T JUST HAPPEN—THEY'RE **ENGINEERED WITH CARE!**

GOOD ROADS ARE LIKE GOOD DESIGN—**FUNCTIONAL, SAFE, AND BUILT TO LAST!**

DESIGNS LOOK GREAT ON PAPER, **BUT IT'S MY JOB TO MAKE THEM WORK IN THE REAL WORLD!**

LET'S GET THIS DONE!

SLOW & STEADY..

DESIGN MATTERS

EVERY STEP COUNTS!

CONTRACTOR NAGESH.
CONTRACTOR, BBMP

ENGINEER MANJUNATH.
EXECUTIVE ENGINEER, BBMP

URBAN DESIGNER GEETA.
SITE ENGINEER, BBMP

CONTRACTOR GOPI.
CONTRACTOR, BBMP

CONTRACTOR NAGESH PLAYS THE ROLE OF A CURIOUS AND EXPERIENCED CONSTRUCTION PROFESSIONAL WHO FREQUENTLY ASKS ENGINEERS QUESTIONS ABOUT THE BEST PRACTICES IN ROAD DESIGN, MATERIALS, SAFETY MEASURES, AND CONSTRUCTION TECHNIQUES. NAGESH'S QUESTIONS FOCUS ON HOW TO IMPLEMENT ENGINEERING CONCEPTS IN THE REAL WORLD, WHERE THINGS DON'T ALWAYS GO AS PLANNED. HIS QUESTIONS HIGHLIGHT THE CHALLENGES OF TRANSLATING THEORY INTO PRACTICE AND CONCERNS OF THE GENERAL PUBLIC.

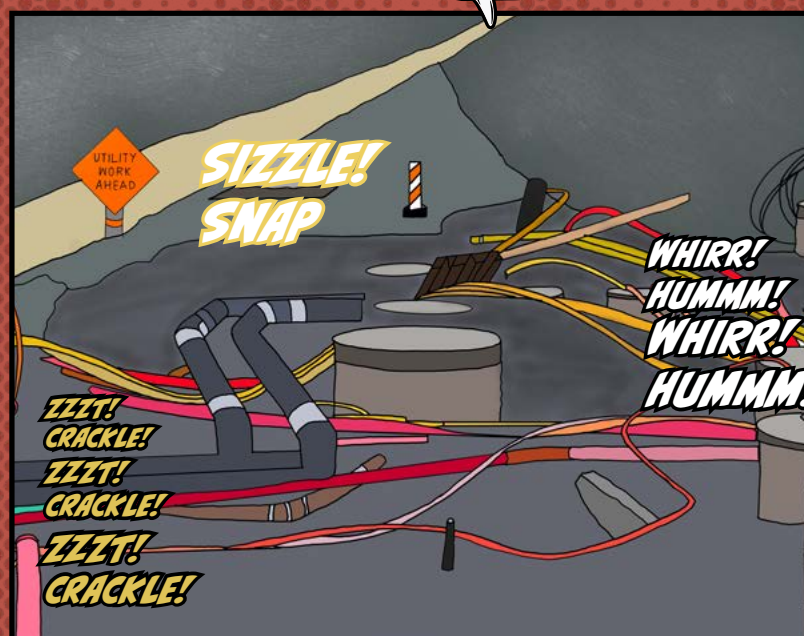
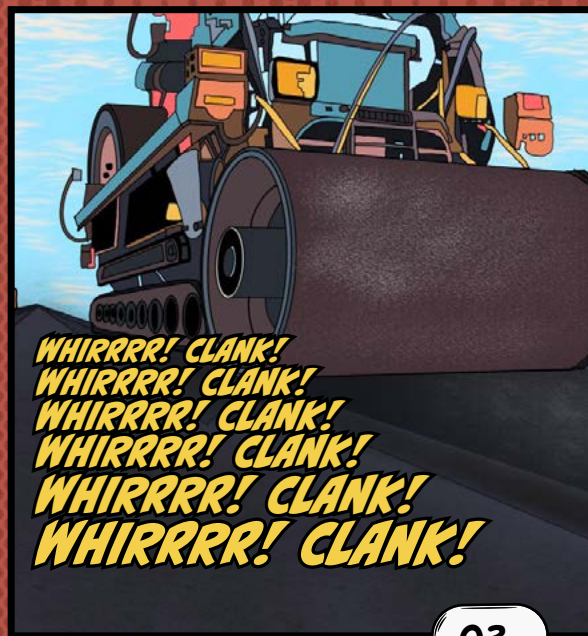
ENGINEER MANJUNATH SERVES AS THE MAIN GUIDE THROUGH THE COMPLEXITIES OF BENGALURU'S ROAD STANDARD OPERATING PRACTICES. HE APPEARS IN VARIOUS SCENARIOS, EXPLAINING CONCEPTS OF ROAD SAFETY, TRAFFIC MANAGEMENT, PEDESTRIAN FACILITIES, AND BEST PRACTICES THROUGH ENGAGING VISUALS AND EASY-TO-UNDERSTAND DIALOGUES. HIS PLAYFUL INTERACTIONS WITH FELLOW ENGINEERS AND CITIZENS ADD A RELATABLE, HUMAN TOUCH TO THE TECHNICAL DETAILS, MAKING COMPLEX ROAD DESIGN TOPICS ACCESSIBLE TO ALL.

DESIGNER GEETA IS THE HEART OF BENGALURU'S BUSTLING ROAD DESIGN EFFORTS, OFFERING A STEADY HAND AS THE CITY TACKLES ITS URBAN MOBILITY CHALLENGES. GEETA IS OFTEN FOUND IN THE THICK OF DESIGNING SAFE, EFFICIENT, AND SUSTAINABLE ROAD SYSTEMS FOR THE CITY. HER ROLE IS CRITICAL IN SHAPING THE ROADS THAT DEFINE THE DAILY COMMUTE OF MILLIONS, AND HER EXPERTISE ENSURES THAT EVERY CURVE, INTERSECTION, AND PEDESTRIAN CROSSING IS CAREFULLY PLANNED TO MEET THE CITY'S GROWING NEEDS.

CONTRACTOR GOPI IS A SHARP-WITTED, HANDS-ON CONSTRUCTION PROFESSIONAL WITH A KNACK FOR TURNING COMPLEX ROAD DESIGN THEORIES INTO PRACTICAL, REAL-WORLD SOLUTIONS. KNOWN FOR HIS RESOURCEFULNESS AND NO-NONSENSE ATTITUDE, HE FREQUENTLY FINDS HIMSELF IN CONVERSATIONS WITH ENGINEERS AND DESIGNERS, CHALLENGING THEM TO THINK OUTSIDE THE BOX. GOPI'S EXPERTISE LIES IN BRIDGING THE GAP BETWEEN METICULOUS PLANNING AND THE UNPREDICTABLE NATURE OF CONSTRUCTION ON THE GROUND.

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3. ENGINEERING

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- B. UTILITY DESIGN

4. OPERATIONS AND MAINTENANCE

CHAPTER - 1

PROJECT PLANNING



WELCOME TO CHAPTER 1!

CHAPTER 1 FOCUSES ON CLEAR PROJECT OUTLINE ENSURES EFFICIENT PLANNING, COORDINATION, AND EXECUTION. THIS CHAPTER COVERS PROJECT CATEGORIZATION, INTERVENTION TYPES, GIS-BASED TRACKING, STAKEHOLDER ROLES, BUDGET ALLOCATION, AND PAYMENT MODELS. BY STREAMLINING THESE PROCESSES, IT ENHANCES EFFICIENCY, PREVENTS DUPLICATION, AND ENSURES WELL-COORDINATED ROAD PROJECTS IN BENGALURU.

STREAMLINING THE PROJECT OUTLINE / VISION

SIR, I'VE GATHERED SOME DATA BUT NEED HELP **FRAMING THE PROJECT OUTLINE.**

SURE, GEETA. FIRST, WE DEFINE THE PROJECT OUTLINE/VISION BY IDENTIFYING ITS **SCOPE**... CURRENTLY, THE WORKS CAN BE IDENTIFIED AS ANY ONE OF THE FOLLOWING:

WHERE DO I BEGIN??

SEPERATE ROADS REQUIRING SAME KIND OF WORK!

BBMP WARDS

01. NETWORK OF STREETS
MULTIPLE CONNECTED ROADS.

02. CLUSTER OF DISCONTINUOUS STREETS
SEPARATE ROADS NEEDING SIMILAR WORK.

03. CLUSTER OF JUNCTIONS
INTERSECTIONS REQUIRING REDESIGN

04. SINGLE STREET OR JUNCTION
ISOLATED UPGRADES.

SO, AFTER CATEGORIZING THE PROJECT, WE DETERMINE THE TYPE OF **INTERVENTION** NEEDED?

THE **INTENT** SHOULD BE TO ADDRESS THE FOLLOWING:

BINGO!! YOU GOT IT!!

A. COMPREHENSIVE DEVELOPMENT
SURFACE AND SUB-SURFACE IMPROVEMENTS.

B. FOOTPATH DEVELOPMENT
GEOMETRY AND FOOTPATH UPGRADES.

C. UTILITY IMPROVEMENTS

D. CARRIAGEWAY IMPROVEMENTS

IDENTIFYING THE LOCATION AND EXTENT OF WORKS

HOW DO WE DETERMINE THE **LOCATION** AND **EXTENT** OF THE WORK?

THAT'S WHERE **GIS MAPPING** HELPS. WE ASSIGN UNIQUE IDS TO STREETS AND JUNCTIONS, LINKING THEM TO THE ICCC FOR CENTRALIZED TRACKING.

SO, THE **GIS SYSTEM** KEEPS A CLEAR **RECORD** OF ALL PROJECTS?

YES, AND IT HELPS CHECK FOR **OVERLAPPING WORKS** TO **AVOID DUPLICATION** AND **IMPROVE RESOURCE ALLOCATION.**

!?!?

HOW DO WE **TRACK** WORK ACROSS DIFFERENT AGENCIES?

WE USE A **DYNAMIC DASHBOARD** ON THE ICCC PORTAL TO TRACK ALL BBMP AND STAKEHOLDER PROJECTS, INCLUDING:

A. ONGOING PROJECTS

B. PROPOSED WORKS

C. UTILITY LAYING BY AGENCIES LIKE BESCOM AND BWSSB

GRRRRR..

SCOPE OF WORK

ONCE THE PROJECT OUTLINE AND LOCATION ARE IDENTIFIED, HOW DO WE DIVIDE THE SCOPE OF WORK?

THE SCOPE OF WORK SHOULD BE DIVIDED INTO **THREE** PARTS:

SCOPE FOR THE DPR CONSULTANT -
DEFINING THE PROJECT DESIGN AND PLANNING.

01. ZAP!!

SCOPE FOR THE PMC (PROJECT MANAGEMENT CONSULTANT) -
OVERSEEING PROJECT EXECUTION

02.

SCOPE FOR IMPLEMENTATION -
EXECUTING THE WORK ON GROUND

03. POINNNNT! WHEEZE!!

WE CALCULATE COSTS USING RATES PER KILOMETER FOR CORRIDORS AND PER SQUARE METER FOR JUNCTIONS.

LET'S TALK BUDGET!

AHA!

WAS THIS HELPFUL?

WHAM!

THE BUDGET IS BASED ON THE FOLLOWING!!

A. SCIBBLE SCIBBLE SCIBBLE PROJECT OUTLINE

B. UGHHHHH! EXTENT OF WORKS

C. SCOPE OF WORK

PAYMENT MODEL

!?! WELL..

SMALL PROJECTS

LARGE PROJECTS

LARGE TO MEGA PROJECTS

HOW DO WE DECIDE THE PAYMENT MODEL FOR DIFFERENT PROJECT SIZES?

PAYMENT REVIEW DEPENDS ON PROJECT SCALE:

A. SMALL TO MEDIUM SCALE PROJECTS ARE REVIEWED BY EXECUTIVE ENGINEERS.

B. LARGE SCALE PROJECTS ARE REVIEWED BY CHIEF ENGINEERS.

C. LARGE TO MEGA SCALE PROJECTS ARE REVIEWED BY CHIEF ENGINEERS, SPECIAL COMMISSIONERS, OR THE COMMISSIONER.

Hmm..

WHO DEFINES THE PROJECT SCALE?

BBMP, GOK, AND OTHER RELEVANT STAKEHOLDERS NEED TO DEFINE THE CRITERIA FOR SMALL, MEDIUM, LARGE, AND MEGA PROJECTS.

YES

DOES THIS SCALE AFFECT THE PROJECT STAGES?

THE DEFINED SCALE SHOULD GUIDE THE PROJECT AT ALL STAGES: FROM RFP TO DPR, IMPLEMENTATION, AND MONITORING, ETC.

CHAPTER - 2

DESIGN

PART A - INTRODUCTION

01. COMPREHENSIVE DEVELOPMENT

02. SURFACE-LVL COMPONENTS

03. SUB-SURFACE LVL COMPONENTS

04. WHY COMPREHENSIVE DEVELOPMENT MATTERS?

WELCOME TO CHAPTER 2A!

IN THIS CHAPTER, WE LOOK AT COMPREHENSIVE DEVELOPMENT, UPGRADING ROADS, FOOTPATHS, DRAINAGE, LIGHTING, AND UNDERGROUND UTILITIES IN A COORDINATED WAY, ENSURING DURABILITY AND REDUCING MAINTENANCE. BY INTEGRATING GEOMETRIC ROAD DESIGN, STORMWATER MANAGEMENT, AND UTILITY PLANNING, IT CREATES SAFER, MORE ACCESSIBLE, AND PEDESTRIAN-FRIENDLY STREETS. THIS CHAPTER EXPLORES HOW A HOLISTIC APPROACH CAN TRANSFORM URBAN INFRASTRUCTURE FOR LONG-TERM EFFICIENCY AND LIVABILITY.



COMPREHENSIVE DEVELOPMENT

MA'AM, I HEARD WE'RE WORKING ON A COMPREHENSIVE ROAD DEVELOPMENT PROJECT. WHAT EXACTLY DOES THAT MEAN?

BEFORE

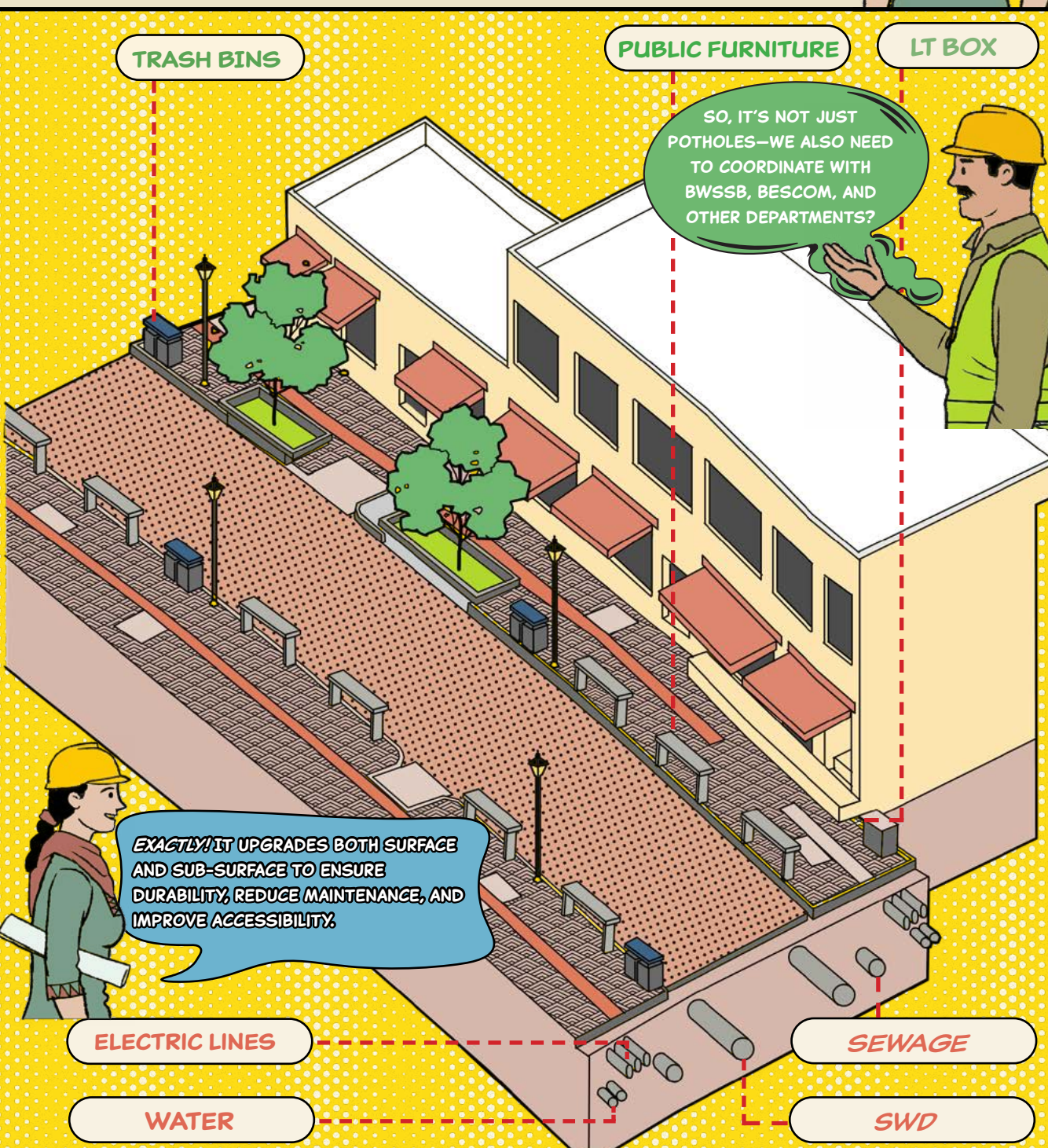


AFTER



THINDI BEEDHI, VV PURAM

COMPREHENSIVE DEVELOPMENT IS UPGRADING EVERYTHING—ROADS, FOOTPATHS, DRAINAGE, LIGHTING, EVEN UNDERGROUND UTILITIES. THE GOAL IS TO DO IT ONCE AND DO IT RIGHT SO WE DON'T KEEP DIGGING UP ROADS LATER.



TRASH BINS

PUBLIC FURNITURE

LT BOX

SO, IT'S NOT JUST POTHOLES—WE ALSO NEED TO COORDINATE WITH BWSSB, BESCOM, AND OTHER DEPARTMENTS?

EXACTLY! IT UPGRADES BOTH SURFACE AND SUB-SURFACE TO ENSURE DURABILITY, REDUCE MAINTENANCE, AND IMPROVE ACCESSIBILITY.

ELECTRIC LINES

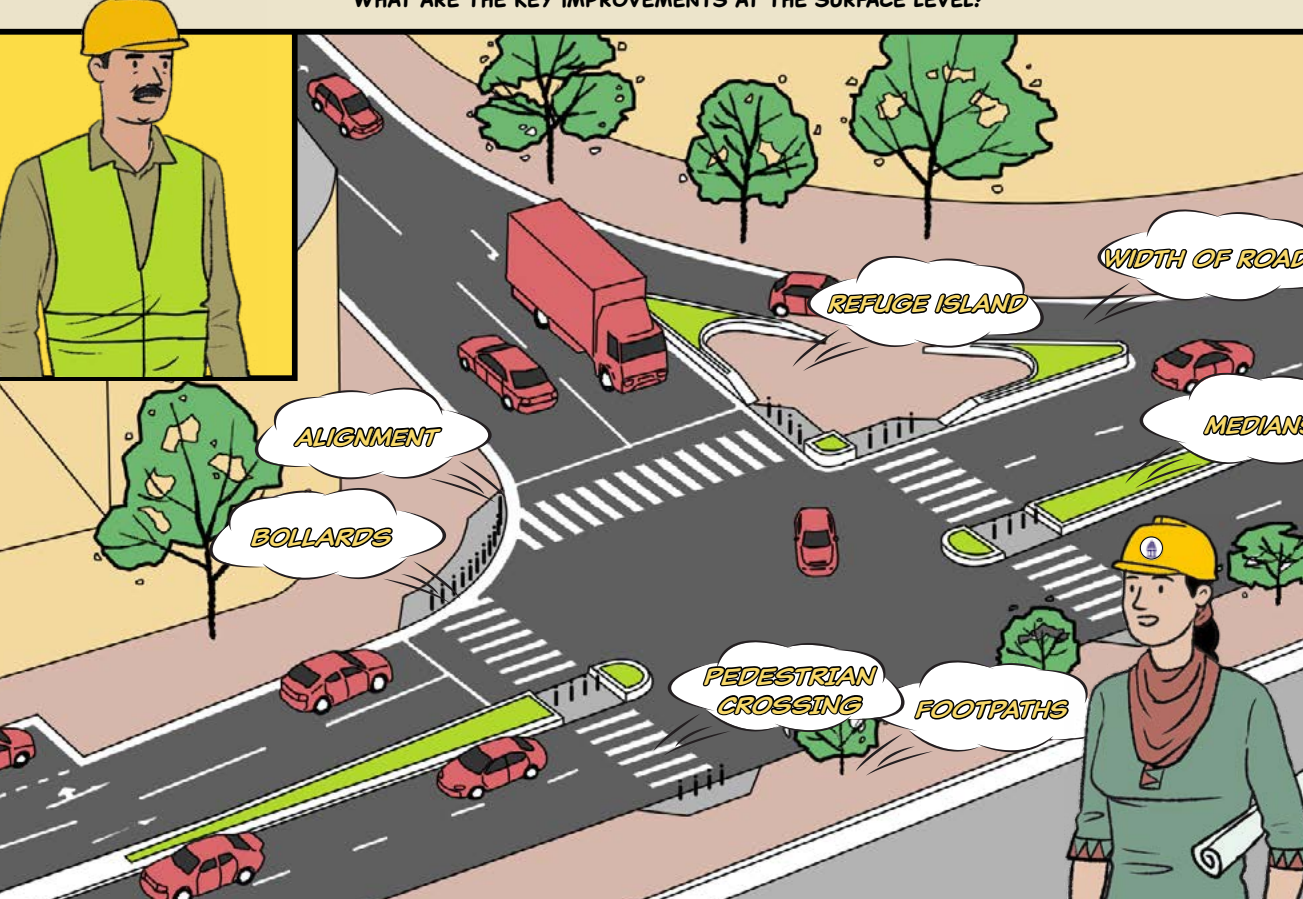
WATER

SEWAGE

SWD

SURFACE - LEVEL COMPONENTS

WHAT ARE THE KEY IMPROVEMENTS AT THE SURFACE LEVEL?



ALIGNMENT

BOLLARDS

REFUGE ISLAND

WIDTH OF ROADS

MEDIANS

PEDESTRIAN CROSSING

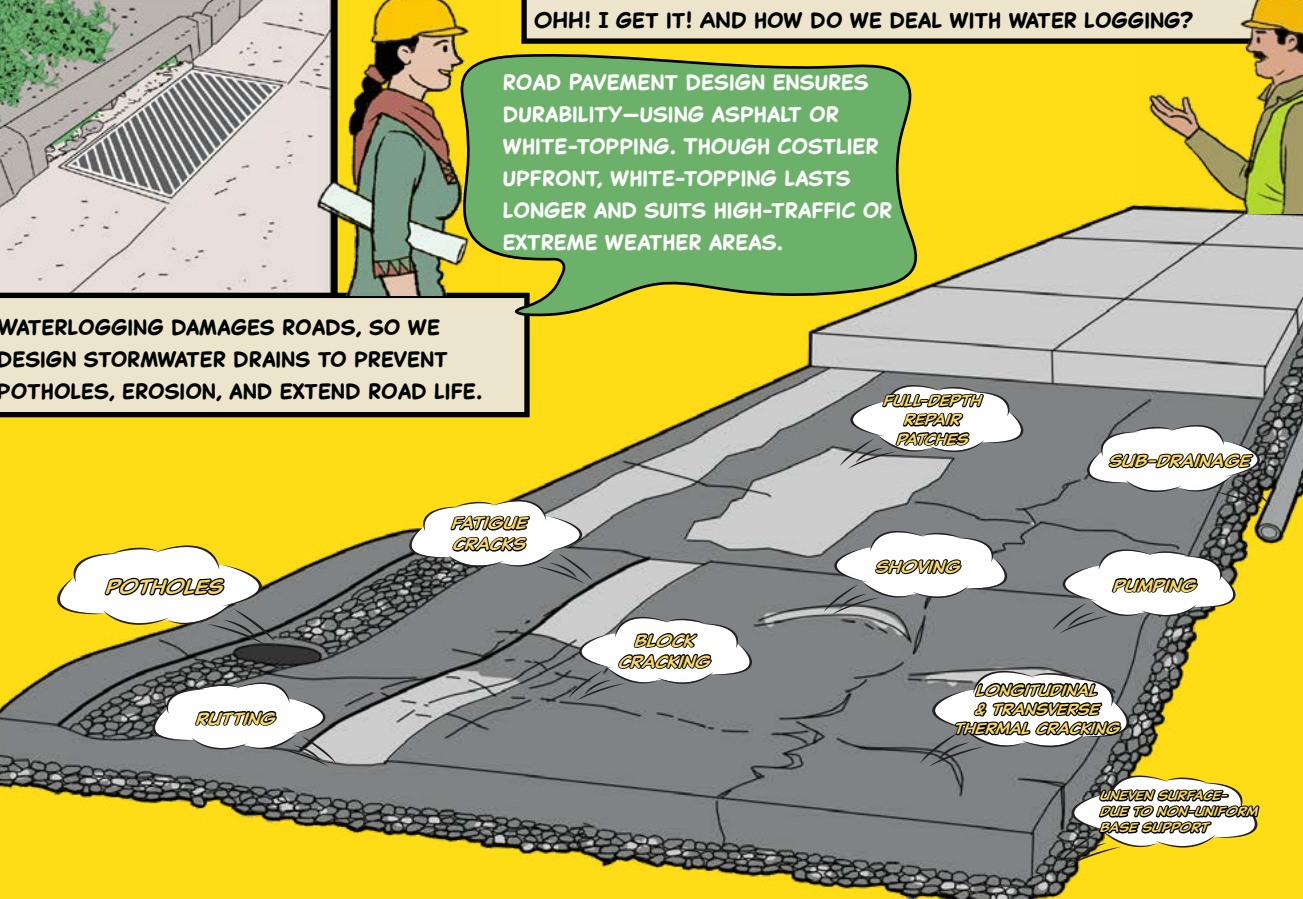
FOOTPATHS

THE FIRST STEP IS GEOMETRIC DESIGN, WHICH INCLUDES WELL DESIGNED CARRIAGEWAYS, FOOTPATHS, SAFE CROSSINGS, STREET FURNITURE, AND LIGHTING FOR ENHANCED SAFETY AND ACCESSIBILITY.

OHH! I GET IT! AND HOW DO WE DEAL WITH WATER LOGGING?

ROAD PAVEMENT DESIGN ENSURES DURABILITY—USING ASPHALT OR WHITE-TOPPING. THOUGH COSTLIER UPFRONT, WHITE-TOPPING LASTS LONGER AND SUITS HIGH-TRAFFIC OR EXTREME WEATHER AREAS.

WATERLOGGING DAMAGES ROADS, SO WE DESIGN STORMWATER DRAINS TO PREVENT POTHOLES, EROSION, AND EXTEND ROAD LIFE.



FULL-DEPTH REPAIR PATCHES

SUB-DRAINAGE

PUMPING

LONGITUDINAL & TRANSVERSE THERMAL CRACKING

UNEVEN SURFACE DUE TO NON-UNIFORM BASE SUPPORT

SHOVING

FATIGUE CRACKS

BLOCK CRACKING

RUTTING

POTHOLES

SUB-SURFACE-LEVEL COMPONENTS

ANOTHER CRITICAL ASPECT IS UTILITY MANAGEMENT.

YOU MEAN SHIFTING ELECTRIC CABLES AND UNDERGROUND UTILITIES?

YES! OFTEN, NEWLY LAID ROADS ARE DUG UP FOR UTILITY REPAIRS. TO AVOID THIS, WE:

01. CONSTRUCT UTILITY DUCTS WHILE RELAYING ROADS.

02. REPLACE LARGE TRANSFORMERS WITH SMALLER, MORE EFFICIENT ONES FOR BETTER SPACE UTILIZATION.

03. SHIFT OVERHEAD CABLES UNDERGROUND TO REDUCE CLUTTER AND WEATHER RELATED DAMAGE

THAT WILL SURELY SAVE COSTS AND PREVENT UNNECESSARY DISRUPTIONS!

WATER SUPPLY

POWER SUPPLY

STORM WATER DRAIN

SEWER

WHY COMPREHENSIVE DEVELOPMENT MATTERS?

THAT'S THE GOAL! COMPREHENSIVE DEVELOPMENT ENSURES:

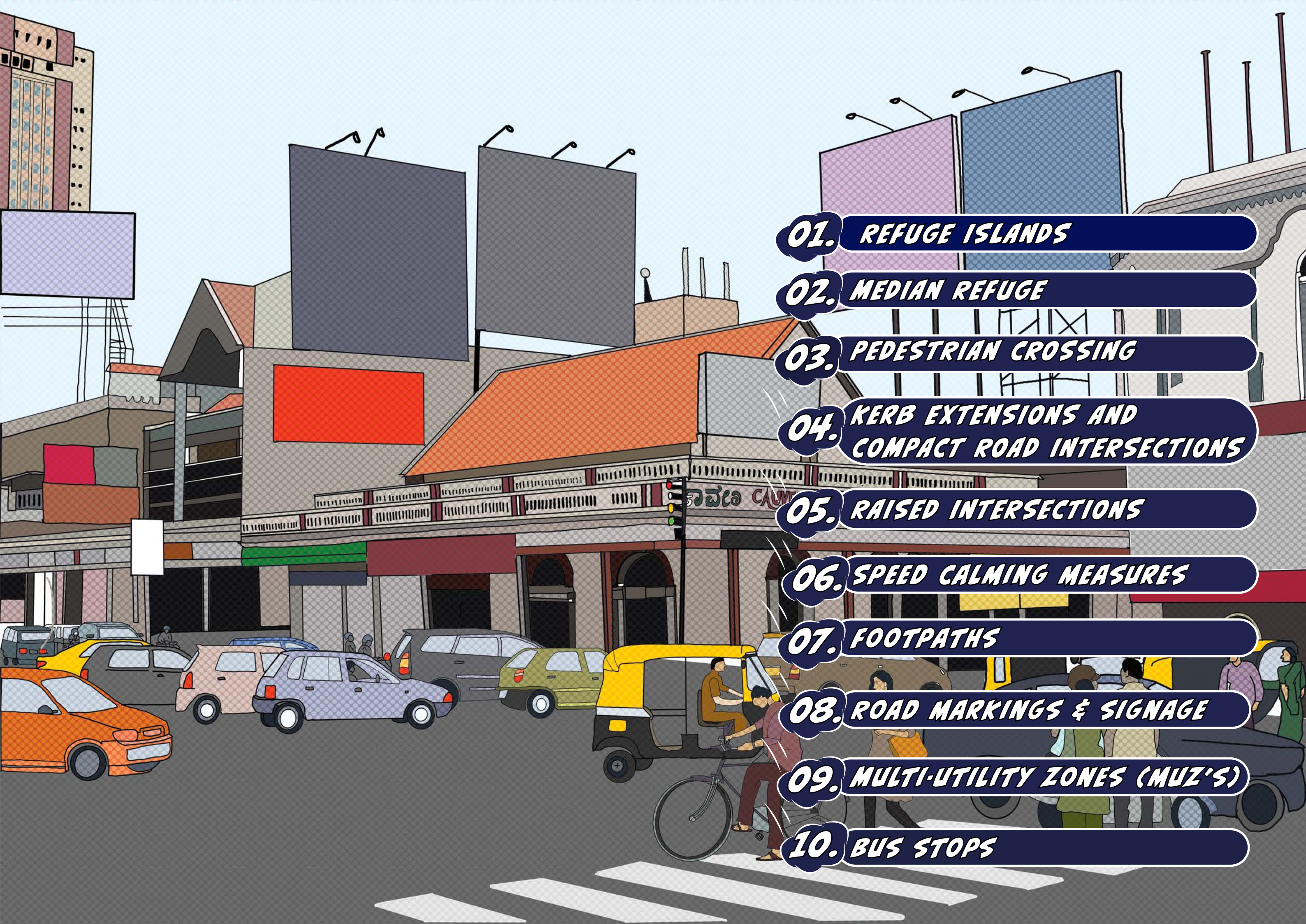
01. IMPROVED LIVEABILITY WITH VIBRANT AND PEDESTRIAN-FRIENDLY SPACES

02. SAFER AND MORE ACCESSIBLE ROADS FOR VEHICLES, PEDESTRIANS, AND CYCLISTS.

I GET IT NOW. INSTEAD OF PATCHWORK SOLUTIONS, WE'RE MAKING ROADS DURABLE, SAFE, EFFICIENT AND FUTURE-READY!

03. LONG-LASTING DESIGNED STREETS WITH LANDSCAPING AND PUBLIC AMENITIES.

EXACTLY, GOPI! LET'S IMPLEMENT THIS PROPERLY SO BENGALURU GETS THE WORLD-CLASS ROAD INFRASTRUCTURE IT DESERVES.



01. REFUGE ISLANDS

02. MEDIAN REFUGE

03. PEDESTRIAN CROSSING

**04. KERB EXTENSIONS AND
COMPACT ROAD INTERSECTIONS**

05. RAISED INTERSECTIONS

06. SPEED CALMING MEASURES

07. FOOTPATHS

08. ROAD MARKINGS & SIGNAGE

09. MULTI-UTILITY ZONES (MUZ'S)

10. BUS STOPS

DESIGN OF ROADS & SPECIAL AREAS

HEY EVERYONE! THIS IS OUR PLAN TO IMPROVE THE BUSY STREETS AND INTERSECTIONS IN BENGALURU. LET'S MAKE OUR ROADS **SAFER** AND **MORE EFFICIENT**!!

BEFORE



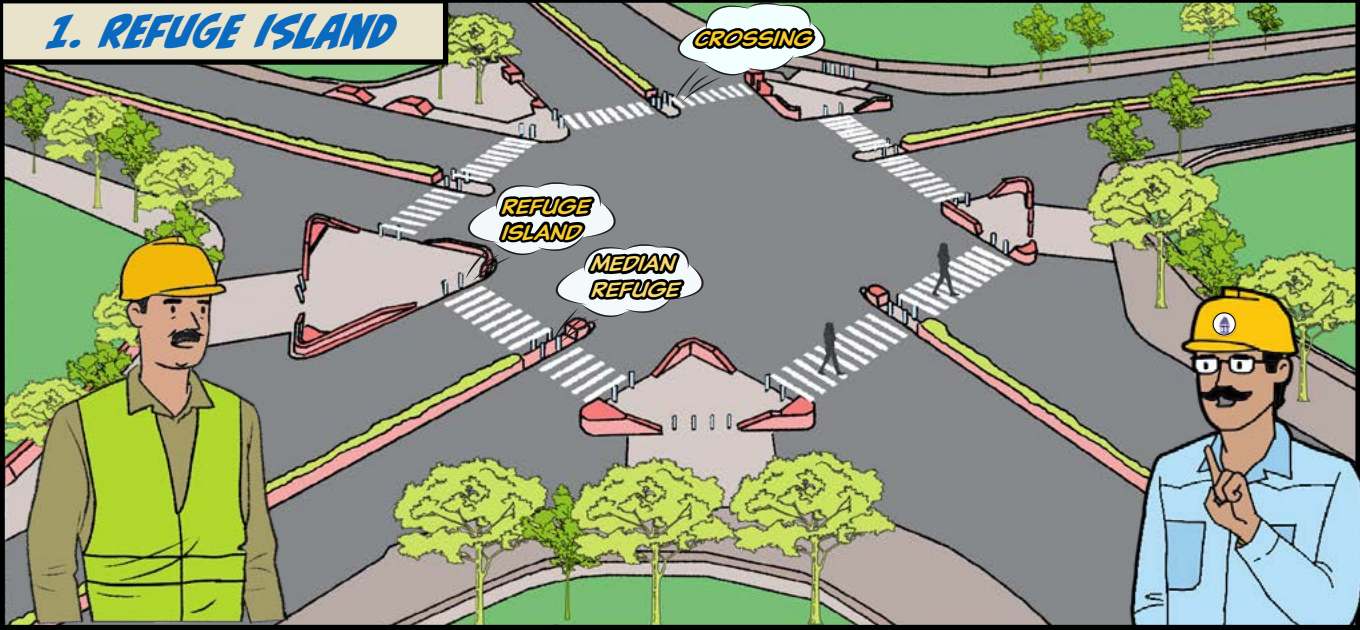
AFTER



CHURCH STREET

THESE ARE PROVEN DESIGNS THAT WORK AROUND THE WORLD! **SIMPLE** AND **COST EFFECTIVE** MEASURES WITH A LARGE IMPACT. LET'S EXAMINE **EACH ONE** IN TURN!

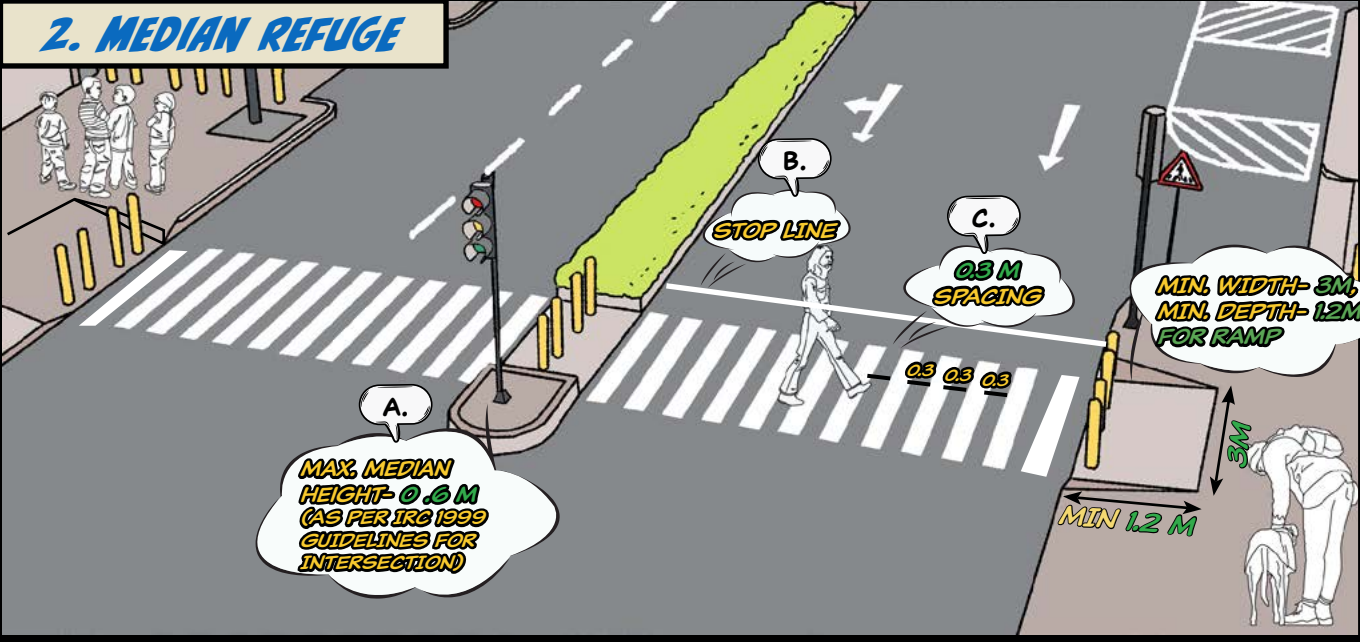
1. REFUGE ISLAND



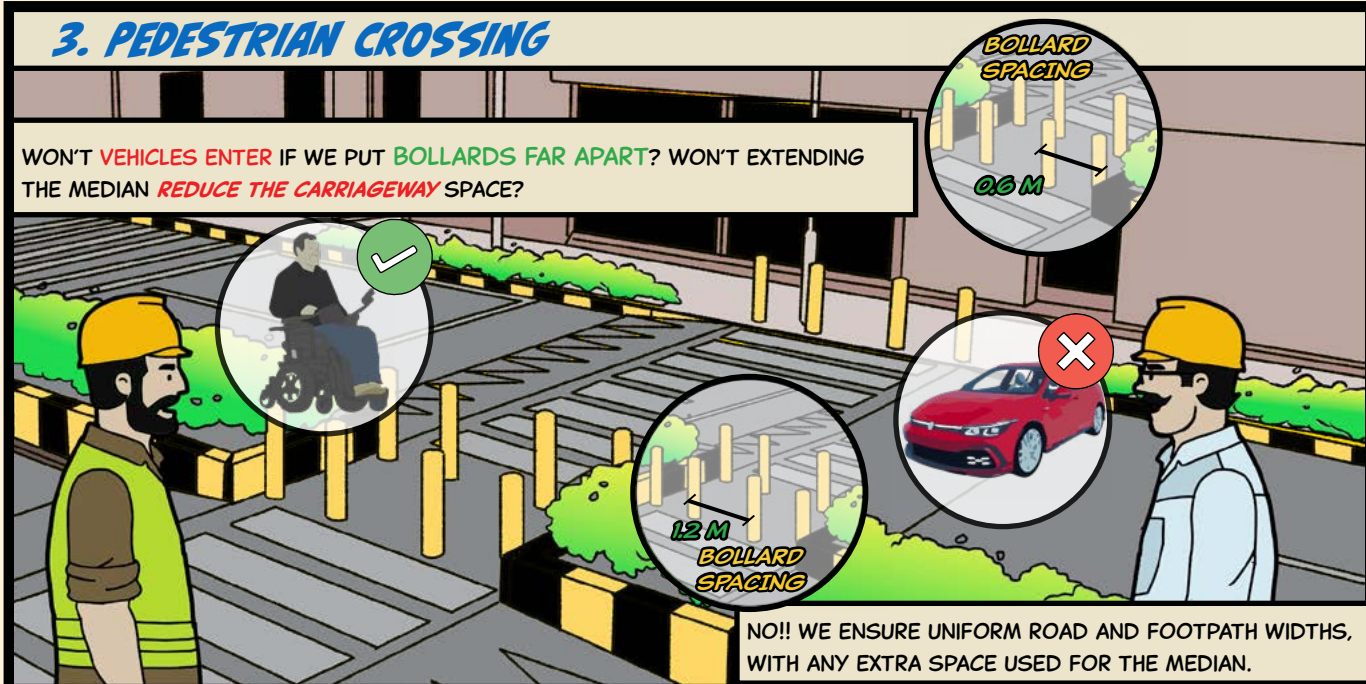
WHY ARE THESE **REFUGE ISLANDS** SO BIG? DON'T THEY JUST WASTE SPACE, MONEY AND CAUSE CONGESTION?

NOT AT ALL! THEY **GUIDE TRAFFIC**, **SHORTEN CROSSING DISTANCES** AND, **IMPROVE VISIBILITY** WITHOUT CAUSING DELAYS.

2. MEDIAN REFUGE



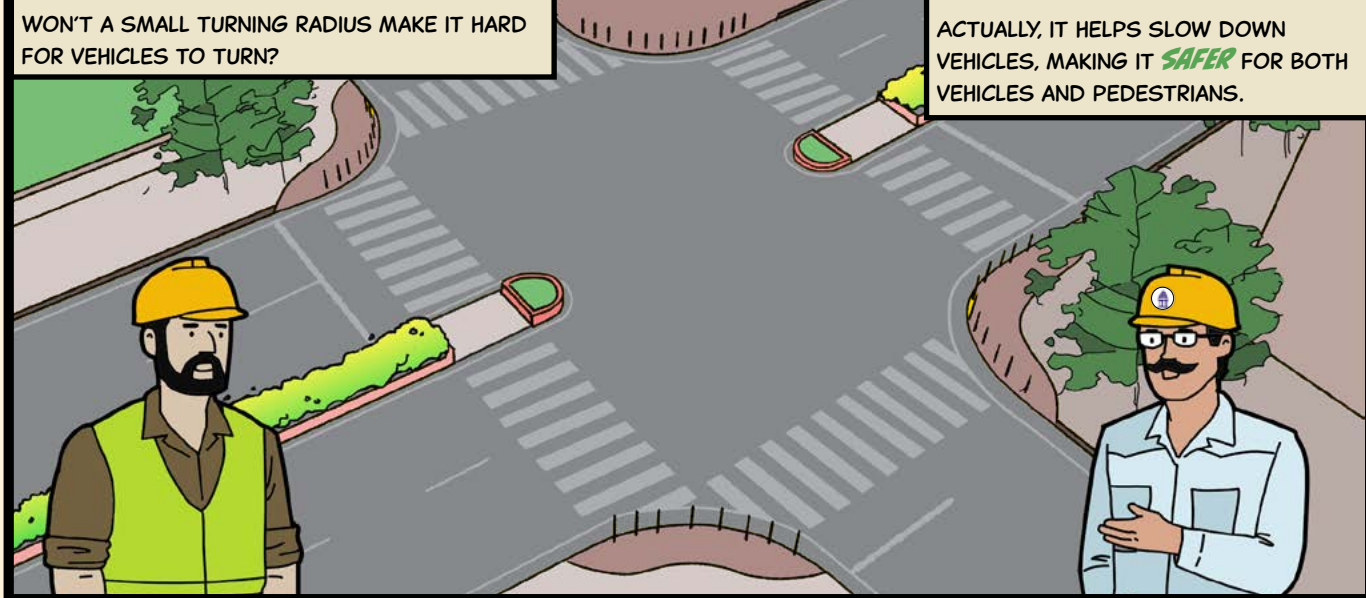
3. PEDESTRIAN CROSSING



WON'T **VEHICLES** ENTER IF WE PUT **BOLLARDS** FAR APART? WON'T EXTENDING THE MEDIAN **REDUCE THE CARRIAGEWAY** SPACE?

NO!! WE ENSURE UNIFORM ROAD AND FOOTPATH WIDTHS, WITH ANY EXTRA SPACE USED FOR THE MEDIAN.

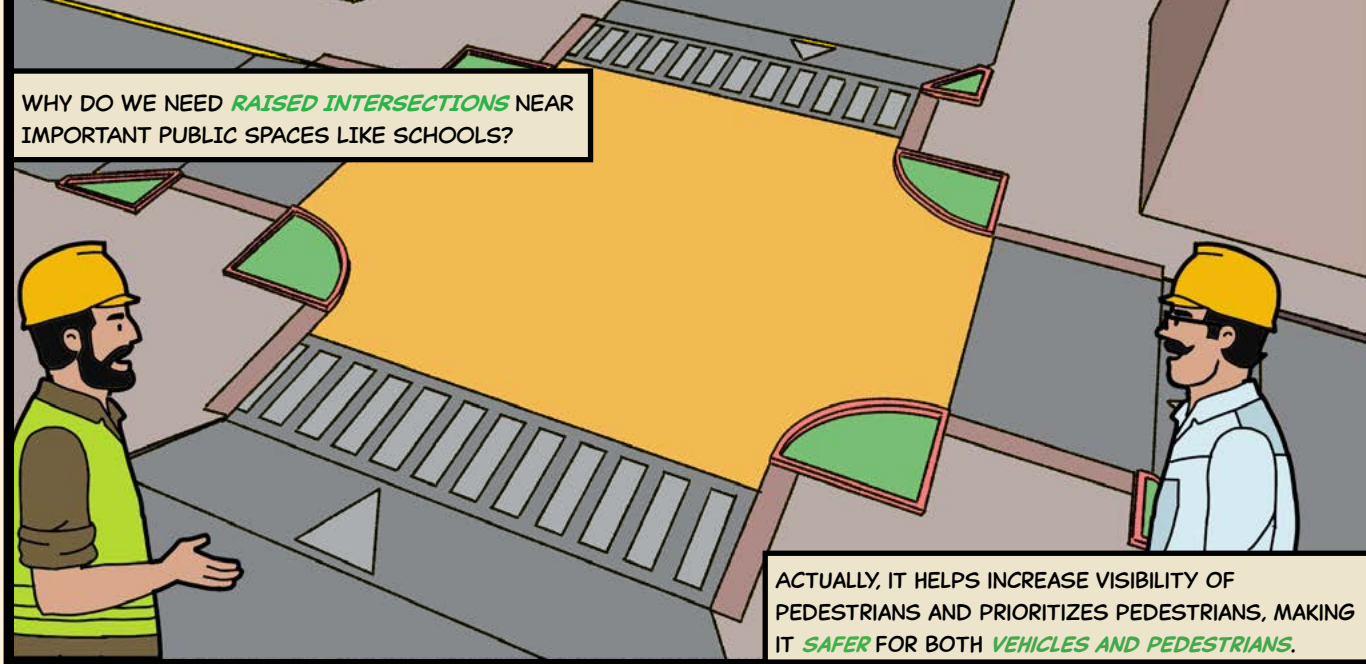
4. KERB EXTENSIONS & COMPACT ROAD INTERSECTIONS



WON'T A SMALL TURNING RADIUS MAKE IT HARD FOR VEHICLES TO TURN?

ACTUALLY, IT HELPS SLOW DOWN VEHICLES, MAKING IT **SAFER** FOR BOTH VEHICLES AND PEDESTRIANS.

5. RAISED INTERSECTIONS



WHY DO WE NEED **RAISED INTERSECTIONS** NEAR IMPORTANT PUBLIC SPACES LIKE SCHOOLS?

ACTUALLY, IT HELPS INCREASE VISIBILITY OF PEDESTRIANS AND PRIORITIZES PEDESTRIANS, MAKING IT **SAFER** FOR BOTH **VEHICLES AND PEDESTRIANS**.

DESIGN OF ROADS & SPECIAL AREAS

BEFORE



AFTER



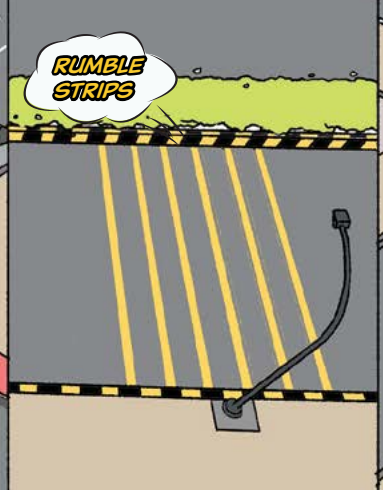
HARE KRISHNA JUNCTION

6. SPEED CALMING MEASURES -HRPC/SPEED HUMPS/RUMBLE STRIPS

ROAD HUMPS



RUMBLE STRIPS



RAISED CROSSING

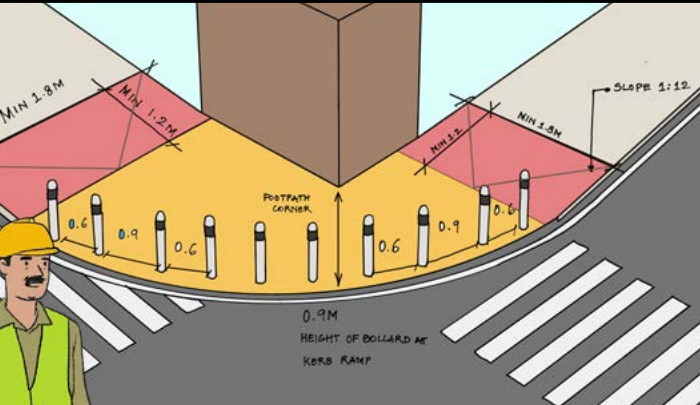


HOW DO WE DECIDE THE SIZE OF THE SPEED HUMP?

AS PER IRC, SPEED HUMPS SHOULD HAVE A 17M RADIUS, 3.7M WIDTH, AND 0.1M HEIGHT, DESIGNED FOR A 25 KM/H ADVISORY SPEED.

7. FOOTPATHS

WHAT IF THE FOOTPATHS ARE TOO SMALL?
WHERE DO WE PUT THE RAMP?



THE RAMP TO THE PROPERTY ENTRANCE SHOULD BE PLACED AT THE ROAD EDGE, NOT OBSTRUCTING THE FOOTPATH.



IF THE FOOTPATH WIDTH IS TOO SMALL TO INCORPORATE A TYPICAL KERB RAMP, WE CAN RAMP THE FOOTPATH ITSELF TO THIS COMMON AREA

8. ROAD MARKING & SIGNAGE

WHY DO WE NEED MARKINGS & SIGNS TO INDICATE SPEED HUMPS?

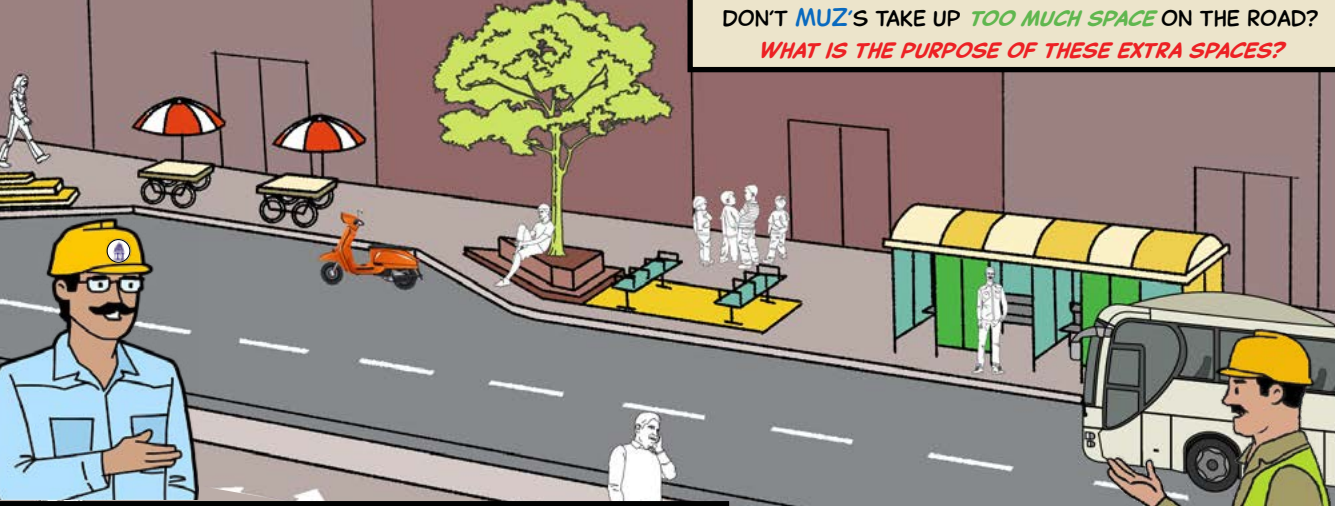


ROAD MARKING HELPS DIRECT, GUIDE AND REGULATE THE ROAD USER.



9. MULTI-UTILITY ZONES (MUZ'S)

DON'T MUZ'S TAKE UP TOO MUCH SPACE ON THE ROAD?
WHAT IS THE PURPOSE OF THESE EXTRA SPACES?

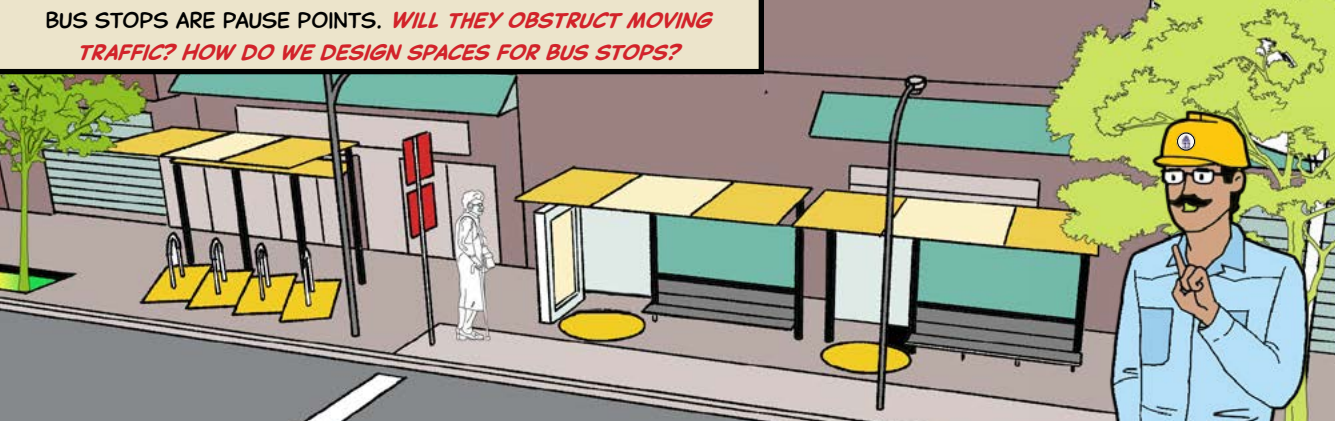


THESE ZONES ENSURE SMOOTHER TRAFFIC FLOW AND DEDICATED AREAS FOR STREET FURNITURE, LANDSCAPE, VENDING, BUS STOPS AND ACCESS RAMPS CONSIDERING THE FOOTPATH BE AT LEAST 1.8M WIDE.

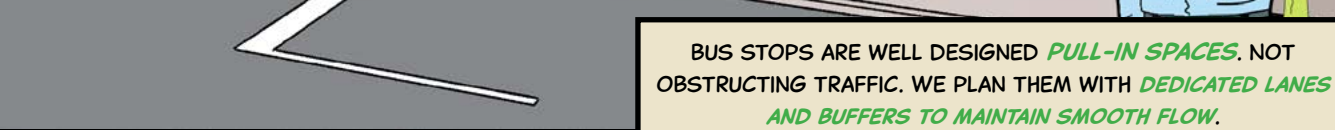


10. BUS STOPS

BUS STOPS ARE PAUSE POINTS. WILL THEY OBSTRUCT MOVING TRAFFIC? HOW DO WE DESIGN SPACES FOR BUS STOPS?



BUS STOPS ARE WELL DESIGNED PULL-IN SPACES. NOT OBSTRUCTING TRAFFIC. WE PLAN THEM WITH DEDICATED LANES AND BUFFERS TO MAINTAIN SMOOTH FLOW.



CHAPTER - 3

ENGINEERING

PART A - ASPHALTING & WHITE-TOPPING

WELCOME TO CHAPTER 3A!

IN THIS CHAPTER, WE FOCUS ON THE CRITICAL PROCESS OF ASPHALTING—A KEY METHOD IN ROAD CONSTRUCTION THAT ENSURES SMOOTH, LONG-LASTING SURFACES FOR ALL TYPES OF TRAFFIC. WHETHER YOU'RE LAYING DOWN FRESH ASPHALT FOR A BRAND-NEW ROAD OR RESURFACING AN EXISTING ONE, UNDERSTANDING THE STEPS AND TECHNIQUES INVOLVED IS ESSENTIAL. THROUGH THIS CHAPTER, WE'LL WALK YOU THROUGH EACH PHASE, SHARE BEST PRACTICES, AND PROVIDE EXPERT TIPS TO ENSURE YOUR PROJECT STANDS THE TEST OF TIME. LET'S GET STARTED!

01. **MILLING**

02. **MATERIAL MATTERS**

03. **COOLING**

04. **CIVIL V/S ASPHALTING**

MILLING

THE FIRST STEP IS MILLING

BEFORE WE START LAYING THE NEW ROAD, THE FIRST STEP IS **MILLING**. DO YOU KNOW WHY THAT'S CRUCIAL?

OF COURSE!! IT'S TO REMOVE THE OLD SURFACE. BUT ISN'T IT JUST ABOUT CLEARING THE WAY FOR THE NEW ASPHALT?

01. SCREE!!

WITHOUT MILLING WE **RISK** THE NEW SURFACE **PEELING OFF** OVER TIME.

02. OOF OOF OOF

IT ENSURES THE FRESH COAT OF ASPHALT ADHERES PROPERLY TO THE CARRIAGEWAY.

03. FOOTPATH 150MM ABOVE ROAD LEVEL

MILLING ENSURES THE LEVEL OF THE **CARRIAGEWAY** IS NOT RAISED. THIS IS A BIG CAUSE OF URBAN FLOODING.

04.

MILLING **ROUGHENS** THE SUBSURFACE.

NOT QUITE! MILLING ENSURES THE ABOVE AND SKIPPING OR RUSHING THIS STEP CAN **COMPROMISE** THE **LONGEVITY** OF THE ROAD.

I SEE. SO, IT'S MORE ABOUT **PREPARATION** THAN JUST REMOVAL.

MATERIAL MATTERS

I HAVE HEARD TALKS ABOUT **SMA TECHNOLOGY**. DO YOU KNOW HOW IS SMA DIFFERENT FROM REGULAR ASPHALT?

STONE MATRIX ASPHALT (SMA)

DENSE GRADE ASPHALT

STONE MATRIX ASPHALT, OR SMA, IS A HIGH-PERFORMANCE SURFACE LAYER. IT HAS A HIGHER PROPORTION OF COARSE AGGREGATES, WHICH IMPROVES **STRENGTH** AND **RESISTANCE** TO DEFORMATION.

THAT SOUNDS IMPRESSIVE. SO SMA PROVIDES **BETTER LONGEVITY**?

EXACTLY. WHILE ITS CAPITAL COST IS 10-15% HIGHER THAN TRADITIONAL ASPHALT, IT **LASTS SIGNIFICANTLY LONGER**, **REDUCING MAINTENANCE COSTS OVER TIME**.

STONE MASTIC ASPHALT - THE MIXTURE ALSO INCLUDES **FIBERS** OR **POLYMERS** TO BIND THE ASPHALT, MAKING IT **MORE DURABLE** AND LESS PRONE TO RUTTING.

STONE

MATRIX

01. 02. 03. 04.

FILLER + SAND + BITUMEN + FIBER

RUMBLE! GRRRSHH! RUMBLE! GRRRSHH! RUMBLE! GRRRSHH! RUMBLE! GRRRSHH!

LET'S NOW TALK ABOUT THE LAYERS IN A TYPICAL ROAD PAVEMENT.

1. SURFACE COURSE (25-50)

2. BINDER COURSE (50-100MM)

3. BASE COURSE (100-300MM)

4. SUB-BASE (100-300MM)

5. SUB-GRADE (150-300MM)

SURE. I KNOW THERE'S THE SUBGRADE AT THE BOTTOM, FOLLOWED BY THE BASE AND SURFACE LAYERS.

COOLING

"ONCE THE ASPHALT IS LAID, WE CAN ALLOW VEHICLES ONTO IT ONCE IT FEELS FIRM, RIGHT?"

GRRRRR.

30°C

"NOT YET. THE ASPHALT MUST COOL TO 30°C BEFORE TRAFFIC CAN PASS. IF IT'S STILL VISCOUS, IT CAN DEFORM UNDER PRESSURE."

SO, HOW DOES COOLING AFFECT THE ROAD'S LIFESPAN?

PSSSS...

COOLING IS KEY—A FEW EXTRA HOURS CAN MAKE THE ASPHALT LAST YEARS LONGER. RUSH IT, AND YOU'LL GET CRACKS.

INSPECTIONS

NIGHT ASPHALTING REDUCES DISRUPTIONS BUT WEAKENS INSPECTION AND COOLING—SHIFTING TO DAYTIME COULD SOLVE THIS.

HONK HONK HONK HONK

ROAD CLOSED

WOULDN'T DAYTIME WORK CREATE TRAFFIC CHAOS?

THUDD!

NOT NECESSARILY. TRUCKS CAN DELIVER ASPHALT EARLY, BEFORE PEAK HOURS. WE WORK DURING THE DAY, AND IT SETS OVERNIGHT.

Diagram illustrating the cooling process of newly laid asphalt. It shows a cross-section of the road surface with rain falling on top. Arrows indicate heat flux moving from the asphalt surface down into the subgrade. The text 'NEWLY LAID ASPHALT' and 'HEAT FLUX' is present.

CIVIL V/S ASPHALTING WORK

ONE THING I'VE NOTICED IS THAT CIVIL WORK OFTEN GETS OVERSHADOWED IN ROAD PROJECTS!

YOU'RE ABSOLUTELY RIGHT! FOOTPATHS, MEDIANS, DRAINS — THESE ARE JUST AS IMPORTANT BUT OFTEN NEGLECTED!!

WHAT'S IS THE SOLUTION ???

FOOTPATHS

MEDIANS

DRAINS

SIGH..

SEPARATING CONTRACTS FOR CIVIC & ASPHALTING WORK

01. EXCAVATING

02. GRADING

03. UTILITY SHIFTING

04. CIVIL WORK

05. ASPHALTING WORK

THIS ENSURES EACH ASPECT RECEIVES THE ATTENTION IT DESERVES AND IS EXECUTED TO THE HIGHEST QUALITY.

MAINTENANCE & MICROSURFACING

ROAD MAINTENANCE IS CRITICAL! LET'S TALK ABOUT MICROSURFACING!

MICROSURFACING, WHEN APPLIED CORRECTLY AND ON TIME, CAN SIGNIFICANTLY EXTEND THE LIFESPAN OF ASPHALT. IT'S A COST-EFFECTIVE MAINTENANCE SOLUTION.

ROAD MAINTENANCE

A. SWEEPING

B. PREVENTING PEBBLES BUILDUP

C. PAINTING

D. CLEARING DRAINS

CHAPTER - 3B

UTILITY DESIGN

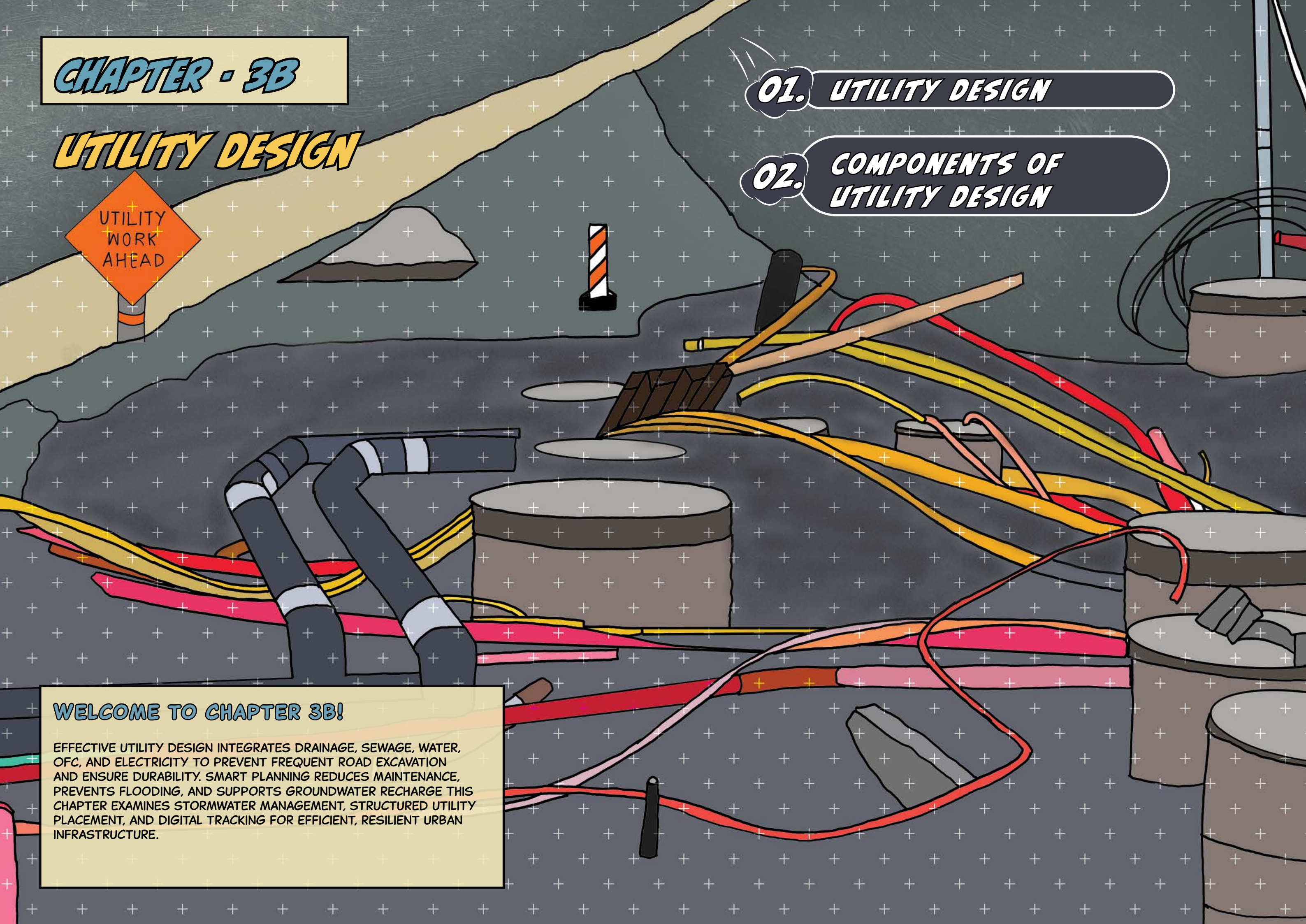


01. UTILITY DESIGN

02. COMPONENTS OF UTILITY DESIGN

WELCOME TO CHAPTER 3B!

EFFECTIVE UTILITY DESIGN INTEGRATES DRAINAGE, SEWAGE, WATER, OFC, AND ELECTRICITY TO PREVENT FREQUENT ROAD EXCAVATION AND ENSURE DURABILITY. SMART PLANNING REDUCES MAINTENANCE, PREVENTS FLOODING, AND SUPPORTS GROUNDWATER RECHARGE THIS CHAPTER EXAMINES STORMWATER MANAGEMENT, STRUCTURED UTILITY PLACEMENT, AND DIGITAL TRACKING FOR EFFICIENT, RESILIENT URBAN INFRASTRUCTURE.



UTILITY DESIGN

DESIGNING, ENGINEERING AND IMPLEMENTATION OF SUB-SURFACE UTILITIES INCLUDING STORM WATER DRAINS, SEWAGE, WATER, OFC, ELECTRIC.

UTILITY DESIGN **ISN'T JUST ABOUT LAYING PIPES!** IT'S ABOUT **SMART PLANNING** SO WE **DON'T KEEP DIGGING UP ROADS!**

SIGH.. **!?!**

YOU GOT IT!

OH, SO IF WE DO IT RIGHT, WE **AVOID** THE CONSTANT **MESS OF REPAIRS?**

STORM WATER DRAINS!

ROAD CAMBERING

UTILITIES

SO, UTILITIES JUST GET PLACED WHEREVER THERE'S SPACE?

WHEN SHOULD UTILITIES BE SHIFTED?

DURING COMPREHENSIVE ROAD DEVELOPMENT—TO AVOID FUTURE DIGGING AND DAMAGE TO PAVEMENTS.

THAT SHOULD BE RARE! MARCS APPLICATIONS FOR DIGGING SHOULD BE HIGHLY RESTRICTED AND ONLY FOR EMERGENCIES.

MARCS APPLICATION

CENTRAL DYNAMIC DASHBOARD UNDER ICDC

NO, THEY NEED TO BE MAPPED AND ORGANIZED FOR EASY MAINTENANCE, UPGRADES, AND EXPANSION.

BUT WHAT IF SOMEONE NEEDS TO DIG LATER?

HOW DO WE KEEP TRACK OF NEW UTILITY LINES?

AND THAT INCLUDES DRAINAGE TOO?

EXACTLY! BY COORDINATING WITH **BWSSB, BESCOM, AND OTHERS**, WE **FUTURE PROOF** THE SYSTEM AND KEEP THINGS **ACCESSIBLE**.

PIPE

BOX DRAINS

PERCOLATION PITS

STORMWATER DRAINS

PERCOLATION PITS ALONG FOOTPATHS

GREEN BUFFERS ALONG FOOTPATHS ALSO HELP ABSORB EXCESS WATER.

REDUCED PRESSURE ON DRAINS & LAKES

MAINTENANCE

COMPONENTS OF UTILITY DESIGNS

THESE ARE THREE KEY PARTS—UNDERGROUND PIPES, GROUNDWATER RECHARGE PITS, PROPERLY DESIGNED STREET DRAINS AND ROAD CAMBERING.

PIPES

OH!! SO, IT'S NOT JUST ABOUT PIPES?

WHY USE PIPES INSTEAD OF BOX DRAINS?

GROUNDWATER RECHARGE

HOW DOES GROUNDWATER RECHARGE WORK?

DRAINS

WHAT ABOUT STREET DRAINS?

THEY NEED SILT CHAMBERS TO TRAP DEBRIS BEFORE IT CLOGS PIPES. REGULAR STREET SWEEPING SHOULD INCLUDE CLEARING THESE CHAMBERS.

UNDERGROUND PIPES

BOX DRAINS

PERCOLATION PITS

STORMWATER DRAINS

PERCOLATION PITS ALONG FOOTPATHS

GREEN BUFFERS ALONG FOOTPATHS ALSO HELP ABSORB EXCESS WATER.

REDUCED PRESSURE ON DRAINS & LAKES

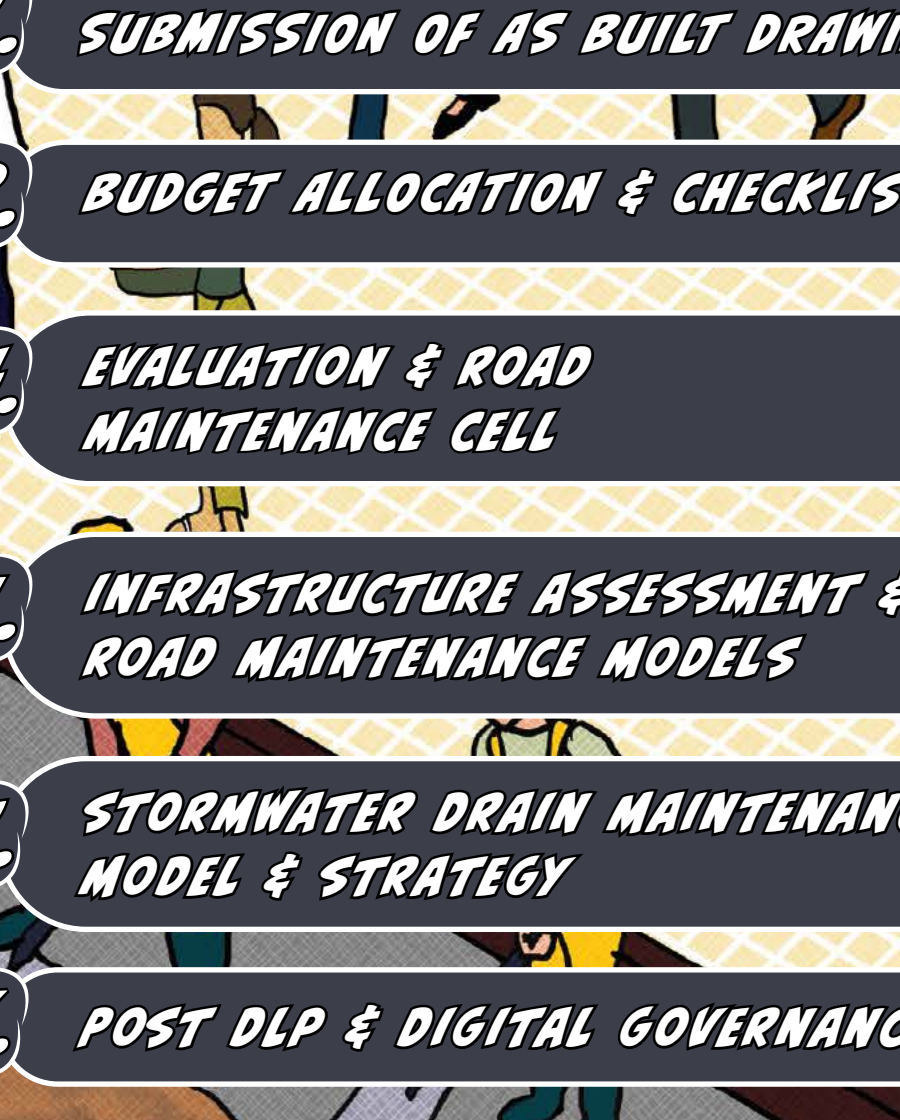
MAINTENANCE

OPERATIONS & MAINTENANCE

OPERATIONS & MAINTENANCE

WELCOME TO CHAPTER 4!

SUSTAINABLE ROAD INFRASTRUCTURE REQUIRES BOTH QUALITY CONSTRUCTION AND LONG-TERM MAINTENANCE. THIS CHAPTER OUTLINES A STRUCTURED ROAD MAINTENANCE STRATEGY FOR BENGALURU, COVERING DEFECT LIABILITY PERIOD (DLP), CONTRACTOR ACCOUNTABILITY, A DEDICATED ROAD MAINTENANCE CELL, AND DIGITAL GOVERNANCE. BY INTEGRATING TECHNOLOGY, CITIZEN ENGAGEMENT, AND SUSTAINABLE PRACTICES, IT ENSURES DURABLE, SAFE, AND WELL-MAINTAINED ROADS.

- 
- 01. DLP & MAINTENANCE MANUAL**
 - 02. SUBMISSION OF AS BUILT DRAWINGS**
 - 03. BUDGET ALLOCATION & CHECKLISTS**
 - 04. EVALUATION & ROAD MAINTENANCE CELL**
 - 05. INFRASTRUCTURE ASSESSMENT & ROAD MAINTENANCE MODELS**
 - 06. STORMWATER DRAIN MAINTENANCE MODEL & STRATEGY**
 - 07. POST DLP & DIGITAL GOVERNANCE**
 - 08. SUSTAINABLE ROAD MAINTENANCE & MONITORING FRAMEWORK**

DEFECT LIABILITY PERIOD (DLP)

WHY IS **D.L.P** IMPORTANT?

THE **DEFECT LIABILITY PERIOD (DLP)** IS CRUCIAL FOR HOLDING **CONTRACTORS ACCOUNTABLE**. WE NEED TO ENSURE THE RFP CLEARLY DEFINES THEIR RESPONSIBILITIES. THE SCOPE SHOULD OUTLINE:

DLP DURATION: CONTRACTOR IS LIABLE FOR REPAIRS AND DEFECTS FOR A SET PERIOD.

COVERED DEFECTS: INCLUDES POTHOLES, SINKHOLES, STRUCTURAL FAILURES, PAVEMENT DAMAGE, AND DRAINAGE ISSUES.

MAINTENANCE DUTIES: ROUTINE CHECKS, EMERGENCY FIXES, AND DEFECT RECTIFICATION.

REPORTING: MUST SUBMIT AS-BUILT DRAWINGS AND POST-IMPLEMENTATION REPORTS.

PENALTIES: STRICT CONSEQUENCES FOR NON-COMPLIANCE.

SUBMISSION OF AS-BUILT DRAWINGS & MAINTENANCE MANUAL

AT PROJECT COMPLETION, CONTRACTORS MUST SUBMIT PROPER DOCUMENTATION.

AS-BUILT DRAWINGS: FINAL CONSTRUCTION PLANS WITH MODIFICATIONS.

POST-IMPLEMENTATION REPORT: MATERIALS, QUALITY CERTIFICATIONS, ROAD HEALTH, AND MAINTENANCE STRATEGY.

MAINTENANCE MANUAL: PROTOCOLS, INSPECTION FREQUENCY, AND PREVENTIVE UPKEEP GUIDELINES.

BUDGET ALLOCATION FOR DOCUMENTATION

WE NEED TO ALLOCATE A BUDGET FOR PROPER DOCUMENTATION. WITHOUT IT, TRACKING ROAD QUALITY AND MAINTENANCE BECOMES A CHALLENGE.

SIMPLE FAILURE WILL LEAD TO AN OFFICIAL NON-COMPLIANCE NOTICE, WHICH GOES ON RECORD.

NO DOCUMENTATION, NO CLEAN HANDOVER!

NON-COMPLIANCE & CONTRACTOR PERFORMANCE EVALUATION

WE SHOULD INTRODUCE A CONTRACTOR PERFORMANCE EVALUATION SYSTEM TO BOOST ACCOUNTABILITY.

YES!! IF CONTRACTORS MISS REQUIRED DOCS—LIKE AS-BUILTS, REPORTS, OR MANUALS—THEY LOSE POINTS FOR FUTURE BBMP BIDS.

STANDARDIZED PROJECT COMPLETION CHECKLIST

WE NEED A STANDARDIZED PROJECT COMPLETION CHECKLIST TO ENSURE **PROPER PROJECT CLOSURE**.

THIS IS THE LAST STEP BEFORE SIGN-OFF AND FINANCIAL CLOSURE WHAT SHOULD IT COVER?

- VERIFY COMPLETED WORK AS PER DESIGN.
- ENSURE MATERIAL QUALITY COMPLIANCE
- CHECK DRAINAGE AND STORMWATER CHANNELS.
- CONFIRM PEDESTRIAN AND VEHICULAR SAFETY MEASURES.
- SUBMIT ALL REQUIRED DOCUMENTS

WE SHOULD ALSO SET UP A MEMO SYSTEM FOR REPEAT VIOLATORS.

DEFINITELY, THESE MEASURES WILL ENSURE ONLY RELIABLE CONTRACTORS ARE ENGAGED IN FUTURE PROJECTS, IMPROVING ROAD QUALITY AND SUSTAINABILITY!

WE NEED A DEDICATED ROAD MAINTENANCE CELL WITHIN BBMP TO KEEP BENGALURU'S ROADS IN CHECK.

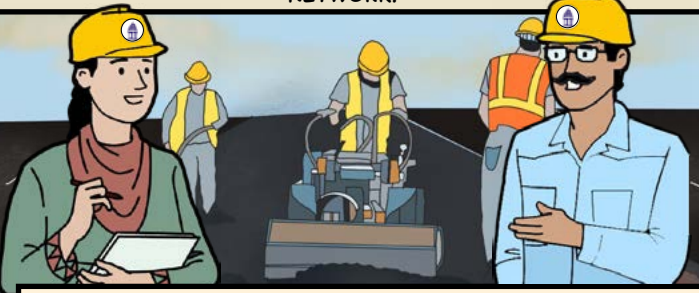
ESTABLISHMENT OF A DEDICATED ROAD MAINTENANCE CELL

PRIMARY FUNCTION OF ROAD MAINTENANCE CELL

ROUTINE INSPECTIONS	EMERGENCY RESPONSE	MAINTENANCE COORDINATION	STAKEHOLDER ENGAGEMENT
MONTHLY AND QUARTERLY AUDITS TO SPOT EARLY DEFECTS LIKE POTHOLES AND CRACKS .	DEDICATED HELPLINE AND DIGITAL SYSTEM FOR PUBLIC COMPLAINTS AND TIMELY FIXES.	SMOOTH COORDINATION BETWEEN BBMP, TRAFFIC POLICE, UTILITY AGENCIES, AND CONTRACTORS.	REGULAR MEETINGS WITH CITIZENS, LOCAL LEADERS, AND URBAN EXPERTS FOR FEEDBACK ON MAINTENANCE.

ANNUAL ROAD INFRASTRUCTURE ASSESSMENT

TO KEEP OUR ROADS IN TOP CONDITION, WE SHOULD CONDUCT A COMPREHENSIVE ANNUAL ASSESSMENT OF BENGALURU'S ROAD NETWORK.



THAT SOUNDS LIKE A PROACTIVE APPROACH. IT'LL HELP US CATCH DEFECTS EARLY AND PLAN MAINTENANCE BETTER.

ASSESSMENT METHODOLOGY

INSPECTIONS & SURVEYS: USE AI, DRONES, AND GIS FOR REGULAR ROAD CONDITION ASSESSMENTS.

DEFECT CLASSIFICATION: PRIORITIZE MAINTENANCE BASED ON DEFECT SEVERITY AND URGENCY.

PUBLIC REPORTING: ENABLE CITIZEN REPORTING WITH GEOTAGGED LOCATIONS FOR BETTER ISSUE TRACKING.

STRUCTURAL TESTS: CONDUCT TESTS ON LOAD-BEARING CAPACITY, MATERIALS, AND SUBSOIL FOR CRITICAL INFRASTRUCTURE.

ADVANCED ROAD MAINTENANCE MODEL



WHO IS RESPONSIBLE FOR ROAD MAINTENANCE?

A SINGLE AGENCY PER WARD, APPOINTED BY BBMP, MONITORED THROUGH PERFORMANCE-BASED CONTRACTS TO ENSURE QUALITY AND ACCOUNTABILITY.

RESPONSIBILITIES

- REGULAR INSPECTION, REPAIR, AND UPKEEP OF ROADS, FOOTPATHS, AND INTERSECTIONS.
- CLEANING AND WASTE DISPOSAL ALONG ALL ROAD CORRIDORS.
- REPORTING AND ADDRESSING DRAINAGE-RELATED ISSUES.
- COORDINATION WITH CIVIC AGENCIES TO PREVENT EXCAVATION DAMAGES.

RISK ASSESSMENT

WHAT'S THE STRATEGY FOR SMD MAINTENANCE?

PRE-MONSOON DESILTING

CLEAR DRAINS **BEFORE** THE RAINY SEASON TO PREVENT **WATER LOGGING**.

POST-MONSOON CLEAN-UP

REMOVE SILT BUILDUP AND REPAIR **DAMAGES AFTER** MONSOONS.

GIS SMD MAPPING

DIGITIZE DRAINAGE NETWORKS TO **MONITOR** HEALTH AND FLOOD-PRONE AREAS.

HOW WILL ROAD CLEANING BE MANAGED?

WARD-LEVEL MECHANICAL SWEEPERS

DEDICATED SWEEPERS FOR DIFFERENT STREET TYPES.

REGULAR MAINTENANCE

MANDATORY **UPKEEP** WITH **ALLOCATED BUDGET**.

TRAINED OPERATORS

SKILLED PERSONNEL WITH PERIODIC **EFFICIENCY CHECKS**.

ENGAGEMENT OF PRIVATE AGENCIES FOR POST-DEFECT LIABILITY PERIOD

WHAT HAPPENS AFTER THE DEFECT LIABILITY PERIOD (DLP) FOR NEWLY CONSTRUCTED OR REPAIRED ROADS?

HOW DO WE ENSURE THEY DELIVER QUALITY WORK?



AFTER THE DLP, **PRIVATE AGENCIES WILL TAKE OVER** MAINTENANCE WITH A CLEAR SCOPE OF WORK, INCLUDING:

- ROUTINE ROAD REPAIRS** TO FIX CRACKS, POTHoles, AND GENERAL WEAR.
- DRAINAGE AND FOOTPATH UPKEEP** TO KEEP STORM-WATER DRAINS AND SIDEWALKS FUNCTIONAL.
- STREET FURNITURE AND SIGNAGE MAINTENANCE** TO ENSURE CROSSINGS, PEDESTRIAN ZONES, AND SIGNS REMAIN IN GOOD CONDITION.

PERFORMANCE-BASED CONTRACTS WILL BE IN PLACE—AGENCIES MUST MEET MAINTENANCE BENCHMARKS BEFORE GETTING PAID.

PUBLIC ENGAGEMENT AND DIGITAL GOVERNANCE

WE NEED CITIZEN INVOLVEMENT IN ROAD MAINTENANCE.

WE CAN DEVELOP AN APP AND A MAINTENANCE DASHBOARD

REAL-TIME MAINTENANCE DASHBOARD FOR MAINTENANCE:

01.

VIEW CONTRACTOR DETAILS & PROJECT TIMELINES



2025 2026 2027 2028

TRACK ACTIVE & COMPLETED REPAIRS

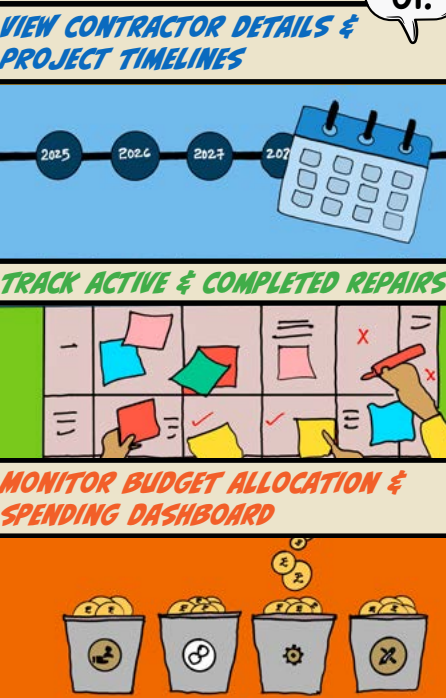
02.

BBMP ROAD WATCH APP: CITIZENS CAN REPORT ROAD DEFECTS EASILY WITH GEO-TAGGED IMAGES.

03.

FORMATION OF WARD-LEVEL COMMITTEES: RWAS, NGOS, AND LOCAL GROUPS TO ACTIVELY MONITOR AND COLLECT ROAD FEEDBACK.

MONITOR BUDGET ALLOCATION & SPENDING DASHBOARD



BUDGET ALLOCATION & SUSTAINABLE ROAD MAINTENANCE

HOW DO WE ENSURE LONG-TERM SUSTAINABILITY OF ROAD MAINTENANCE?

ANNUAL MAINTENANCE FUND

ALLOCATE BUDGET FOR PROACTIVE REPAIRS, ENSURING LONG-TERM ROAD SUSTAINABILITY.

PPP MODEL FOR MAINTENANCE

COLLABORATE WITH PRIVATE PARTNERS AND CSR INITIATIVES FOR CO-FUNDING AND LONG-TERM ROAD UPKEEP.

SUSTAINABLE REPAIR TECHNIQUES

USE RECYCLED MATERIALS, COLD-MIX ASPHALT, AND PERMEABLE PAVEMENTS FOR ENHANCED DURABILITY.

MONITORING & EVALUATION FRAMEWORK

WHAT WILL THE MONITORING AND EVALUATION TEAM WITH THE ROAD MAINTENANCE CELL BE RESPONSIBLE FOR?

CENTRALIZED ROAD MAINTENANCE: LEVERAGING TECHNOLOGY, STAKEHOLDERS, SUSTAINABILITY FOR QUALITY, COST AND SAFETY



THIRD-PARTY QUALITY AUDITS

INDEPENDENT AUDITS EVERY SIX MONTHS TO ENSURE ROAD QUALITY.

CONTRACTOR PERFORMANCE RATINGS

REGULAR EVALUATIONS AND BLACKLISTING OF DEFAULTERS FOR BETTER ACCOUNTABILITY.

QUARTERLY PROGRESS REPORTS

PUBLISH UPDATES ON BBMP'S PORTAL FOR PUBLIC TRANSPARENCY.

