

ASPHALT, BITUMEN AND HIGHLY REDUCED GRAPHENE OXIDE HrGO

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WHAT IS OUR PROPRIETARY HrGO

HrGO STANDS FOR HIGHLY REDUCED
GRAPHENE WHICH IS HEAT RESISTANT
GRAPHENE OXIDE ALSO AND IS
ESPECIALLY ENGINEERED TO WORK
IN HIGH TEMPERATURE
ENVIRONMENTS.



**OUR PROPRIETARY HrGO HAS
AN EDGE OVER TRADITIONAL
GRAPHENE NANO PLATELETS
GENERALLY (GNP) USED WITH
BITUMEN AND ASPHALT FOR
HIGHWAY APPLICATIONS.
THE FOLLOWING THREE
SLIDES DESCRIBE THIS.**



WHY OUR HrGO OUTPERFORMS TRADITIONAL GNP SLIDE-1

SUPERIOR INTERFICIAL BONDING

- WHY HrGO WINS: HrGO HAS RESIDUAL OXYGEN FUNCTIONAL GROUPS AT THE EDGES AND A WRINKLED SURFACE MORPHOLOGY, ENABLING STRONG CHEMICAL AND MECHANICAL ANCHORING WITH POLYMER AND ASPHALT BINDER.**
- WHY GNP LAGS: GNP IS HIGHLY INERT AND FLAT, OFFERING POOR COMPATIBILITY WITH POLYMERS WITHOUT COSTLY SURFACE MODIFICATION.**



WHY OUR HrGO OUTPERFORMS TRADITIONAL GNP

SLIDE-2

BETTER DISPERSION IN POLYMER MATRIX

- **HrGO ADVANTAGE:** EDGE FUNCTIONALIZATION AND RESIDUAL OXYGEN GROUPS ALLOW HrGO TO DISPERSE UNIFORMLY IN POLYMER AND ASPHALT BINDER, PREVENTING AGGLOMERATION.
- **GNP LIMITATION:** GNP TENDS TO STACK AND AGGLOMERATE, LEADING TO UNEVEN PERFORMANCE AND REDUCED REINFORCEMENT EFFICIENCY.



WHY OUR HrGO OUTPERFORMS TRADITIONAL GNP

SLIDE-3

ENHANCED MECHANICAL PERFORMANCE

- **HrGO ADVANTAGE: PROVIDES SUPERIOR TENSILE STRENGTH, FATIGUE LIFE, AND RUTTING RESISTANCE DUE TO EDGE INTERLOCKING AND POLYMER GRAFTING CAPABILITY.**
- **GNP LIMITATION: OFFERS ONLY BASAL-PLANE REINFORCEMENT; LACKS STRONG EDGE INTERACTION, REDUCING OVERALL DURABILITY.**



COST SAVING IN HIGHWAY CONSTRUCTION BY HPRB

(HrGO-POLYMER REINFORCED BITUMEN)

SLIDE-1

REDUCED MATERIAL CONSUMPTION

- **BENEFIT: HIGHER STRENGTH AND DURABILITY MEAN THINNER ASPHALT LAYERS CAN ACHIEVE THE SAME PERFORMANCE AS THICKER CONVENTIONAL LAYERS.**
- **IMPACT: SAVES UP TO 10–15% ON RAW MATERIAL COSTS (AGGREGATE + BINDER).**



COST SAVING IN HIGHWAY CONSTRUCTION BY HPRB

(HrGO-POLYMER REINFORCED BITUMEN)

SLIDE-2

FASTER CONSTRUCTION & LOWER DOWNTIME

- **BENEFIT: IMPROVED HIGH-TEMPERATURE PERFORMANCE AND WORKABILITY REDUCE LAYING TIME AND COMPACTION ISSUES.**
- **IMPACT: SPEEDS UP PROJECT EXECUTION, SAVING LABOR, EQUIPMENT RENTAL, AND PENALTY COSTS FOR DELAYS.**



COST SAVING IN HIGHWAY CONSTRUCTION BY HPRB

(HrGO-POLYMER REINFORCED BITUMEN)

SLIDE-3

- **BENEFIT: FEWER INTERVENTIONS (AND
LONGER PAVEMENT LIFE REDUCE THE
OVERALL LCC BY
25–40% COMPARED TO CONVENTIONAL OR
GNP-BASED SYSTEMS.**
- **IMPACT: ENSURES PREDICTABLE BUDGETS
AND HIGHER ROI FOR CONSTRUCTION**

COST SAVING IN HIGHWAY CONSTRUCTION BY HPRB

(HrGO-POLYMER REINFORCED BITUMEN)

SLIDE-4

LOWER MAINTENANCE & LONGER SERVICE LIFE

- **BENEFIT: HrGO REINFORCEMENT SIGNIFICANTLY IMPROVES RUTTING RESISTANCE, CRACK RESISTANCE, AND FATIGUE LIFE.**
- **IMPACT: REDUCES FREQUENCY OF ROAD REPAIRS BY 30–50%, CUTTING MAINTENANCE COSTS OVER THE PROJECT LIFE CYCLE.**

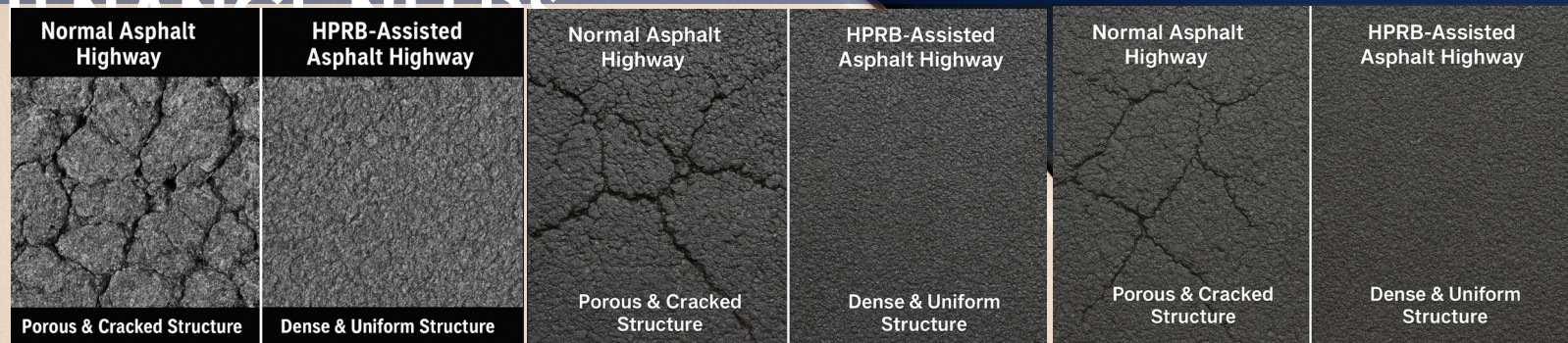


HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR PERFORMING AS NEXT GENERATION INTELLIGENT NANO BINDER FOR ASPHALT (INBA)

ADVANTAGES

SLIDE-1

OUTSTANDING CRACK RESISTANCE
HrGO STRENGTHENS THE BITUMINOUS MATRIX,
EFFECTIVELY MINIMIZING MICRO-CRACK
FORMATION AND STOPPING CRACK PROPAGATION
FROM THERMAL STRESS AND HEAVY TRAFFIC LOADS
—SIGNIFICANTLY REDUCING LONG-TERM
MAINTENANCE NEEDS



HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR PERFORMING AS NEXT GENERATION INTELLIGENT NANO BINDER FOR ASPHALT (INBA)

ADVANTAGES

SLIDE-2

**SUPERIOR MECHANICAL STRENGTH
HPRB ENHANCES THE TENSILE STRENGTH AND
ELASTICITY OF ASPHALT, REDUCING DEFORMATION
UNDER HEAVY TRAFFIC LOADS. THIS IMPROVEMENT
ENSURES THE PAVEMENT CAN WITHSTAND HIGH-
PRESSURE STRESSES WITHOUT CRITTING**



Visible Depression



No Depression



**Normal Asphalt
Highway**



**HPRB-Assisted
Asphalt Highway**



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-3

OUTSTANDING THERMAL STABILITY

- **HrGO OFFERS REMARKABLE STABILITY AT HIGH MIXING AND SERVICE TEMPERATURES, PREVENTING SOFTENING OF ASPHALT UNDER EXTREME HEAT AND MINIMIZING PERMANENT DEFORMATION RISKS.**



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-4

EXCELLENT LOW-TEMPERATURE FLEXIBILITY

**THE INTEGRATION OF HrGO PROVIDES DUCTILITY
AT LOW TEMPERATURES, REDUCING THERMAL
CRACKING IN COLD CLIMATES AND ENSURING
ALL-SEASON PERFORMANCE OF THE PAVEMENT.**



HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR PERFORMING AS NEXT GENERATION INTELLIGENT NANO BINDER FOR ASPHALT (INBA)

ADVANTAGES

SLIDE-5

THE COMBINED IMPROVEMENTS IN
MECHANICAL STRENGTH, THERMAL
RESISTANCE, AND DURABILITY
TRANSLATE INTO A SIGNIFICANT
INCREASE IN THE LIFESPAN OF
ASPHALT ROADS, REDUCING THE
FREQUENCY OF COSTLY REPAIRS AND
OVERLAYS.



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-6

SUPERIOR RUTTING RESISTANCE

**HrGO-MODIFIED ASPHALT DEMONSTRATES
MUCH HIGHER RESISTANCE TO RUTTING UNDER
HEAVY AXLE LOADS, MAKING IT IDEAL FOR
HIGHWAYS, AIRPORTS, AND FREIGHT
CORRIDORS.**



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-7

IMPROVED FATIGUE LIFE

**HrGO IMPROVES THE ASPHALT'S FATIGUE
PERFORMANCE UNDER REPETITIVE TRAFFIC
LOADING, DELAYING STRUCTURAL FAILURE
AND ENHANCING PAVEMENT RELIABILITY.**



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-8

ENHANCED ADHESION WITH BITUMEN

THE FUNCTIONAL GROUPS PRESENT ON HrGO SURFACES CREATE STRONGER BONDING INTERACTIONS WITH BITUMEN MOLECULES, LEADING TO A MORE COHESIVE AND STABLE ASPHALT MATRIX.



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-9

HIGH THERMAL CONDUCTIVITY

**GRAPHENE-BASED STRUCTURES LIKE HrGO
EXHIBIT EXCEPTIONAL THERMAL
CONDUCTIVITY, WHICH HELPS IN UNIFORM
HEAT DISTRIBUTION DURING MIXING,
COMPACTION, AND SERVICE LIFE, REDUCING
LOCALIZED HOT SPOTS.**



HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR PERFORMING AS NEXT GENERATION INTELLIGENT NANO BINDER FOR ASPHALT (INBA)

ADVANTAGES

SLIDE-10

REDUCTION IN OXIDATIVE AGING

**HrGO CREATES A BARRIER EFFECT THAT
SLOWS DOWN THE OXIDATIVE AGING
PROCESS OF ASPHALT BINDERS,
MAINTAINING THEIR VISCOELASTIC
PROPERTIES OVER TIME AND DELAYING
BRITTLINESS.**



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-11

INCREASED MOISTURE DAMAGE RESISTANCE

**HrGO ENHANCES THE HYDROPHOBIC
CHARACTERISTICS OF THE ASPHALT MATRIX,
REDUCING MOISTURE SUSCEPTIBILITY AND
STRIPPING ISSUES, WHICH ARE MAJOR
CAUSES OF EARLY PAVEMENT FAILURE.**



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-12

BETTER LOAD DISTRIBUTION

**THE HrGO-REINFORCED ASPHALT EXHIBITS
IMPROVED STIFFNESS MODULUS, DISTRIBUTING
HEAVY VEHICULAR LOADS MORE EFFECTIVELY
AND REDUCING LOCALIZED STRESSES ON THE
PAVEMENT STRUCTURE.**



**HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR
PERFORMING AS NEXT GENERATION INTELLIGENT NANO
BINDER FOR ASPHALT (INBA)**

ADVANTAGES

SLIDE-13

SUSTAINABLE AND GREEN SOLUTION

**USING HrGO IN ASPHALT REDUCES THE NEED
FOR THICKER OVERLAYS AND FREQUENT
RECONSTRUCTIONS, CUTTING DOWN ON
RAW MATERIAL CONSUMPTION AND
LOWERING THE OVERALL CARBON FOOTPRINT
OF HIGHWAY PROJECTS.**



HrGO-POLYMER REINFORCED BITUMEN (HPRB) FOR PERFORMING AS NEXT GENERATION INTELLIGENT NANO BINDER FOR ASPHALT (INBA)

ADVANTAGES

SLIDE-14

INCREASED SKID RESISTANCE AND SAFETY

**HrGO IMPROVES THE MICROTTEXTURE AND
BONDING WITHIN THE ASPHALT,
MAINTAINING SURFACE ROUGHNESS FOR
BETTER TIRE GRIP AND SAFER DRIVING
CONDITIONS IN BOTH DRY AND WET
SCENARIOS.**



IMPLEMENTATION OF GO NANO SUPER PLASTICIZERS IN MEGA-SCALE



IMPLEMENTATION OF GO NANO SUPER PLASTICIZERS IN MEGA-SCALE



“HIGHWAYS ARE MORE THAN ROADS—THEY CONNECT DREAMS, FAMILIES, AND PROGRESS. EVERY CRACK THAT APPEARS IS A BREAK IN TRUST, EVERY REPAIR A BURDEN ON TIME, MONEY, AND OUR PLANET. WITH HPRB INNOVATION, WE ARE BUILDING HIGHWAYS THAT LAST LONGER, REDUCE MAINTENANCE, AND CUT CARBON EMISSIONS BY MINIMIZING FREQUENT REPAIRS AND RESOURCE WASTAGE. TOGETHER, LET’S CREATE ROADS THAT PROTECT BOTH YOUR INVESTMENT AND OUR ENVIRONMENT—FOR GENERATIONS TO COME.”

LET’S COLLABORATE

- CONTACT US FOR PILOT SAMPLES, TECH SHEETS, OR BULK ORDERS.
-  INFO@RIIIGROUP.COM | INSTRUMENTRI@GMAIL.COM |
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