AMAAC

MEXICAN ASSOCIATION OF ASPHALT

MEXICO´S MODIFIED ASPHALT EXPERIENCE.

Gabriel Hernández

Kansas City. February 2011.

AGENDA.

1. BACKGROUND.
2. BASIS FOR SPECIFICATION.
3. AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.
4. APPLICATION RESULTS.
5. CONCLUSION.

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1. **<u>BACKGROUND.</u>**

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BACKGROUND.

Undoubtedly, Mexico's pavement engineering is currently debating against the urgent need to improve the design and construction procedures, along with the ultimate goal of achieving, an improved performance of such structures which allow optimization of maintenance and rehabilitation costs associated, and especially, the operating costs for users.

BACKGROUND.

In pursuit of these objectives, the quality characteristics of each of the materials which make up a pavement, play a significant role, especially those related to the asphalt being directly exposed to environmental aggressions and vehicular traffic as well .

BACKGROUND.

LIKE A GOOD COOKIE RECIPE !!!

In pursuit of these objectives, the quality characteristics of each of the materials which make up a pavement, play a significant role, especially those related to the asphalt being directly exposed to environmental aggressions and vehicular traffic as well .

BACKGROUND.

Therefore, at the initiative of the Mexican Association of Asphalt (AMAAC); a technical committee with experts from both the private and public sectors, including research centers, as well as Universities, has proposed a **protocol** for the design and control of asphalt mixtures containing high performance dense granulometry.

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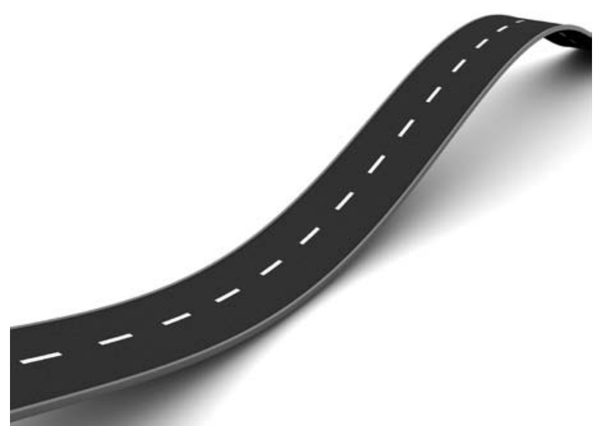
BACKGROUND.

Even though many of the mentioned assays are already widely being used in Mexico, but in others countries, are at their initial impulse, all together, make up a such wealth of experience, knowledge, and technology which is required to actually contribute to an improved road infrastructure in Mexico.

This protocol besides of being a philosophy, it is expected to serve as a basis for those administrations that may include it within the upcoming bidding work related to highway projects.



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FEBRUARY 2008. TECHNICAL COMMITTEE MEMBERS TRAVELED TO SPAIN AND FRANCE IN ORDER TO LEARN ABOUT ROAD CONSTRUCTION PROCEDURES, VISITING ENTITIES AS **LCPC** AND **CEDEX**, AMONG OTHERS.

BASIS FOR SPECIFICATION.

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OCTOBER 2008 – LAUNCHING !!!!

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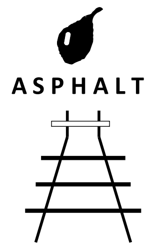
AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.

- The asphalt mixture is a compounded material formed by an eventual conjunction of stone aggregates

and asphalt cement



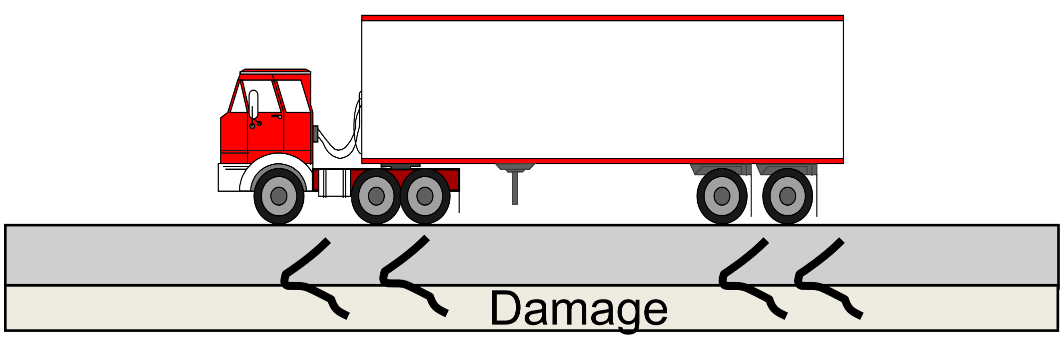
with additives, whose mechanical deformation, and permeability strength properties are conditioned to those particular properties within each mixture component.

For use in road pavements, the high performance asphalt mixture must be resistant to plastic deformation, fatigue phenomenon as well as moisture damage, thus overcoming the conventional asphalt mixtures performance.

Damage on pavements.

Damage on pavements can be classified as:

- Structural.
- Functional.



Structural damage.

Collapse of pavement structure or any of its components. This failure is not capable of supporting loads and reduce the integrity from pavement.

If failure continues, it can generate a functional damage.

Functional damage.

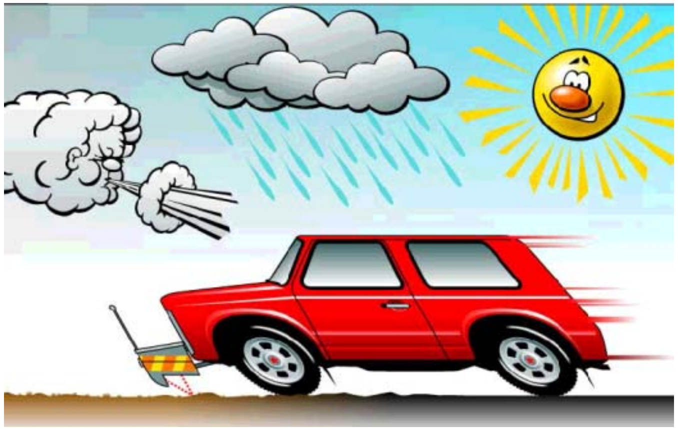
This damage provokes discomfort, insecure conditions for road users, and damage in vehicles.

These functional damages not always has an structural damage associated.

Durability on asphalt roads.

Durability of asphalt mix to resist different phenomenon as aggregate disintegration and change on asphalt by aging, polymerization or oxidation.

One main cause is the separation and lack of covering from asphalt in the aggregates particles. These is a bad result from transit and weather.



AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.

PARAMETER CONTROL PROPOSED:

1) QUALITY ON PETREOUS AGGREGATES.

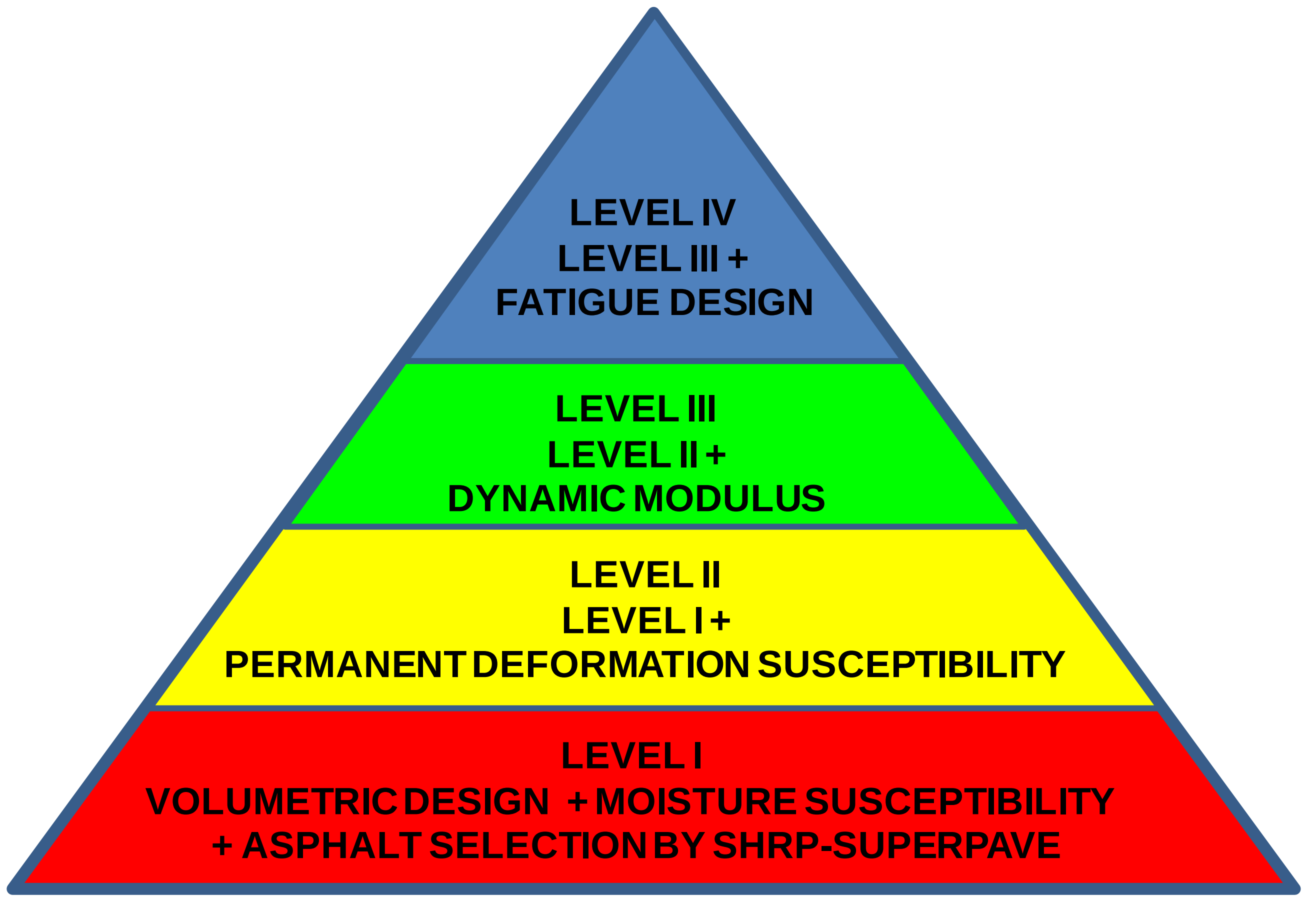
2) QUALITY ON ASPHALT BINDER.

3) SIEVE SIZE DISTRIBUTION CARACTERISTICS ON AGGREGATES.

4) PERFORMANCE LEVEL TO FULFILL.

THE PROTOCOL DESIGN PROVIDES FOUR DIFFERENT LEVELS FOR A DENSE ASPHALT MIXTURE DESIGN, AS A FUNCTION OF THE RELEVANCE OF THE ROAD WHICH IS DETERMINED BY THE EXPECTED LEVEL OF TRAFFIC IN THE DESIGN LANE.

AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.



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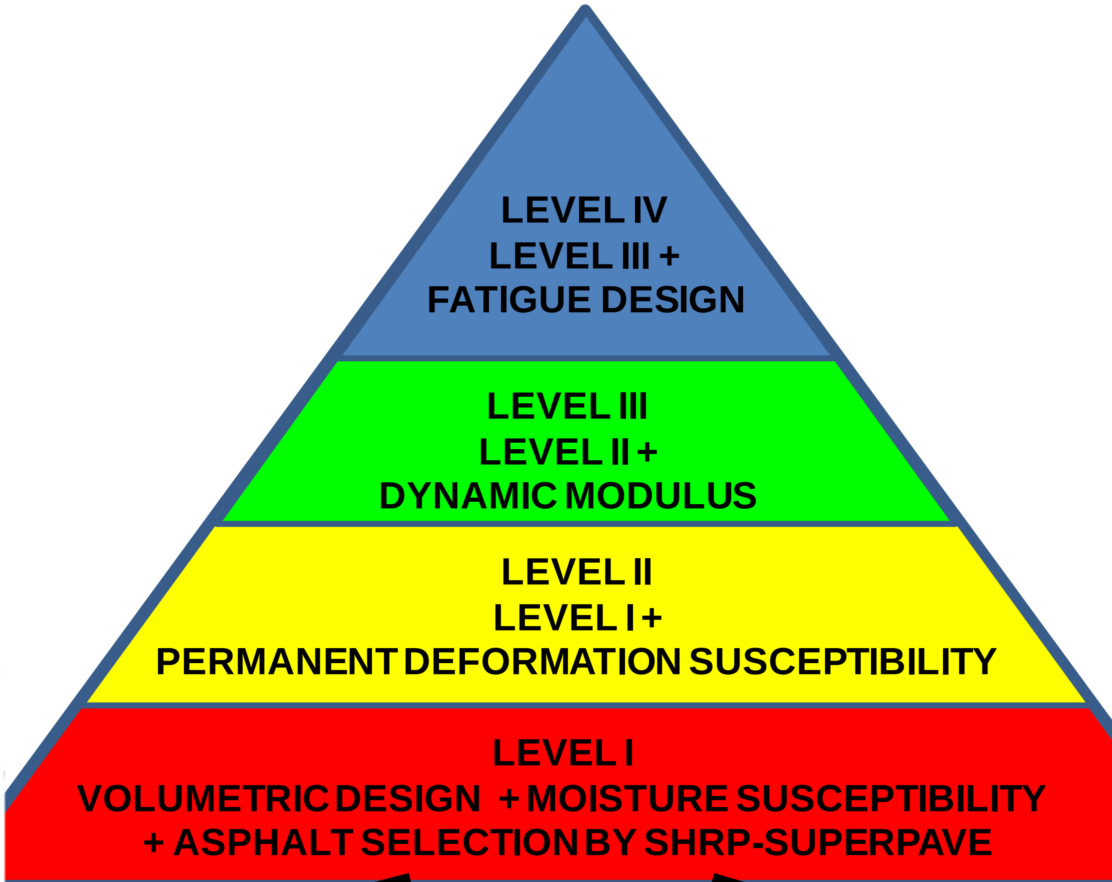

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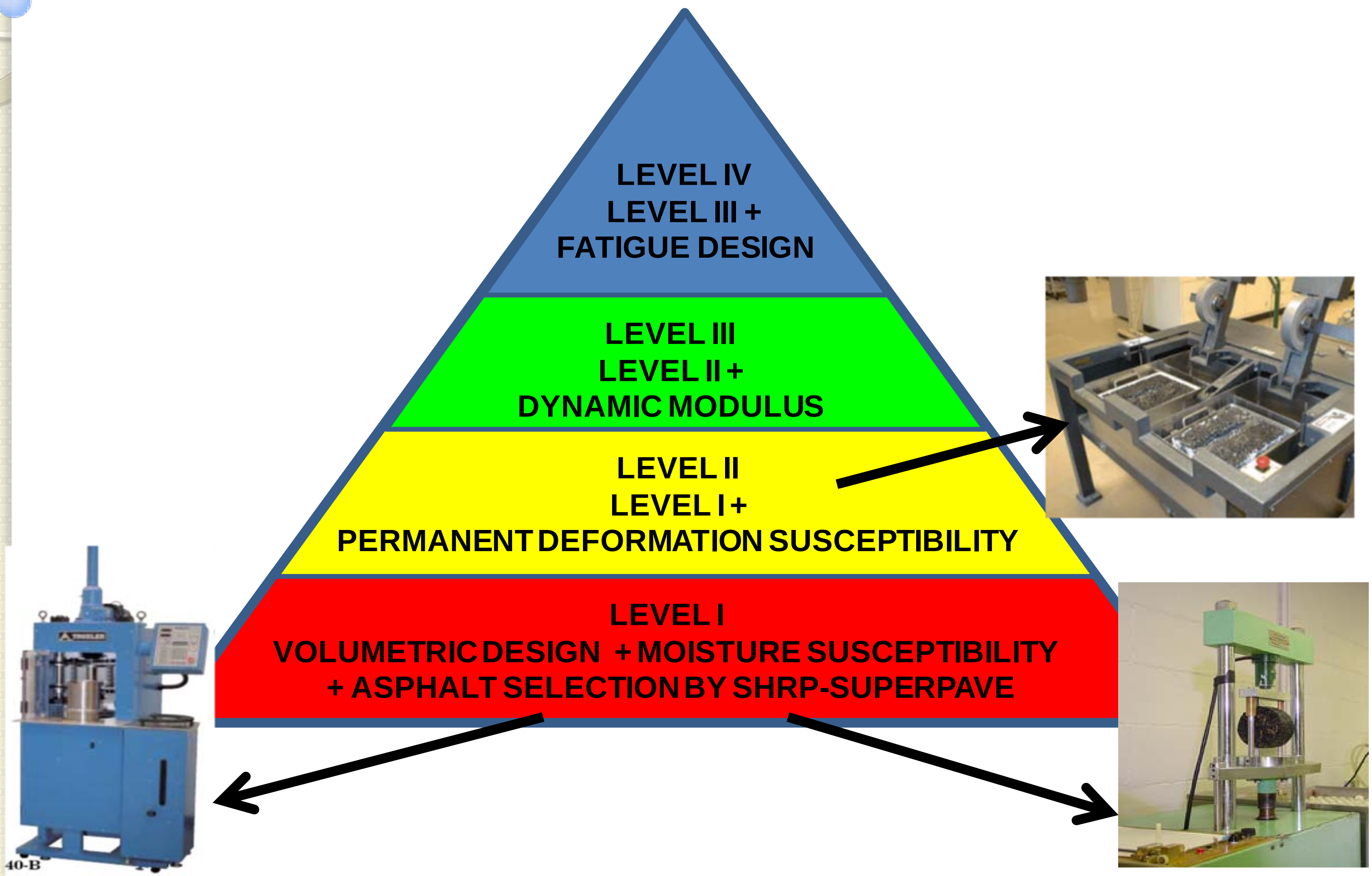

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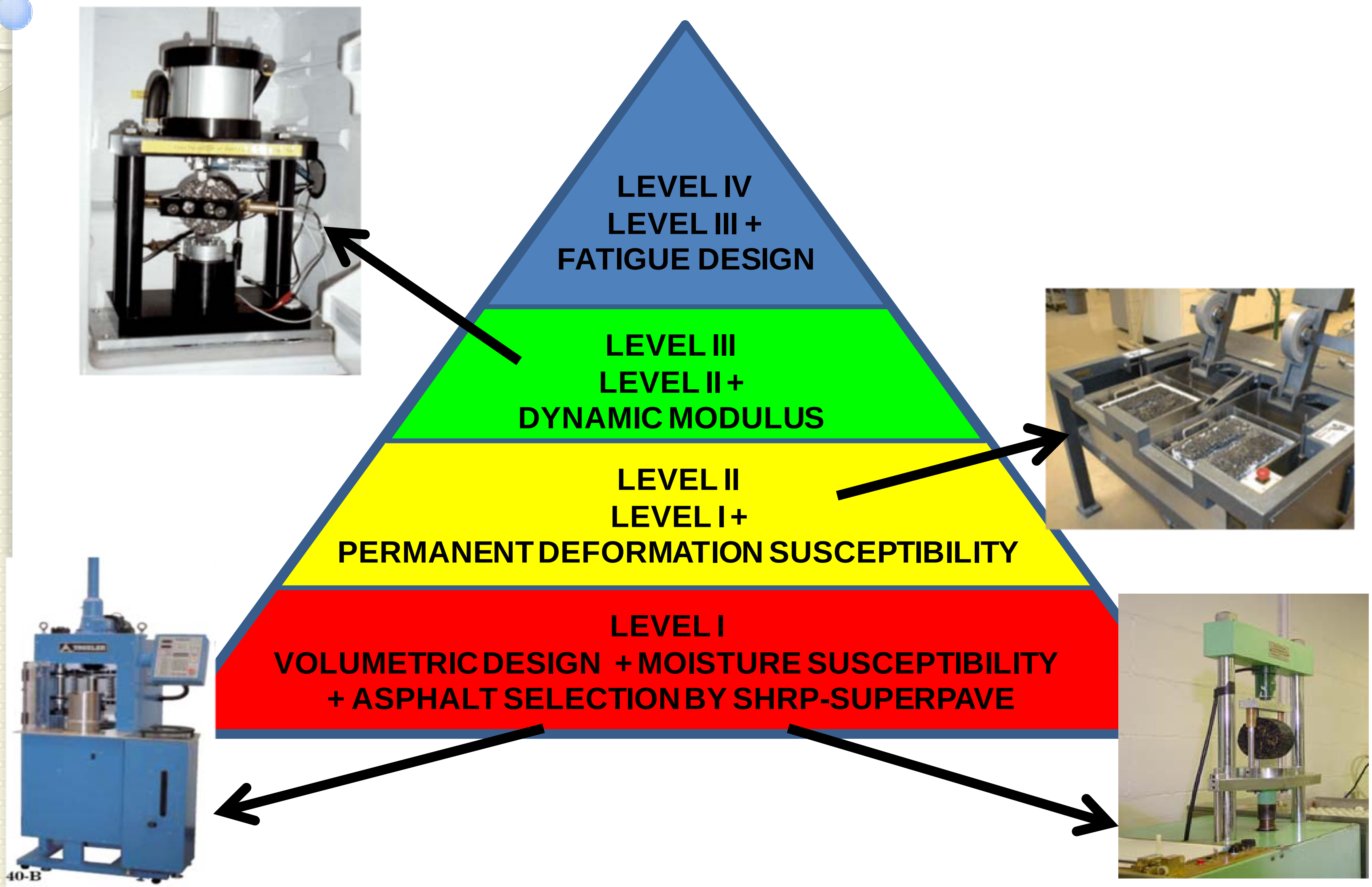

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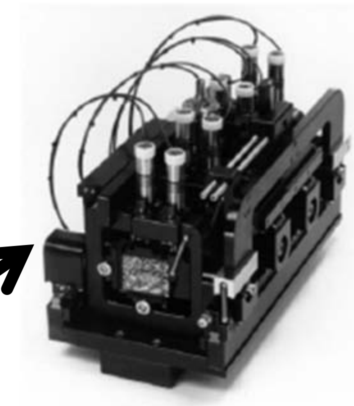
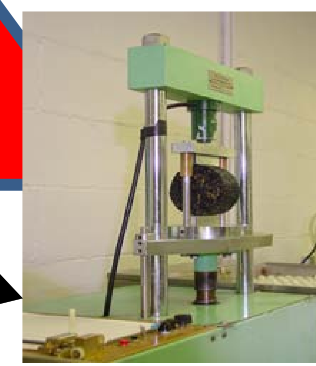


LEVEL IV
LEVEL III +
FATIGUE DESIGN

LEVEL III
LEVEL II +
DYNAMIC MODULUS

LEVEL II
LEVEL I +
PERMANENT DEFORMATION SUSCEPTIBILITY

LEVEL I
VOLUMETRIC DESIGN + MOISTURE SUSCEPTIBILITY
+ ASPHALT SELECTION BY SHRP-SUPERPAVE



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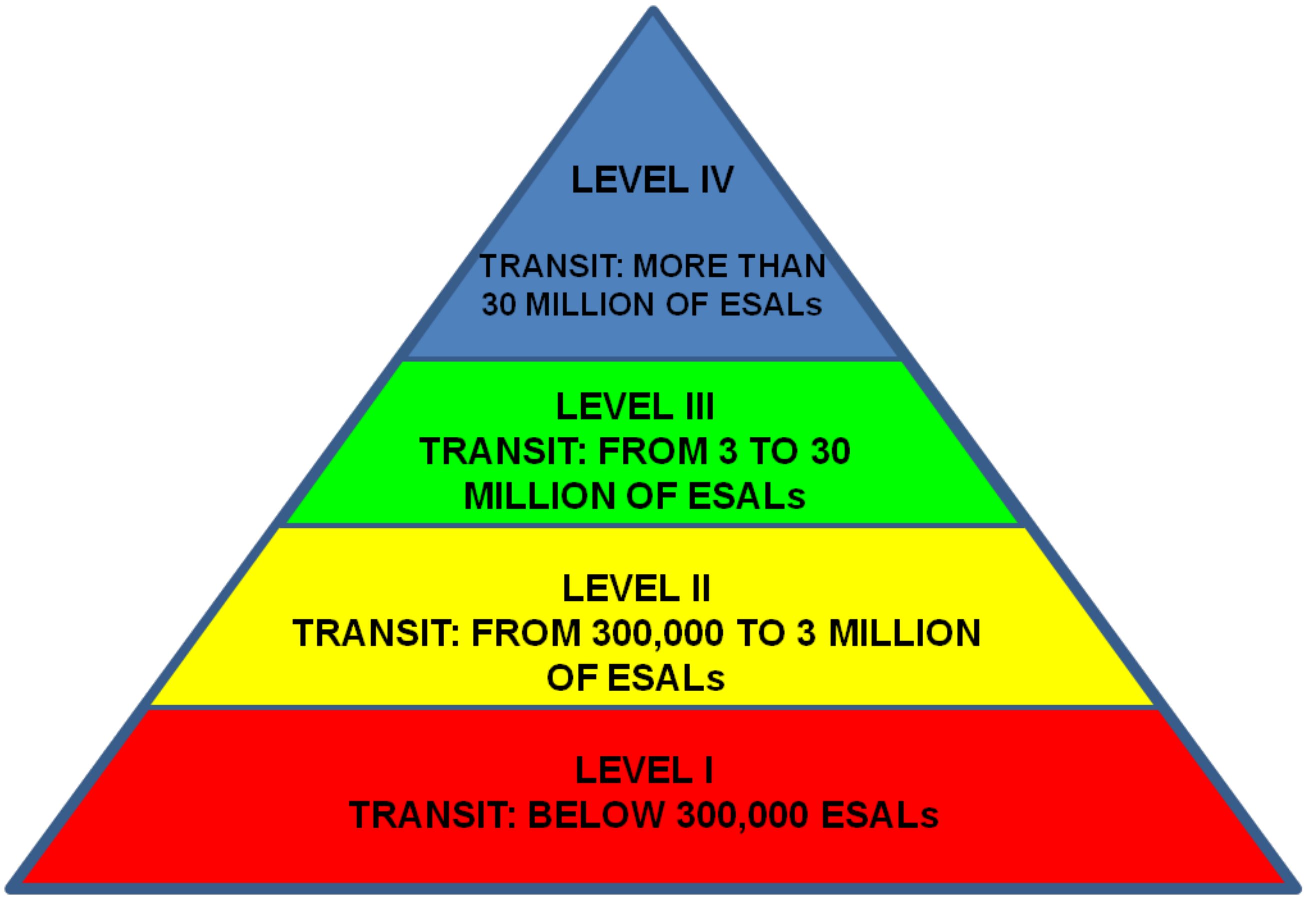
AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.

- **ESALs** = Equivalent Single Axle Loads.



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1 ESALs = 8,200 Kg = 8.2 Tons.

1 ESALs = 18,073 Pounds

Asphalt mix.

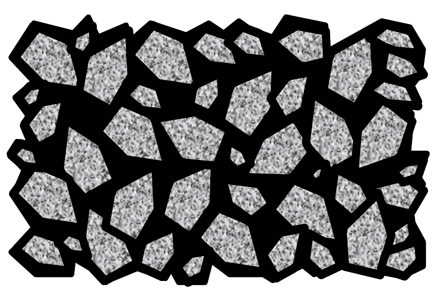
As general requirements:

N CMT 4 04 Quality on aggregate materials for Asphalt mix.

N CMT 4 05 001 Quality on asphaltic materials; and, *N CMT 4 05 004 CMA PG grades asphaltic materials.*

N CMT 4 05 002 Quality on modified asphaltic materials.

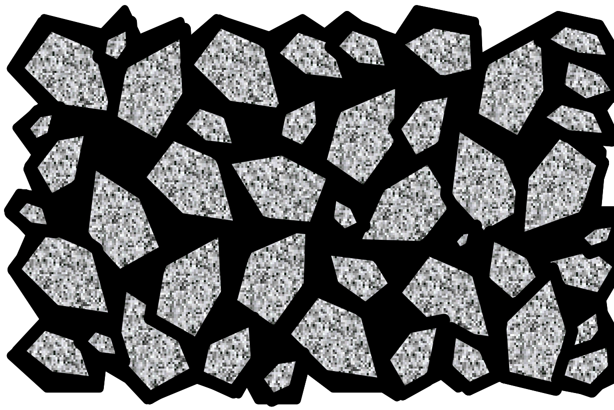
N CMT 4 05 003 Quality on hot mix asphalt for roads



For example:

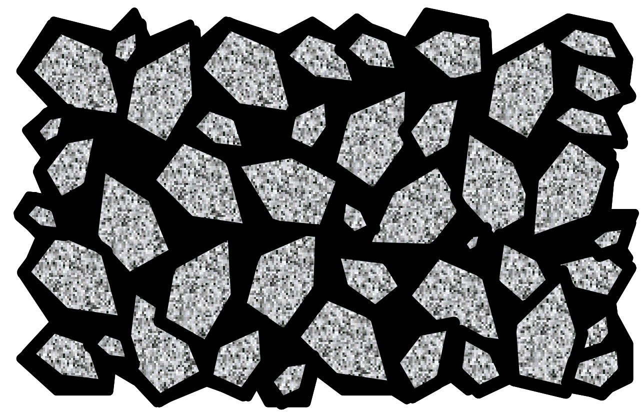
N CMT 4 05 003 Quality on hot mix asphalt for roads.

- Marshall method (MGD).
- Hveem method (MGD).
- Cantabro method (MGA).
- Hubbard field method (mortars).
- Discontinue granulometry method (SMA).



Dense asphalt mix.

Finished requeriments:



Match with PROFILE INDEX of 14 centimeter/Km as maximum on each 200 meter of road.

FRICTION RESISTANCE of 0.6 at 75 Km/Hour of speed (measure by mu-meter).

AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.

TRANSIT LEVEL	ESAL´s	TYPE OF ROAD	RECOMMENDED TEST
LEVEL 1 LOW TRANSIT	BELOW 300,000	➢FEDERAL ROADS TYPE D. ➢ROAD ENTRANCE. ➢STATE AND COUNTY ROADS. ➢URBAN STREETS	VOLUMETRIC DESIGN AND MOISTURE SUSCEPTIBILITY.
LEVEL II MEDIUM TRANSIT	FROM 300,000 TO 3,000,000	➢STATE ROADS. ➢FEDERAL ROADS TYPE B AND C. ➢URBAN ROADS.	VOLUMETRIC DESIGN AND MOISTURE SUSCEPTIBILITY. PERMANENT DEFORMATION SUSCEPTIBILITY.
LEVEL III HIGH TRANSIT	FROM 3,000,000 TO 30,000,000	➢FEDERAL ROADS TYPE A. ➢TOLL ROADS.	VOLUMETRIC DESIGN AND MOISTURE SUSCEPTIBILITY. PERMANENT DEFORMATION SUSCEPTIBILITY. DYNAMIC MODULUS.
LEVEL IV HEAVY TRANSIT	MORE THAN 30,000,000	➢OF OR PERT FEDERAL ROADS. ➢IMPORTANT TOLL ROADS. ➢SUBURBAN ROADS ON BIG CITIES.	VOLUMETRIC DESIGN AND MOISTURE SUSCEPTIBILITY. PERMANENT DEFORMATION SUSCEPTIBILITY. DYNAMIC MODULUS. FATIGUE.

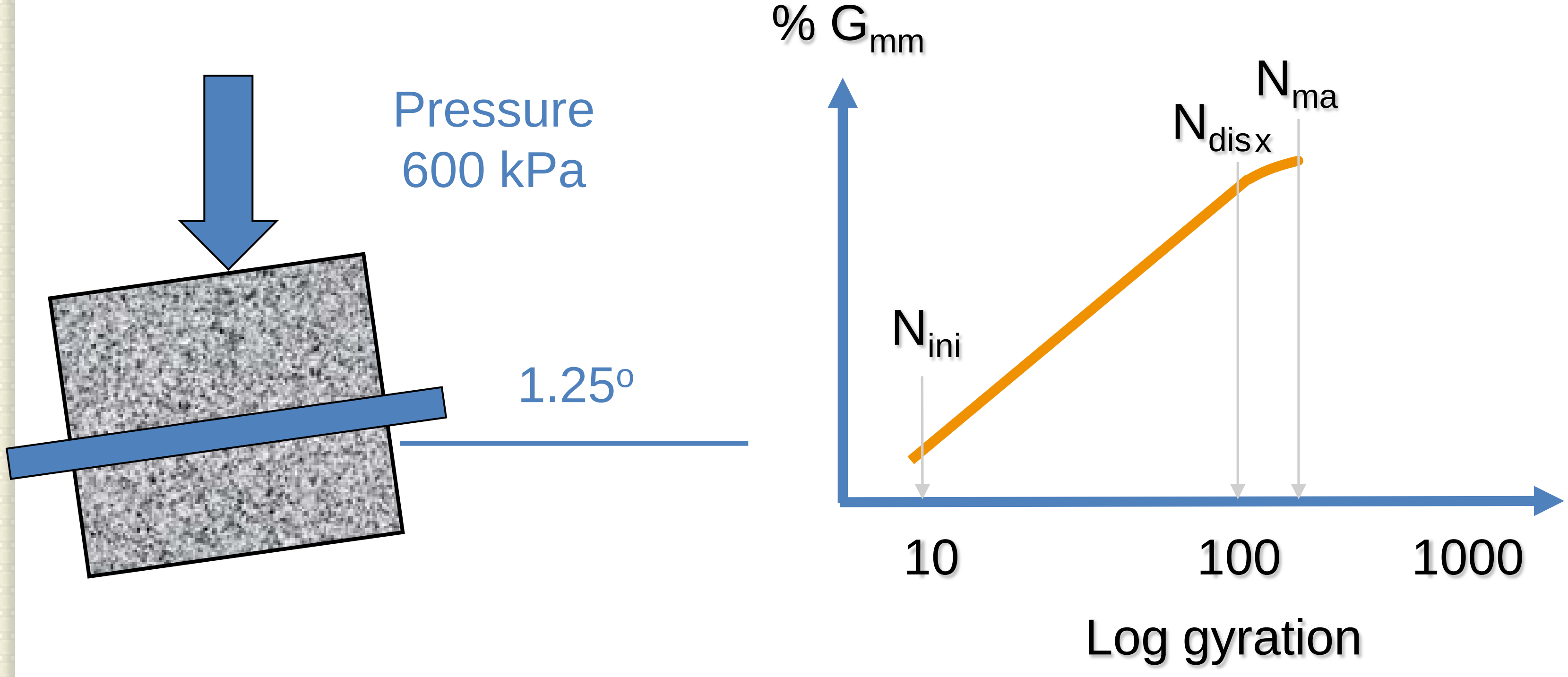
LEVEL I

VOLUMETRIC DESIGN + MOISTURE SUSCEPTIBILITY + ASPHALT SELECTION BY SHRP-SUPERPAVE.

LOW TRANSIT.

Less than 1 million ESALs

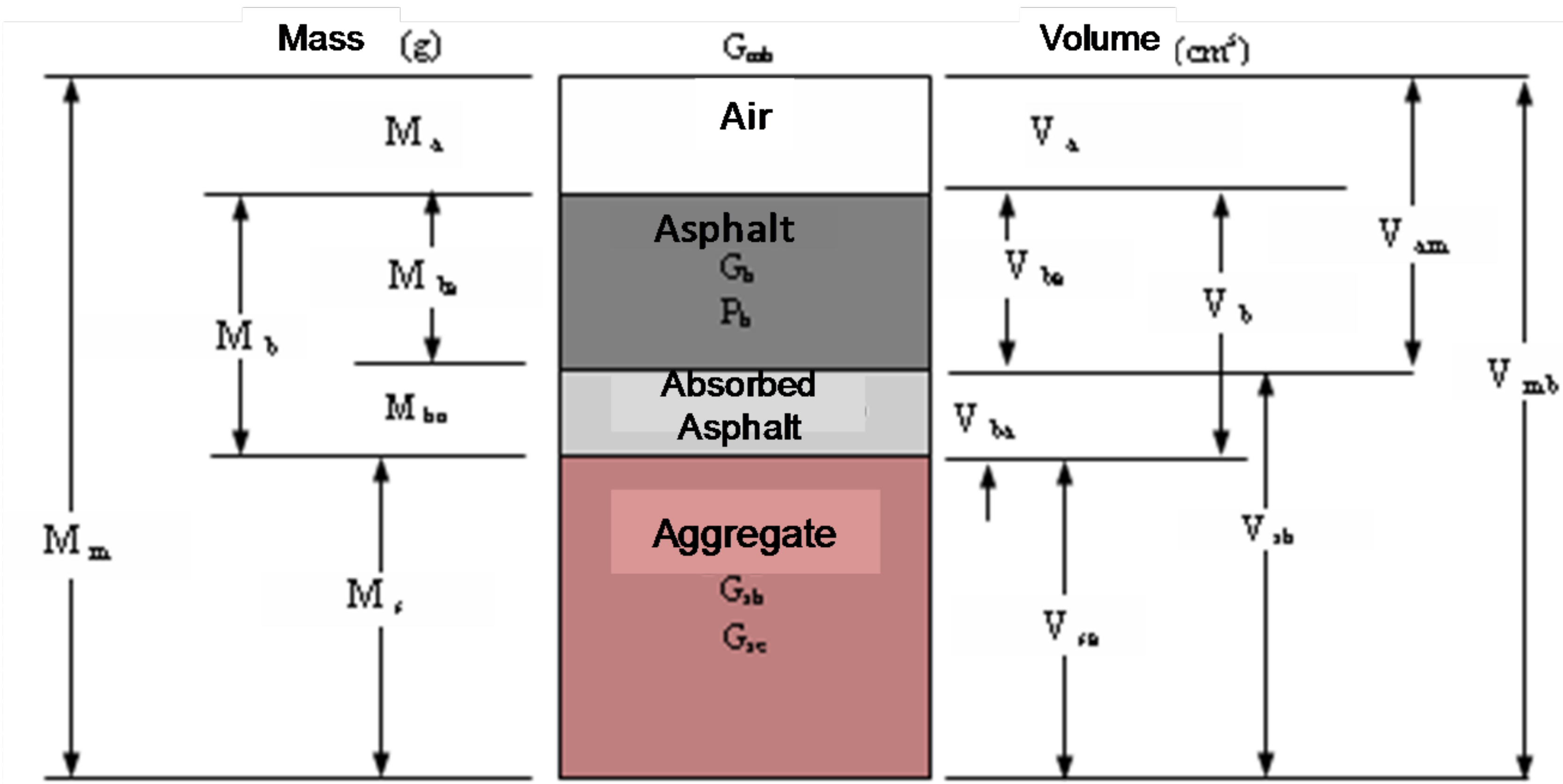
Gyrator compactor conditions



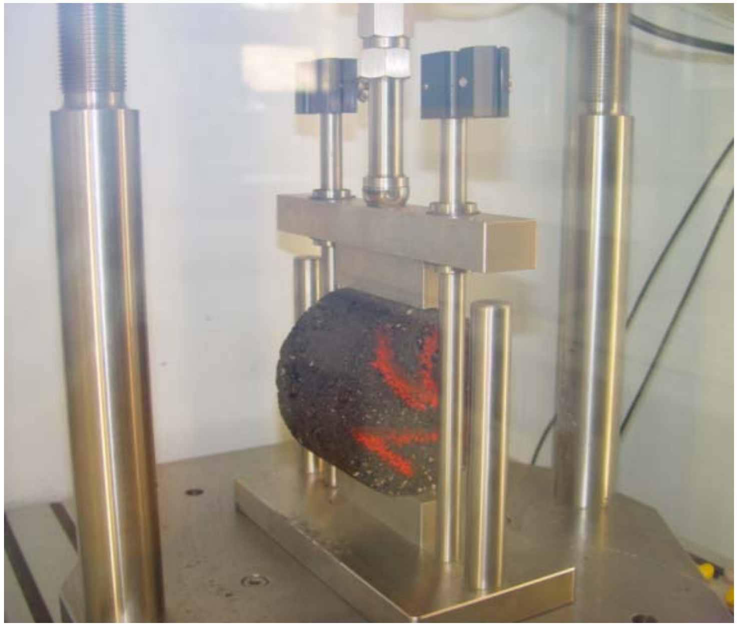
Gyrator compactor.

Gyrator compactor.

Volumetric design.



Moisture susceptibility.



Moisture susceptibility.

AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.

ASPHALT BINDER SELECTION:

CONVENTIONAL ASPHALT: AC-20 (PENETRATION 60-80 (0.1 mm) AT 25°C ACCORDING TO ASTM D5).

POLYMER MODIFIED ASPHALT: FOLLOWING SHRP-SUPERPAVE CRITERION (PG GRADES).

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POLYMER MODIFIED ASPHALT.

TYPE I. ELASTOMERS: SBS AND SB COPOLYMERS.

TYPE II. LATEX: NATURAL LATEX, SBR, NEOPRENE.

TYPE III. PLASTOMERS: POLIETHYLENE, EVA, ETC.

CRUMB RUBBER ASPHALT: TIRES AND OTHER SOURCES.

AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.

POLYMER MODIFIED ASPHALT **TYPE I**: ELASTOMERS.

- Elastomer nature on polymers.
- High elastic recovery.
- High work temperature range (high and low temperatures).
- High viscosity.
- High thermal resistance.
- High modulus.
- High fatigue resistance.
- High adherence

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POLYMER MODIFIED ASPHALT **TYPE II**: LATEX.

- Water dispersion elastomers.
- Elasticity.
- High work temperature range (high and low temperatures).
- High viscosity.
- High thermal resistance.
- High modulus.
- High fatigue resistance.
- High adherence.

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POLYMER MODIFIED ASPHALT **TYPE III**: PLASTOMERS.

- High modulus.
- Low elasticity increment and more plasticity.
- High viscosity.
- High thermal resistance.
- High adherence (E.V.A.).
- Better for high work temperatures.

AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.

CRUMB RUBBER ASPHALT.

- Different sources.
- Elasticity.
- High work temperatures.
- Very high viscosity.
- High thermal resistance.
- Ecological benefits.
- Main problem. Phase separation.

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LEVEL II

LEVEL I +
PERMANENT DEFORMATION.

MEDIUM TRANSIT.

From 1 to 10 million ESALs

Hamburg wheel tracking test.

Asphalt Superior PG grade	Minimum of cycles for maximum deformation of 10 millimeter
PG 64 or inferior	10,000
PG 70	15,000
PG 76 or superior	20,000

Asphaltic Pavement Analyzer (APA) AASHTO TP 63-03.

Transit Level	Maximum rutting
Low	7.0 millimeter
Medium	5.5 millimeter
High	4.0 millimeter
Super High	3.0 millimeter

APA test.

Dry

Under water

Spanish wheel tracking test.

Superior PG grade asphalt	TRANSIT CATEGORY			
	LOW	MEDIUM	HIGH	SUPERHIGH
PG 64 or Lower	20	20	20	15
PG 70	20	20	15	15
PG 76 or superior	20	20	15	12

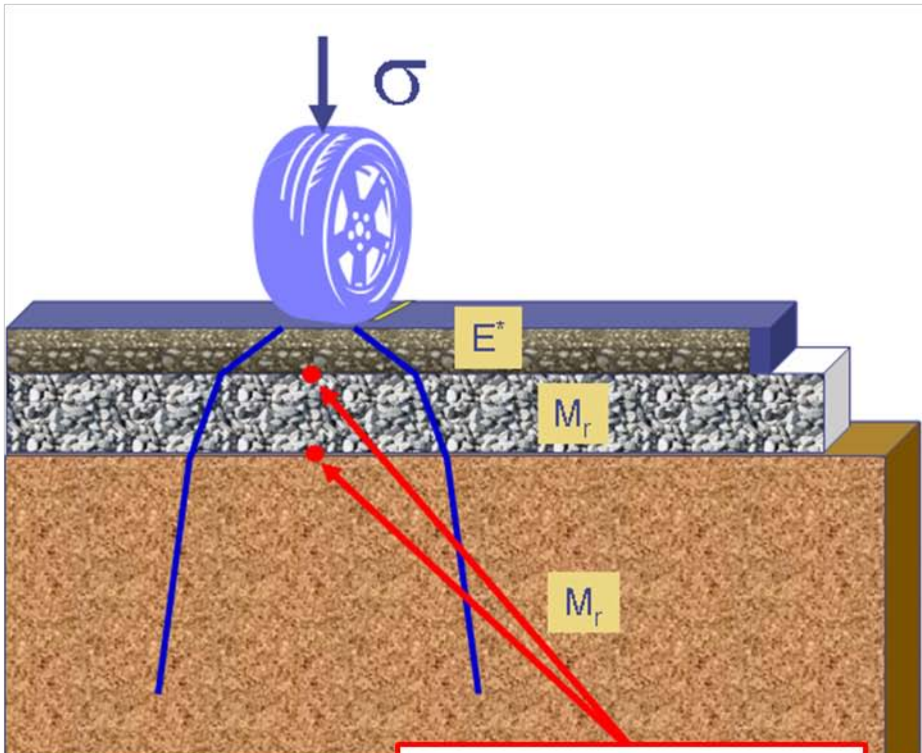
LEVEL III

LEVEL II +
DYNAMIC MODULUS.

HIGH TRANSIT.

From 10 to 30 million ESALs

AMAAC PROTOCOL: A PAVEMENT DESIGN GUIDE.



Deformation calculus

Hooke law:

$E = \sigma / \varepsilon$

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LEVEL IV

LEVEL III +
FATIGUE DESIGN.

SUPERHIGH TRANSIT.

More than 30 million ESALs

Fatigue AASHTO T 321

- Frequency: 10 Hz
- Empty volume: 4 ± 1%
- Temperature: 20°C

Asphalt type	Minimum cycles for test
Conventional asphalt AC-20	**2,000**
Modified Asphalt or PG Asphalt Grade PG 70 - 22 PG 70 - 28 PG 76 - 22 PG 82 - 22	**5,000**

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5. CONCLUSION.

APPLICATION RESULTS.

In 2009, there were built two roads following the AMAAC protocol, one in Jalisco state (near Guadalajara) and other one in Nuevo León State (near Monterrey).

In 2010, there are new initiatives for 18 new roads in different states of Mexican Republic: Nuevo Leon, Jalisco, Sonora, Campeche and Guanajuato.

AMAAC in cooperation with IMT (Mexican Transportation Institute) have a training program with executive seminars on asphalt mix design, quality control laboratories and main test from AMAAC protocol.

APPLICATION RESULTS.

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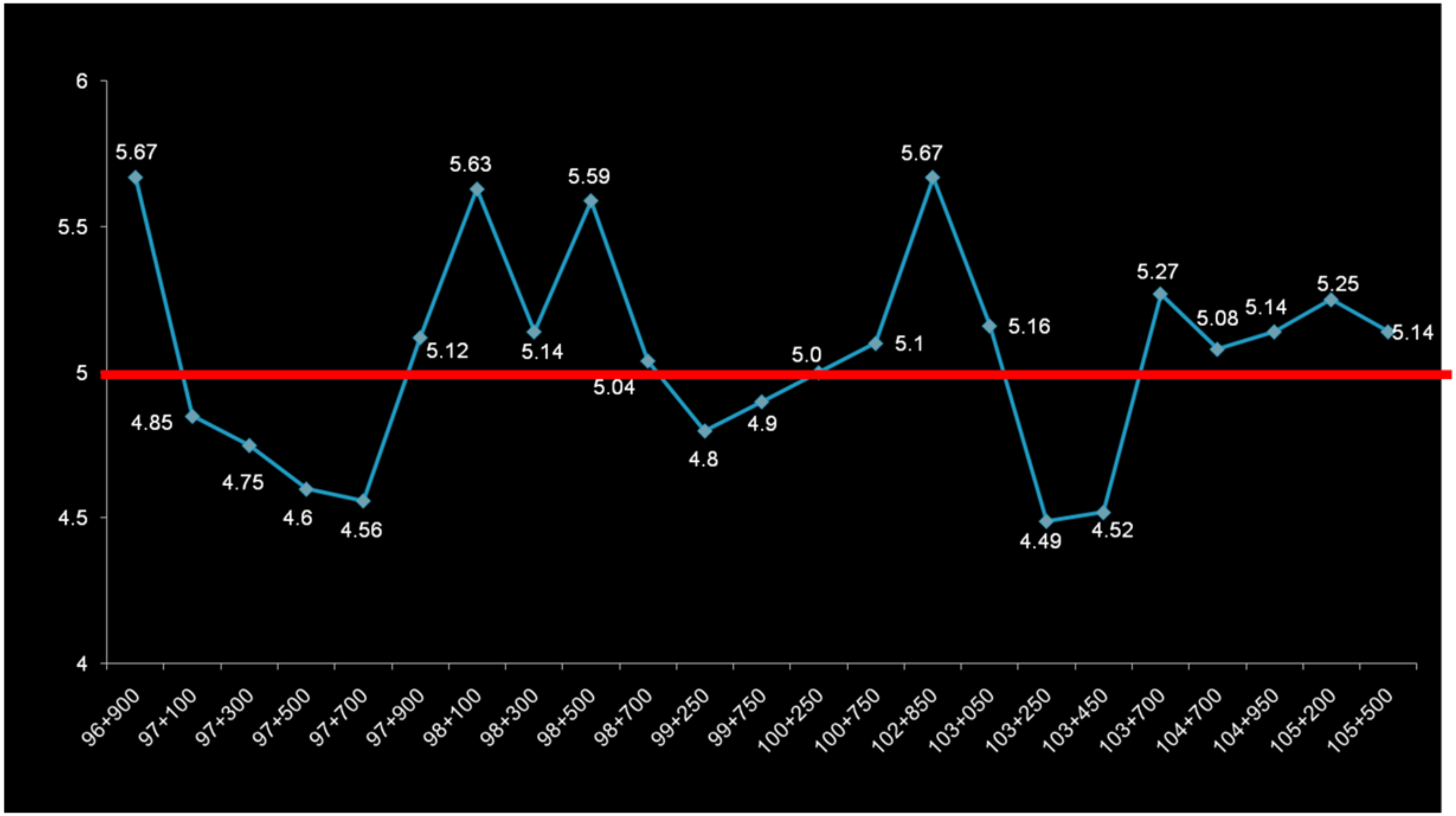
APPLICATION RESULTS.

ASPHALT CONTENT.



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APPLICATION RESULTS.

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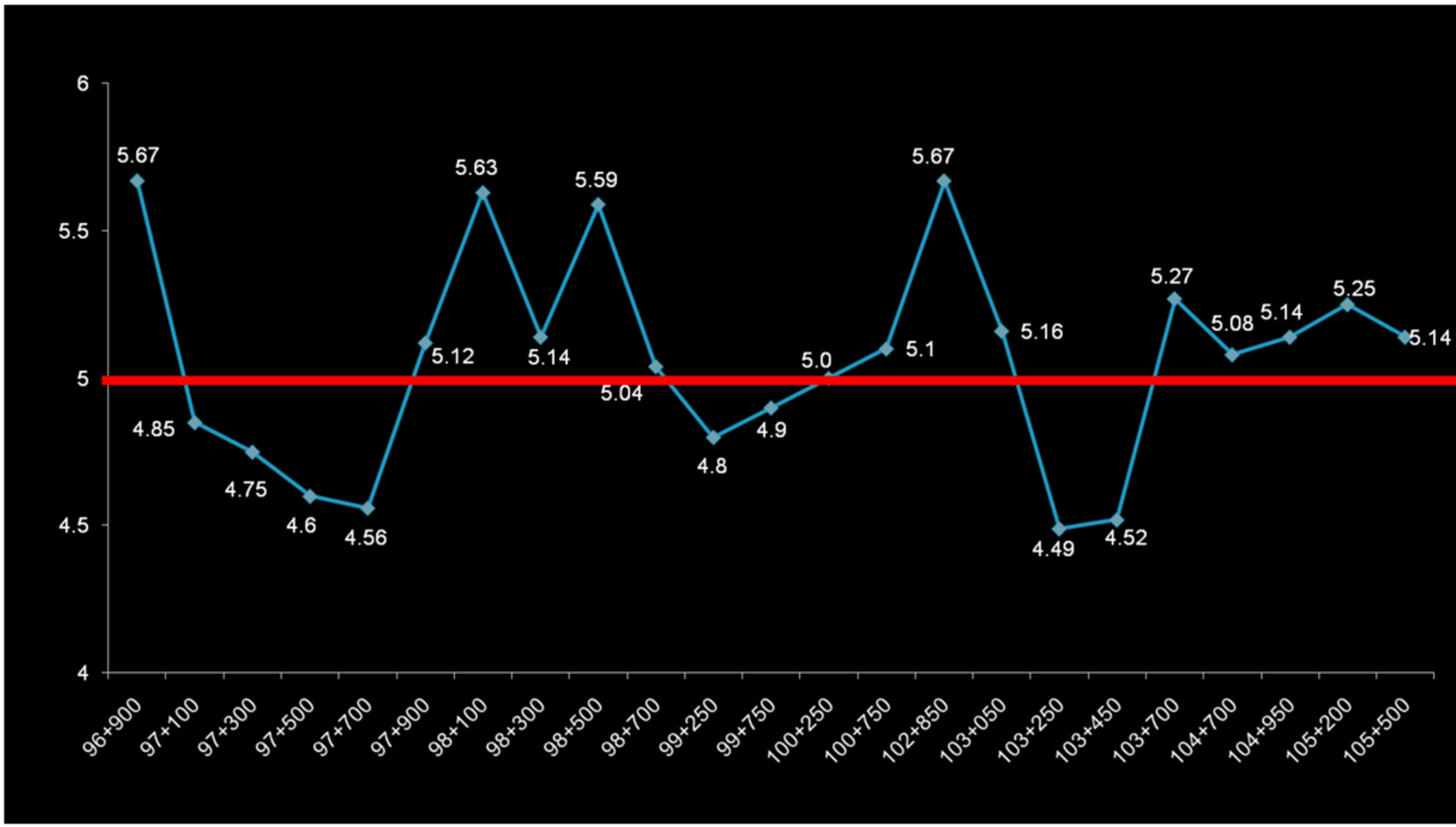
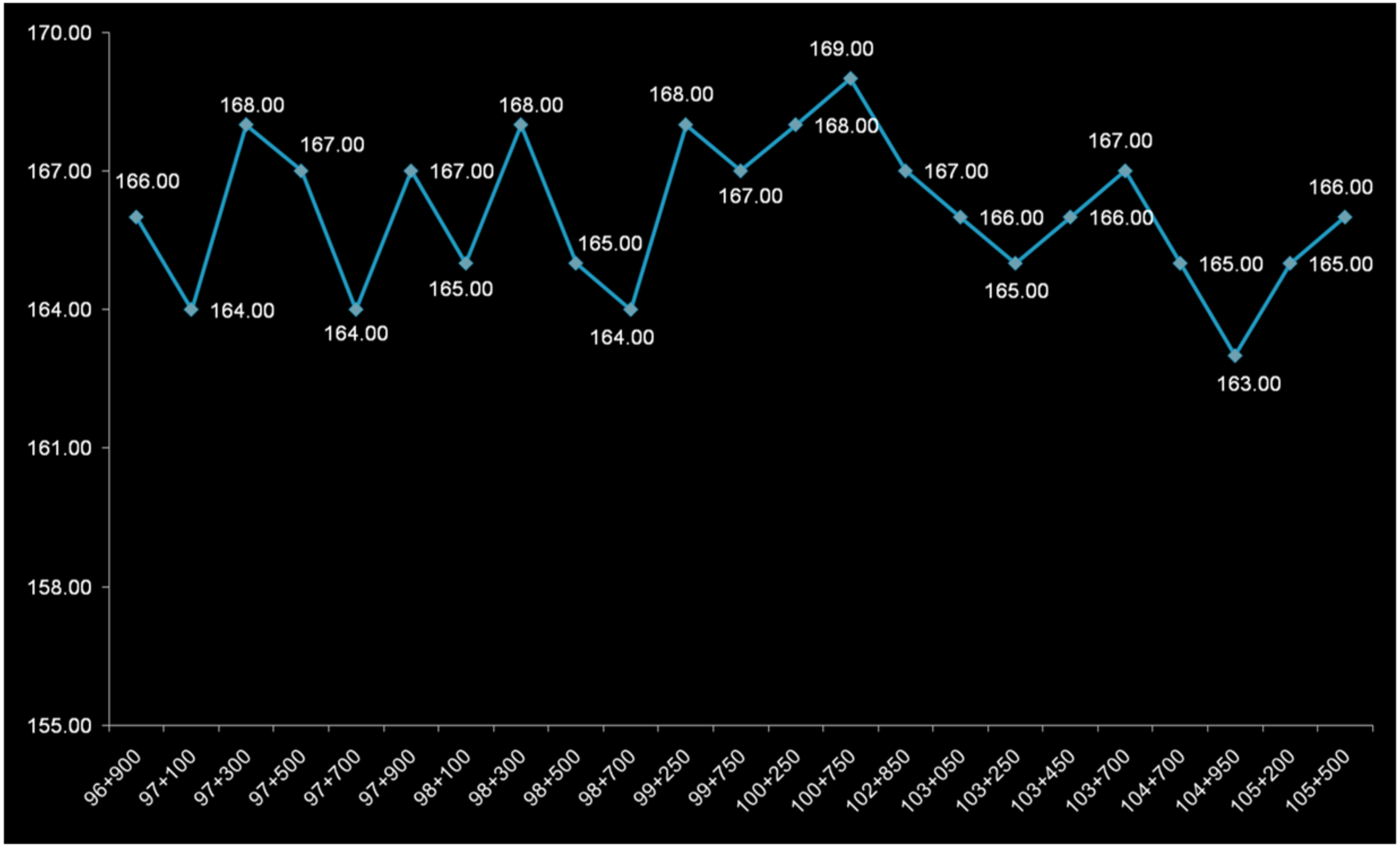


APPLICATION RESULTS.

LAYING DOWN TEMPERATURE.



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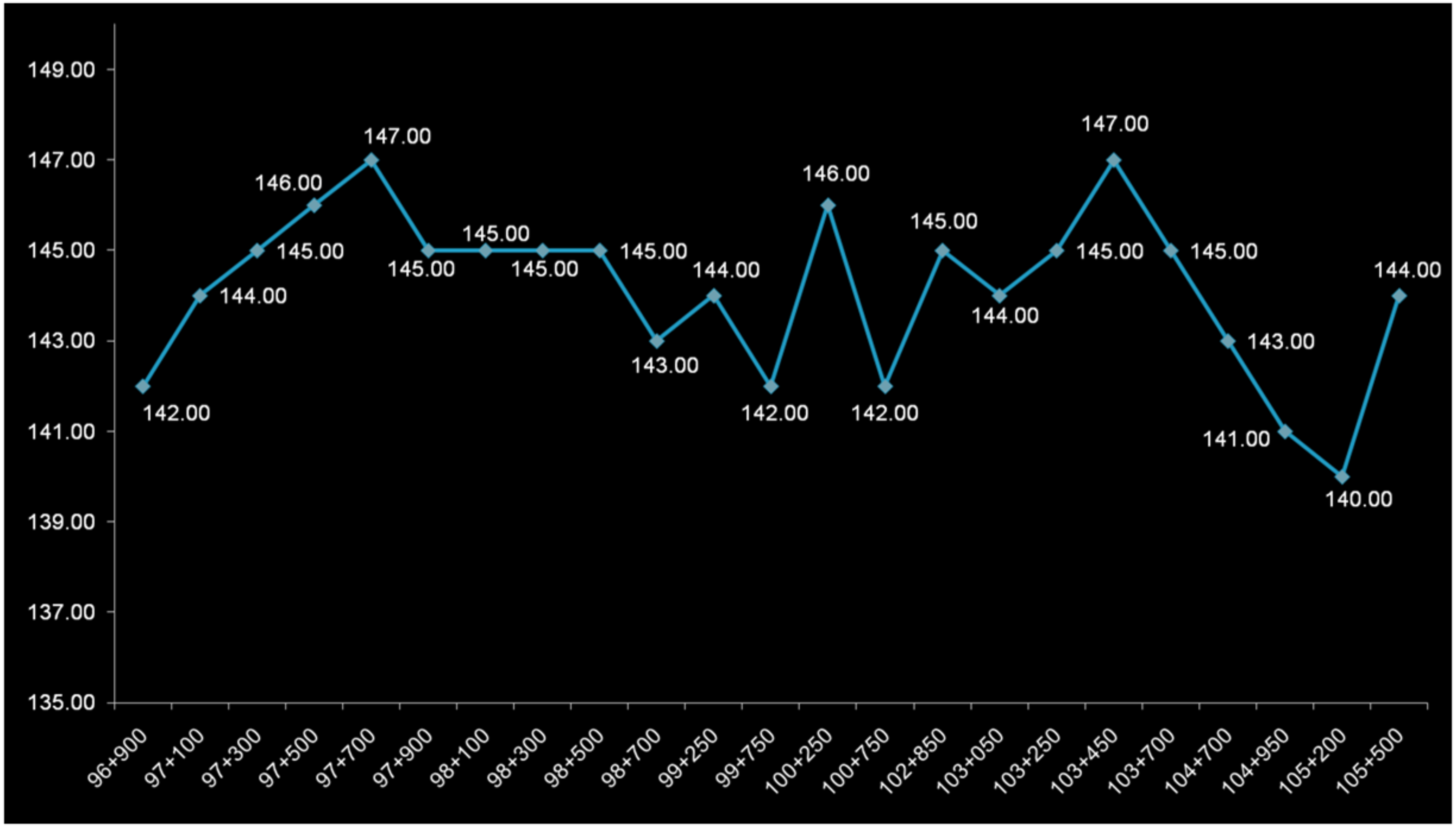
APPLICATION RESULTS.

COMPACTATION TEMPERATURE.



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APPLICATION RESULTS.

QUALITY CONTROL ITEMS.

APPLICATION RESULTS.

MAIN PROJECTS SUPPORTED BY FEDERATION.

1. Mexicali-San Felipe
2. La Paz-Los Cabos y Puente Álvaro Obregón
3. San Pedro-Cabo San Lucas y Libramiento de Todos los Santos
4. Escárcega-Xpujil
5. Zacatecas-Saltillo
6. Piedras Negras-Acuña
7. Tapanatepec-Tuxtla Gutiérrez
8. Durango-Fresnillo
9. Las Amarillas-Villa de Arriaga
10. Tuxtla Gutiérrez-Ocozocoautla
11. La Y-Barranca Larga-Ventanilla y Puerto Escondido-Pochutla-Huatulco
12. Cafetal-Tulum
13. Zacatecas-San Luis Potosí
14. Caborca-Sonoyta
15. Sonoyta-San Luis Río Colorado
16. Calpulalpan-Ocotoxco

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APPLICATION RESULTS.

MAIN PROJECTS (PUBLICS AND PRIVATES).

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CONCLUSION.

QUALITY OF PAVEMENTS STARTS WITH A GOOD DESIGN AT LAB SCALE.

A GOOD EXPERIMENTAL DESIGN STARTS CONTROLLING ALL THE QUALITY FROM INGREDIENTS AND WAY OF USE.

AMAAC PROTOCOL IS A STRUCTURAL GUIDE TO BUILT DENSE MIX PAVEMENTS.

CONCLUSION.

AMAAC PROTOCOL DEFINES THE TYPE OF CONTROL TEST AS FUNCTION OF DIFFERENT LOAD RESISTANCE LEVELS DEFINED BY ESAL´s.

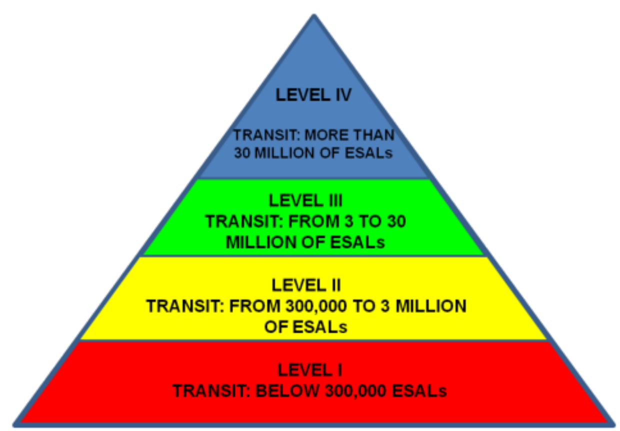
THE GOAL IS TO OBTAIN ROADS WITH:

GOOD RESISTANCE TO PLASTIC DEFORMATIONS.

FATIGUE DAMAGE.

MOISTURE DAMAGE.

HIGH MODULUS ASPHALT MIX.



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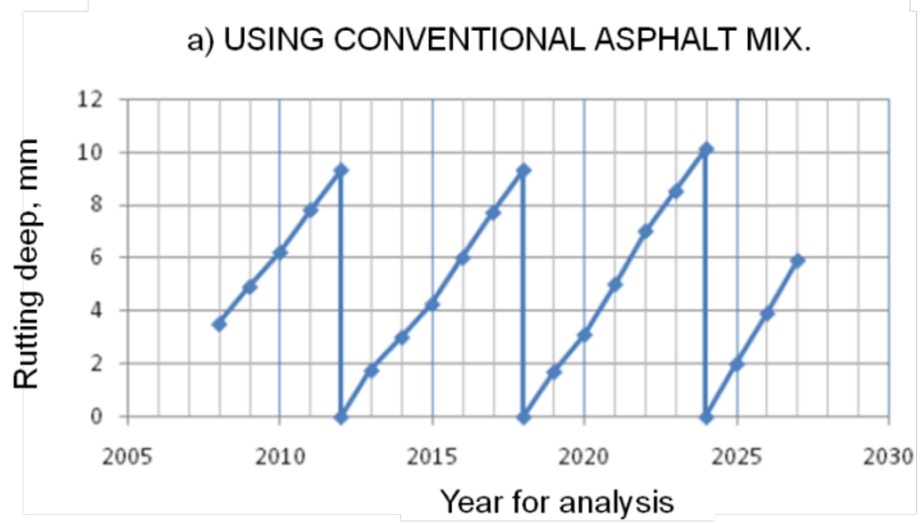
CONCLUSION.

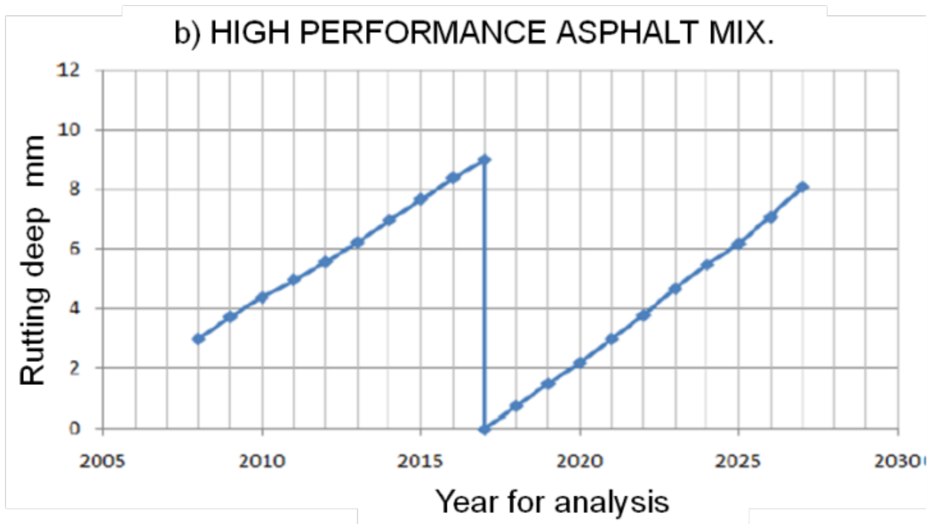
BESIDES THE GOOD QUALITY IN INGREDIENTS AND SUPERVISION ACCORDING WITH RECOMMENDED TEST FORM PAVEMENTS. THE FINISHED ROAD SHOULD OBTAIN:

- ✓ PROFILE INDEX OF 14 CENTIMETER/KILOMETER AS MAXIMUM PER EACH 200 METER OF LAY DOWN LINE.

- ✓ ALSO, MINIMUM FRICTION RESISTANCE SHOULD BE 0.6 AT 75 KILOMETER/HOUR OF SPEED (MEASURED BY MU-METER).

CONCLUSION.





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2007-2012 Mexican strategic highway project (Source: SCT)

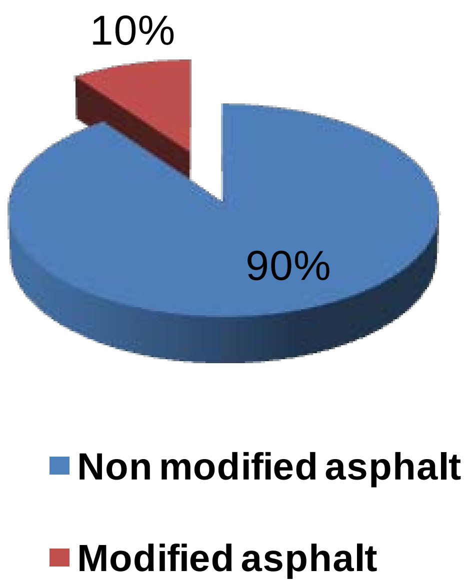
• The actual plan includes 100 new highway projects which are expected to transform the highway infrastructure.

• The SCT has stated as a priority the preservation of the busiest highway sections.

• 17,400 km is the estimated length of the new highway projects, where 52% of the total is for new highway network, 23% urban roads, 10% interstate highways and 15% other projects.

• 44,800 km is the estimated of the actual highway network planned for preservation.

CONCLUSION.



AMAAC Mexican asphalt market statistics:

- The total consumption of asphalt in Mexico is between 1.8 – 2.4 millions of tones.
- Around 88% of the total asphalt consumption is supplied by domestic petrochemical company (and the rest is from imports).
- 10% of the total asphalt of usage is modified with elastomers, plastomers and other products.

CONCLUSION.

AMAAC PROTOCOL IS A COMBINATION OF AMERICAN PRACTICE OF PAVING DESIGN (BASED SUPERPAVE) IN COMBINATION WITH SOME EUROPEAN CRITERION, MAINLY SPANISH AND FRENCH.

AMAAC PROTOCOL IS CALLING FOR TECHNOLOGY UP TO DATE AND KNOWLEDGE. IT COULD BE INCLUDED AT CIVIL ENGINEERING STUDIES IN UNIVERSITIES SUBJECTS, BUT WITHOUT LOOKING A DRASTIC CHANGE OF TRADITIONAL DESIGN METODOLOGIES (FOR EXAMPLE, MARSHALL METHOD).

CONCLUSION.

AMAAC PROTOCOL ALSO LOOKS THE OPPORTUNITY FOR IMPROVING THE RESEARCH AND DEVELOPMENT ON ROAD ENGINEERING, AS WELL AS NEW STUDIES ON ASPHALTIC MATERIALS.

IT IS AN EXPECTATIVE ABOUT THE IMPROVEMENT ON MEXICAN INFRASTRUCTURE ROADS; HOWEVER, THERE IS A CLEAR COMPROMISE AMONG ALL ACTORS WHO ARE PATICIPATING IN EACH STAGE DURING ROAD DESIGN: DESIGNER, CONSTRUCTION, PRESERVATION AND OPERATION OF NETWORK ROADS: ALWAYS LOOKING FOR CONTINUE IMPROVEMENT.

THANK YOU.

DO YOU HAVE ANY QUESTION?......

MEXICAN ASSOCIATION OF ASPHALT.