Asphalt pavement design: State of practice

Jorge Soares, UFC

Fortaleza
October 6th, 2009

OUTLINE

(I) "GENERAL ASPECTS OF ASPHALTIC PAVEMENT DESIGN METHODS FROM DIFFERENT COUNTRIES AND RELATION TO A NEW BRAZILIAN DESIGN METHOD"

Jorge Barbosa Soares, LMP/UFC
Angel Mateos Moreno, CEDEX Transport Research Center, Madrid
Laura Maria Goretti da Motta, COPPE/UFRJ

(II) NATIONAL PROJECT: "ASPHALTIC PAVEMENT DESIGN SYSTEM"

(I) PAPER MOTIVATION

- **Limitations** of the current Brazilian design method **(1966)**
  - CBR for sublayers
  - Structural coefficients (no advantage taken from the quality of the materials)
  - *ESAL's* for traffic
  - Aspects from USACE and AASHTO design methods

- **Fatigue** is not considered

- **Mechanistic methods** today in Brazil are **restricted to toll-roads**

- Recent developments by **AASHTO (MEPDG)**

UNITED STATES

- 2 methods of **analysis**: multilayer linear elastic and FEM
- **4 *inputs:*** traffic, material characterization, climate and reliability
- **3 levels** *f* (importance of project and data availability):
  - **(i)** **Level 1** – properties from mechanical testing, e.g., complex modulus
  - **(ii)** **Level 2** – correlations. Dynamic modulus estimated from binder testing, aggregates and mixture characteristics
  - **(iii)** **Level 3** – less precision, correlations

- Eliminates **Equivalence Factor**; uses **full axle load spectrum** *(yields higher levels of rutting and cracking compared to 18K ESAL's)*
- **Vehicle Speed** affects the **<u>viscoelastic response</u>** of the asphaltic layer
- **Transfer functions** still used as criteria

International Society for Asphalt Pavements - ISAP
Workshop
Cold and Warm Asphalt Mixture Design / Characterization and Pavement Design
October 05-06, 2009

IV SINAPPRE
FORTALEZA

19th Brazilian Asphalt Conference

" OVERVIEW OF THE NEW 2007 AASHTO MECHANISTIC-EMPIRICAL PAVEMENT DESIGN GUIDE

BRIDGING THE GAP BETWEEN MIX AND STRUCTURAL DESIGN"

By

Dr.M.W.Witczak

Professor

Arizona State University

Professor Emeritus,

University of Maryland

9-11 June 2008

Rio de Janeiro, Brazil

FEATURES OF THE AASHTO M-E PAVEMENT DESIGN GUIDE

- *Developed under the US NAS (National Academy of Sciences)–NCHRP (National Cooperative Highway Research program)*
- *$11,000,000 – 7 Year Effort* **Asphalt Consortium !**
- *Project Team Leaders: AC/Flexible Pavements: Dr. M.W.Witczak*
  Rigid Pavements: Dr.M.Darter
- *The AC/Flexible Pavement Group (Team)*
  - *Team comprised of 27 Professionals: 21 – PhD's; 6 – MSCE*
  - *Flexible Team Make-up by Countries: US, Egypt, Israel, Brazil, India, Pakistan, Lebanon, Romania, Poland, Mexico, Bangladesh, Finland, Taiwan, France, Switzerland, Peru, China, Palestine, Colombia*

M-E PDG is the most powerful Pavement-Material Analysis-Design Tool ever developed.

SITUATION IN DIFFERENT COUNTRIES – EUROPE

Germany, Austria, Belgium, Spain, France, Italy, Portugal, Great Britain, and Switzerland

INFORMATION

- **(i) date** / previous version
- **(ii) agency** responsible
- **(iii) format** for practical use
- **(iv) structural analysis**
- **(v) alternative methods**
- **(vi) traffic and subgrade**
- **(vii) materials characterization**

MATERIALS IN EUROPE

- **Use of granular layers** under asphaltic surface coarse (help structure capacity)

- Minimum depth, **200mm**

- **Base materials** mainly processed (crushed). Natural materials in different %

- Common: granular and crushed materials **w/ cement (min 3%; up to 6%).** Minimum depth:**150-200mm**

- High quality layers, including modified w/ cement, as **subbase** (semirigid pavements). **Inverted pavements:** asphaltic surface, subbase material w/cement, and crushed material in the base layer (avoid reflection of contraction cracks); depth of **anti-cracking layer 120-150mm**

MATERIALS IN EUROPE

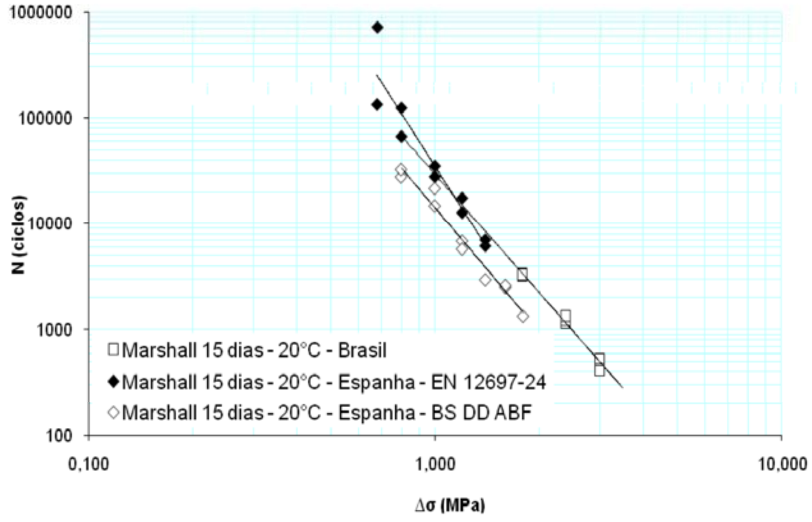
- Asphalt Mixtures: min depth / heavy traffic (even not so heavy traffic): **100mm**

- Seven types: Most common ***Asphalt Concrete (AC)**
    * **4-6% binder** content and **3-6% void** content
    * BBTM; SA; HRA; SMA; MA; PA

- **Project** (mechanical behavior):
    lab wheel tracking (EN 12697-22)
    water sensitivity – **Marshall** specimen
    MME (high modulus), min **11,000MPa**

    fatigue test, 4 points (EN 12697-24) –

- **Quality control** determined in terms of **dens**



GENERAL INFO

- Most recent documents: **US 2004 (2008)**, Spain (2003), Germany and Great Britain (2001)

- Older documents: **14 yrs** (Portugal and Italy)

- Typically **revised every 10 yrs**

- Brazil: **1966** (minor revision in 1981), therefore, **over 40 yrs**

TRAFFIC

- Most detailed part of methods. Sometimes **separate standard** (different definitions of **heavy vehicles** or equivalence factors)

- **Standard Axle**: **8t** (Great Britain and Switzerland), **10t** (Germany and Austria), **13t** (Spain and France)

- **Max axle load (single axle)**: **11,5t**, but not widespread yet

- Fourth power law for equivalence factors

- **Project time: 20 yrs**

SUBGRADE

- **Compressibility modulus (or deformability)**, plate test; **CBR**, and more frequently my **resilient modulus**

- Correlation: compressibility modulus (MPa) = 10 x CBR

- **Minimum values:** **30MPa** (Italy, Switzerland and Portugal), **35MPa** (Austria), **45MPa** (Germany), **50MPa** (France), **60MPa** (Spain) and **150MPa** (Great Britain)

- For heavy traffic: 80MPa (Portugal), 90MPa (Italy), 120MPa (France) and 300MPa (Spain)

PRESENTATION OF THE METHOD

- Majority considers the **structural response**; calibration with lab results and field data (existing or testing sections)

- Europe in general utilizes **catalogues** with pre-defined sections for pavement design

BRAZIL

- In principle, the simplification by catalogues is not the idea that we intend to follow for the **New Brazilian Design Method**

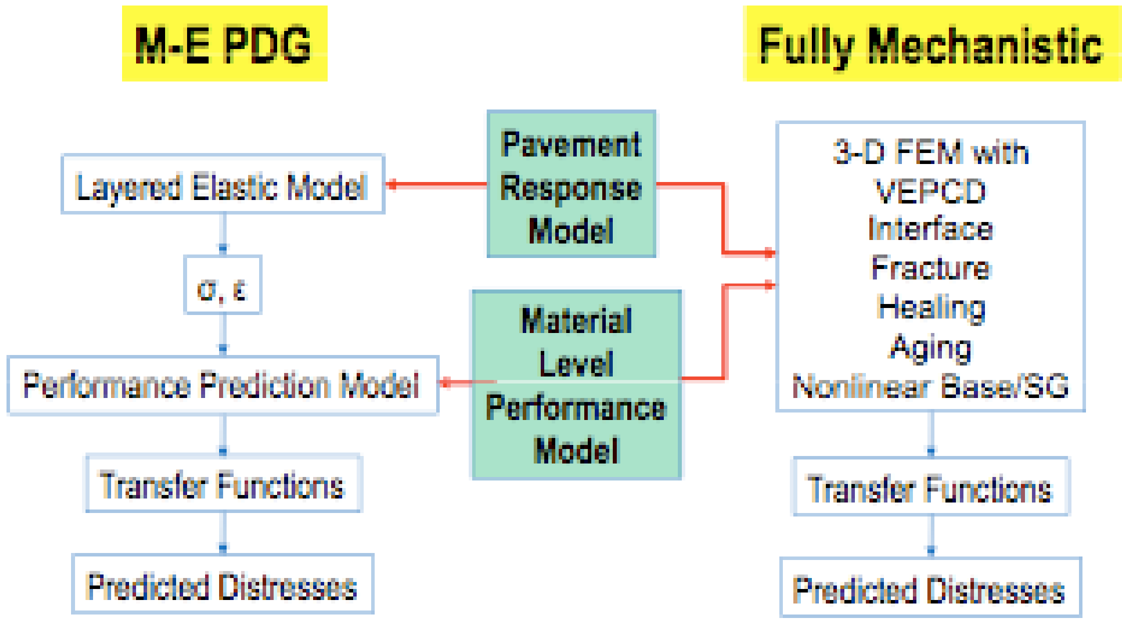
- The plan is to **develop a system:**

- **structural modeling (FEM)**
- **materials modeling (performance tests)**
- **design criteria (transfer functions)**

ME-PDG calibrated with Brazilian data?

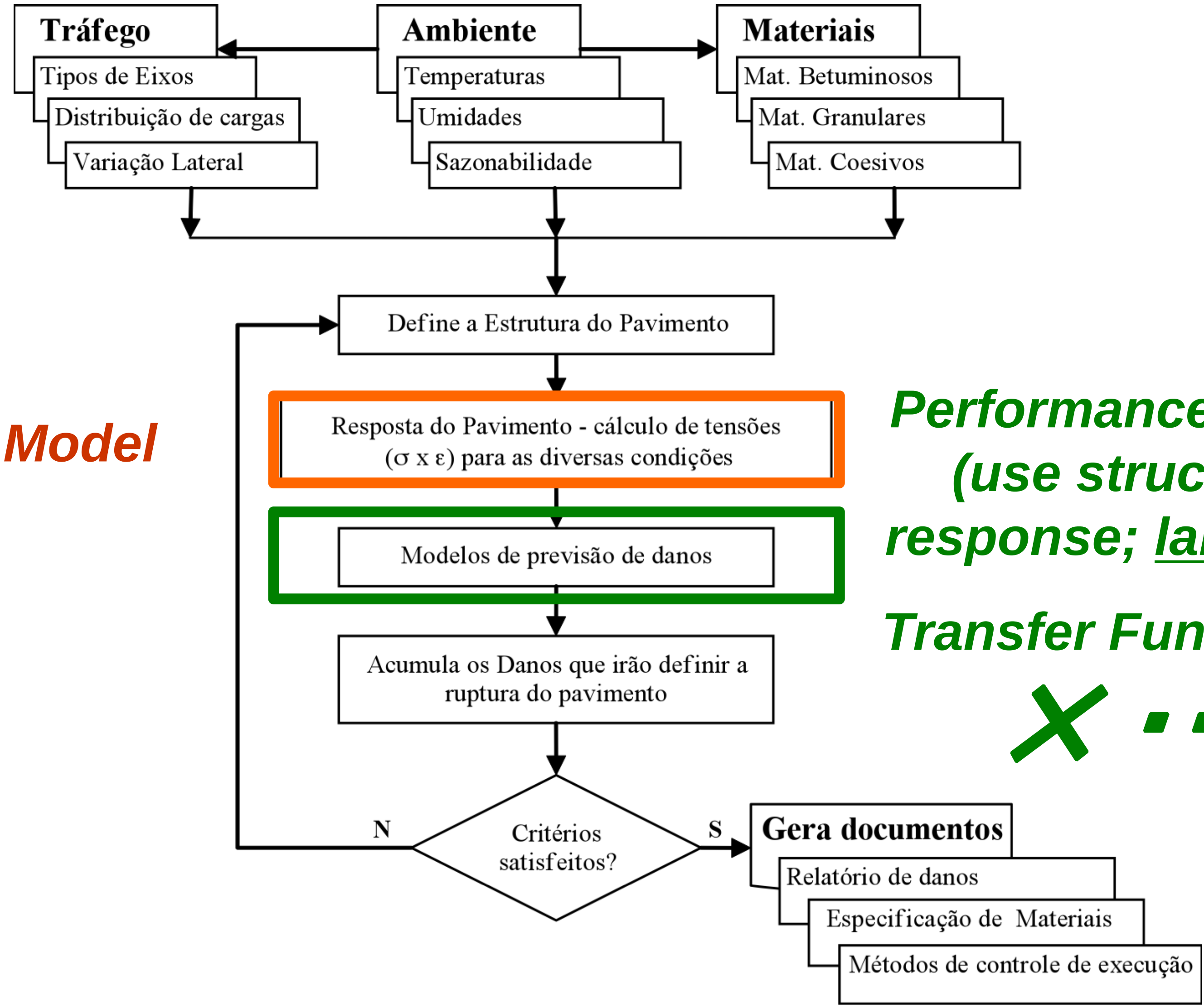
NC STATE UNIVERSITY

Integrated Method



achieve!

Structural Model ✔



Performance Model (use structural response; lab tests)

Transfer Functions

✗ ...

IV SINAPPRE
FORTALEZA

OUTLINE

(I) "GENERAL ASPECTS OF ASPHALTIC PAVAMENT DESIGN METHODS FROM DIFFERENT COUNTRIES AND THE RELATION TO A NEW BRAZILIAN DESIGN METHOD"

Jorge Barbosa Soares, LMP/UFC, Fortaleza
Angel Mateos Moreno, CEDEX Transport Research Center, Madrid, Espanha
Laura Maria Goretti da Motta, COPPE/UFRJ, Rio de Janeiro

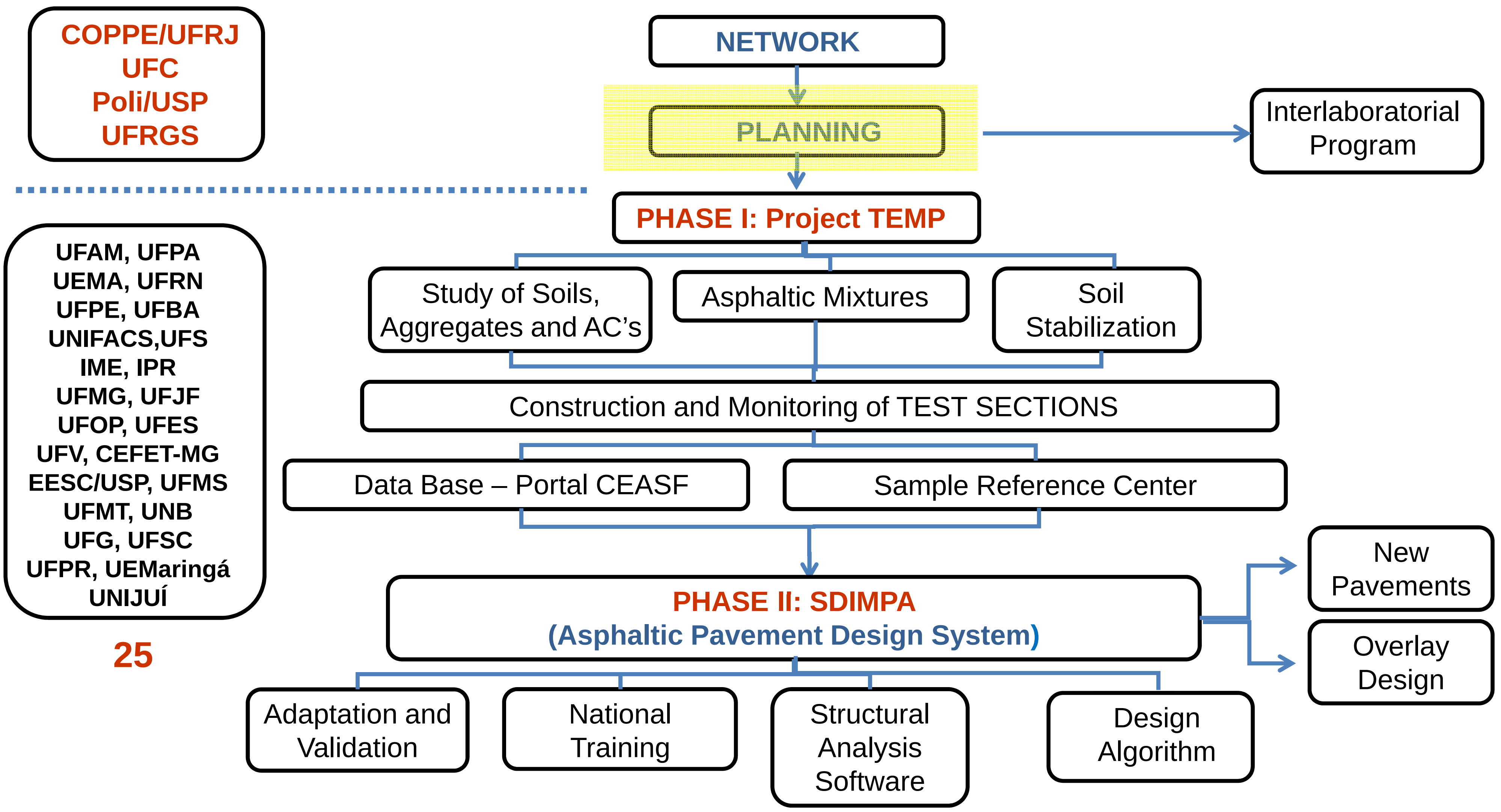
(II) NATIONAL PROJECT: "ASPHALTIC PAVEMENT DESIGN METHOD"

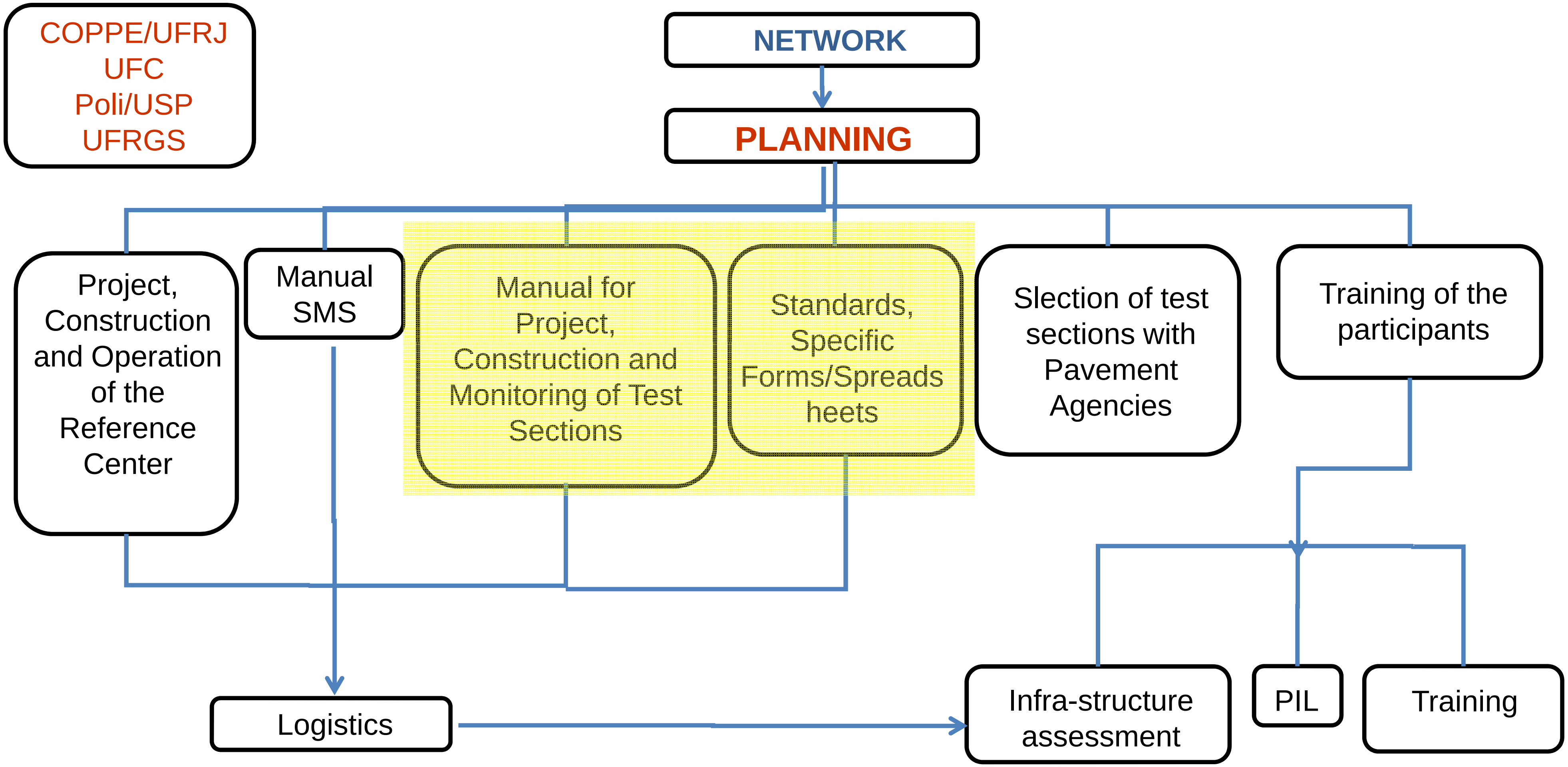
REDE TEMÁTICA DE ASFALTO

ASPHALT NETWORK

DEVELOPMENT OF AN ASPHALTIC PAVEMENT DESIGN METHOD

BR PETROBRAS


COPPE/UFRJ
UFC
Poli/USP
UFRGS
NETWORK
PLANNING
Interlaboratorial Program
PHASE I: Project TEMP
Study of Soils, Aggregates and AC's
Asphaltic Mixtures
Soil Stabilization
Construction and Monitoring of TEST SECTIONS
Data Base – Portal CEASF
Sample Reference Center
UFAM, UFPA
UEMA, UFRN
UFPE, UFBA
UNIFACS,UFS
IME, IPR
UFMG, UFJF
UFOP, UFES
UFV, CEFET-MG
EESC/USP, UFMS
UFMT, UNB
UFG, UFSC
UFPR, UEMaringá
UNIJUÍ
25
PHASE II: SDIMPA
(Asphaltic Pavement Design System)
New Pavements
Overlay Design
Adaptation and Validation
National Training
Structural Analysis Software
Design Algorithm


COPPE/UFRJ
UFC
Poli/USP
UFRGS
NETWORK
PLANNING
Project, Construction and Operation of the Reference Center
Manual SMS
Manual for Project, Construction and Monitoring of Test Sections
Standards, Specific Forms/Spreadsheets
Slection of test sections with Pavement Agencies
Training of the participants
Logistics
Infra-structure assessment
PIL
Training

Manual for Project, Construction, and Monitoring of Test Sections