

Inovação Tecnológica na Construção Civil

PCC 5975

Drivers das Inovações na Construção Civil:

- Aumento de Produtividade
- Melhora de desempenho/durabilidade
- Incorporação de outras funções
- Segurança
- Redução de impactos e aumento da sustentabilidade

Drivers das Inovações na Construção Civil:

- Qual é o problema existe?
- Quais as possibilidades?
- Quem é o cliente?
- O que é valor para o cliente?

Inovações na Construção Civil:

- Melhoria de processos já existentes
- Desenvolvimento de novas funções
- Mudança de processos

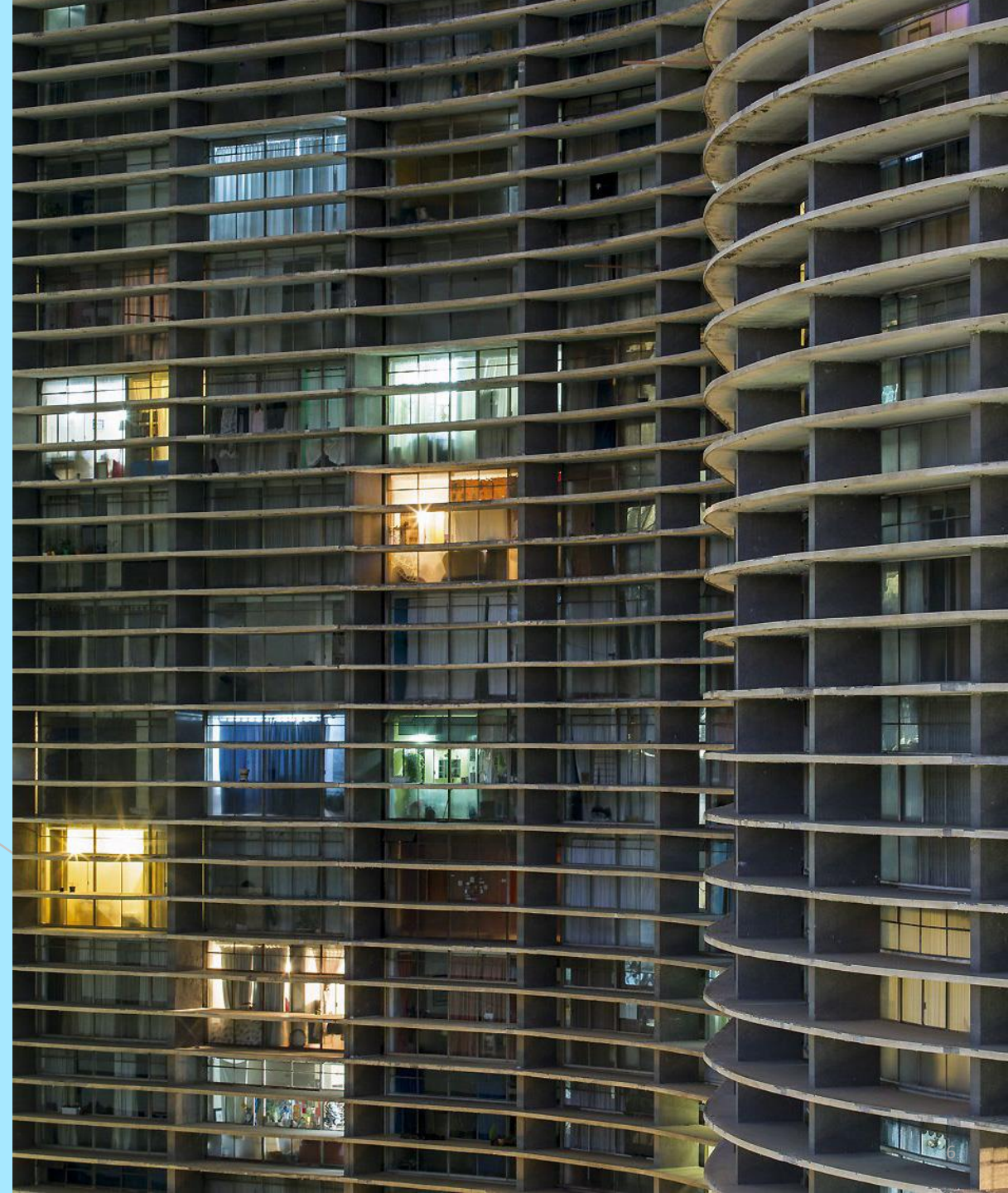
COMO É FEITO HOJE?

- MAPEAMENTO É DEMORADO, CUSTOSO E PERIGOSO;
- GRANDE INCIDÊNCIA DE ERRO DE DIAGNÓSTICOS
- ATUALMENTE REQUER:
 - CERTIFICAÇÃO À NR-35;
 - MONTAGEM DE ANDAIMES;
 - DISPONIBILIDADE DE MÃO DE OBRA; (TREINAMENTO P/ TRABALHO EM ALTURA).
- RESPONSABILIDADE CIVIL DOS CONDOMÍNIOS;
- CONFIABILIDADE DA PERCUSSÃO.



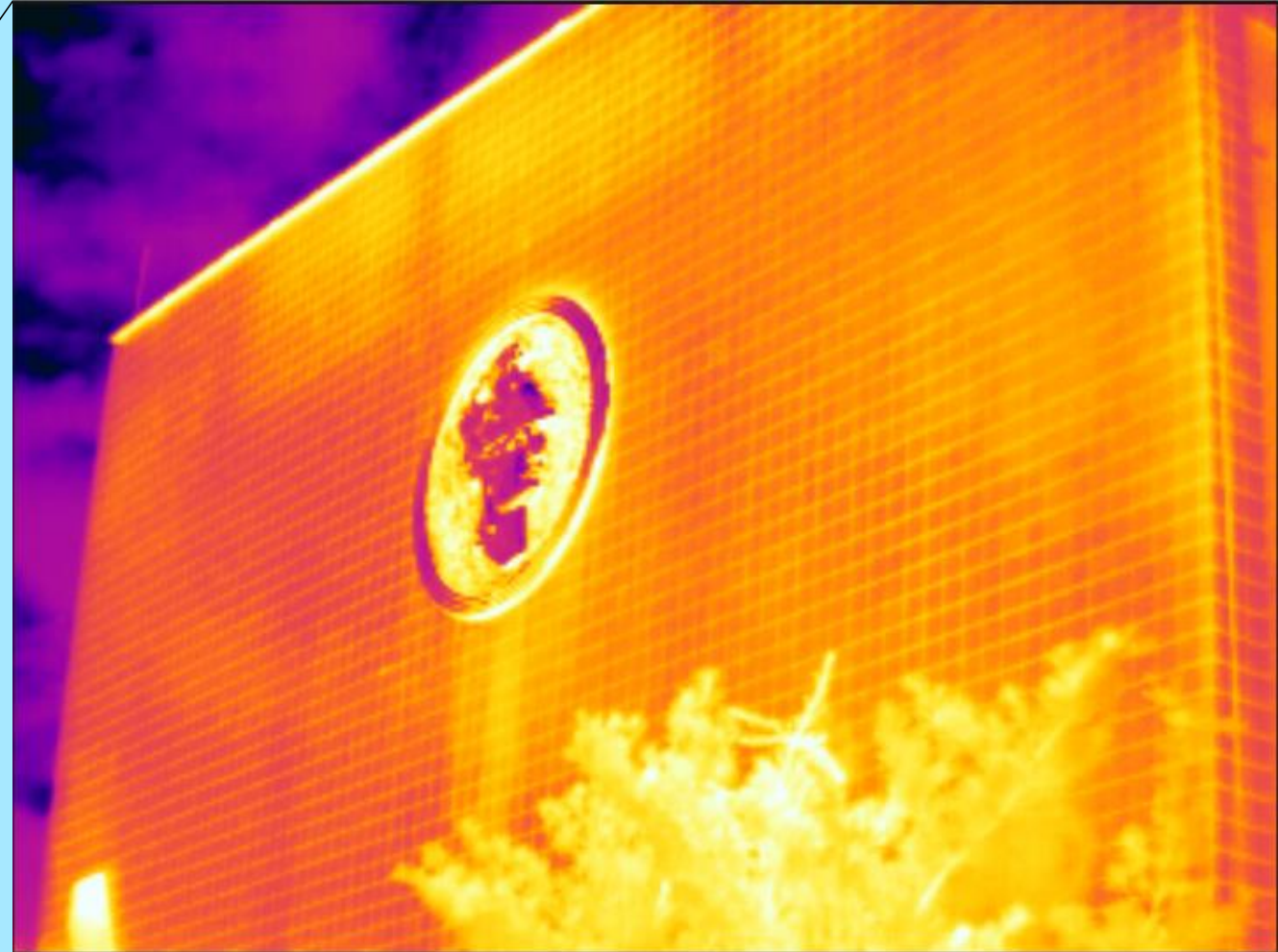
COMO É FEITO HOJE?

- **INSPEÇÕES EM FACHADAS ENCONTRAM OBSTÁCULOS:**
 - PROCESSO DE INSPEÇÃO GERA TRANSTORNO AOS CONDÔMINOS;
 - DETALHES ARQUITETÔNICOS PODEM DIFICULTAR A ANÁLISE.
- **TÉCNICAS NÃO DESTRUTIVAS APRESENTAM VANTAGENS:**
 - RAPIDEZ NAS INSPEÇÕES PRELIMINARES;
 - POSSIBILIDADE DE DETECÇÃO DE DESTACAMENTOS;
 - SEM CUSTOS INICIAIS;
 - MITIGAÇÃO DE RISCOS DE ACIDENTES EM TRABALHOS COM ALTURA.



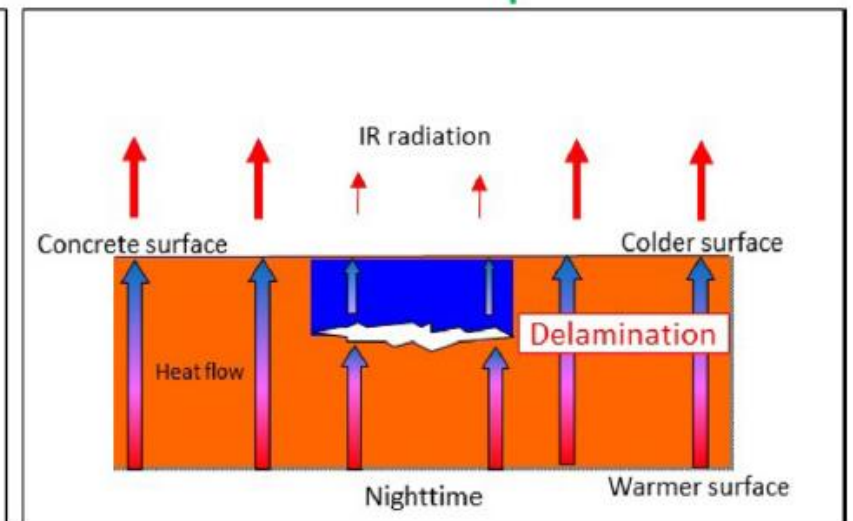
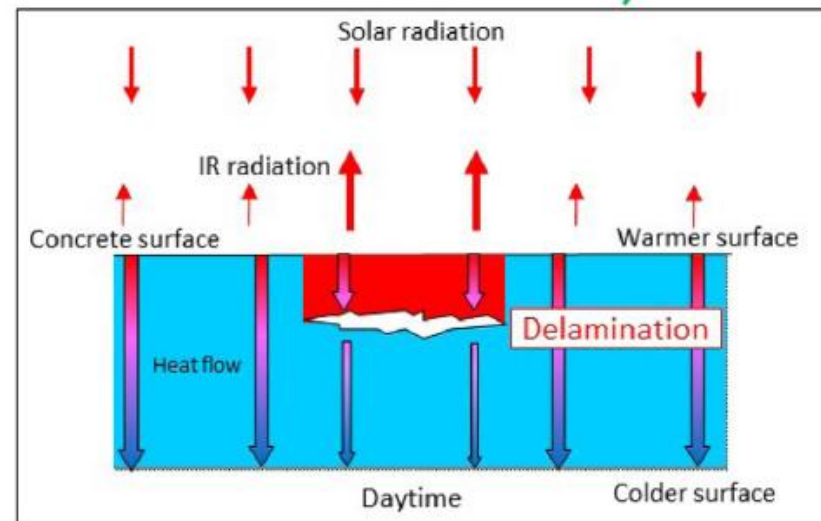
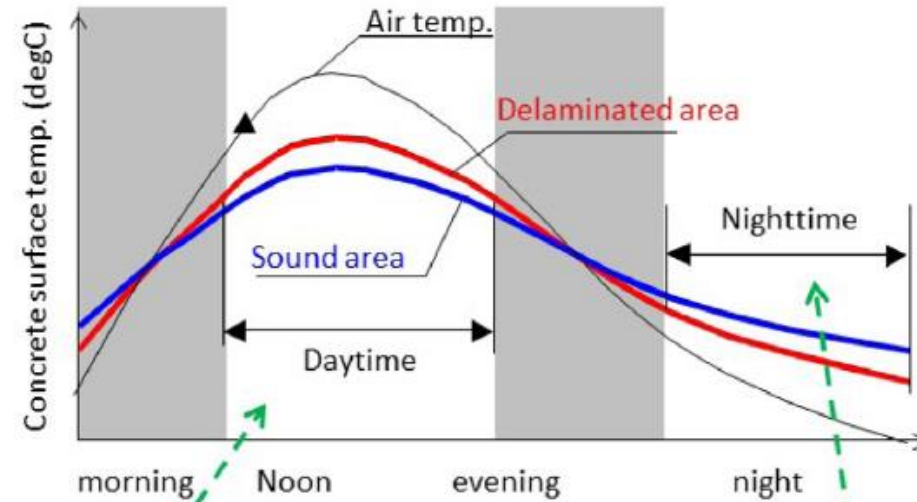
BASES CIENTÍFICAS

- **TERMOGRAFIA INFRAVERMELHA:**
 - VISUALIZAÇÃO DO FENÔMENOS TÉRMICO;
 - SEM CONTATO;
 - ANÁLISE INSTANTÂNEA, PRÁTICA E ECONÔMICA;



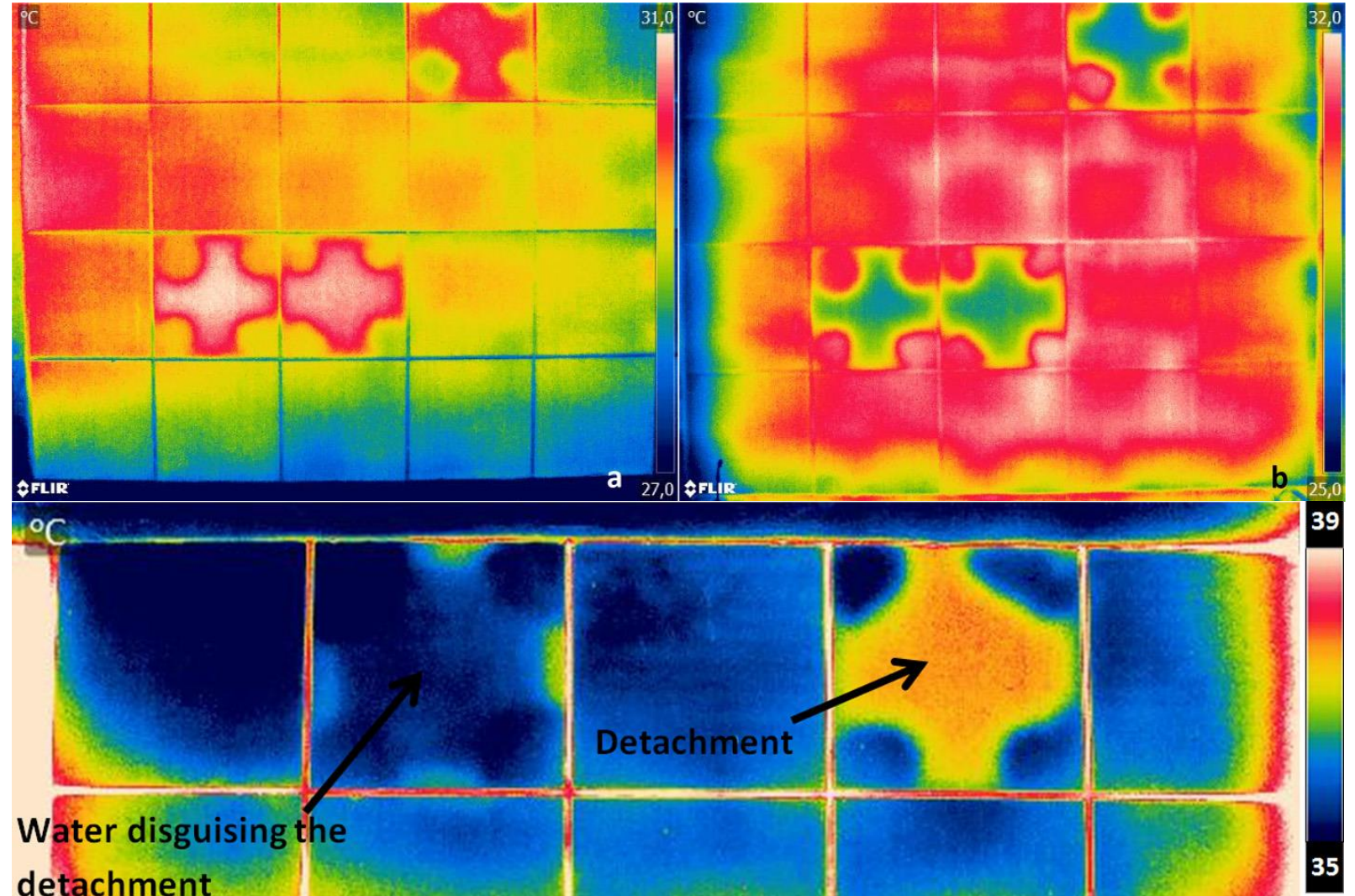
TERMOGRAFIA NA DETECÇÃO DE ANOMALIAS EM SISTEMAS ADERIDOS

- Processo de condução térmica, afetado pela presença de falhas, inclusões, umidade, etc;
- Objetos em equilíbrio térmico ou higroscópico não possibilita a análise por termografia;
- A intensidade e sentido do fluxo de calor que atravessa o elemento vai determinar o momento em que a anomalia é visível.



TERMOGRAFIA NA DETECÇÃO DE ANOMALIAS EM SISTEMAS ADERIDOS

Detecção de destacamento em ensaio laboratorial com termografia passiva.



TERMOGRAFIA NA DETECÇÃO DE ANOMALIAS EM SISTEMAS ADERIDOS

FATORES QUE INFLUENCIAM A ANÁLISE:

- Qualidade de imagem (distância x camera)
- Condições locais (sobras)
- Condições atmosféricas (temperature e incidência)
- Propriedades dos materiais

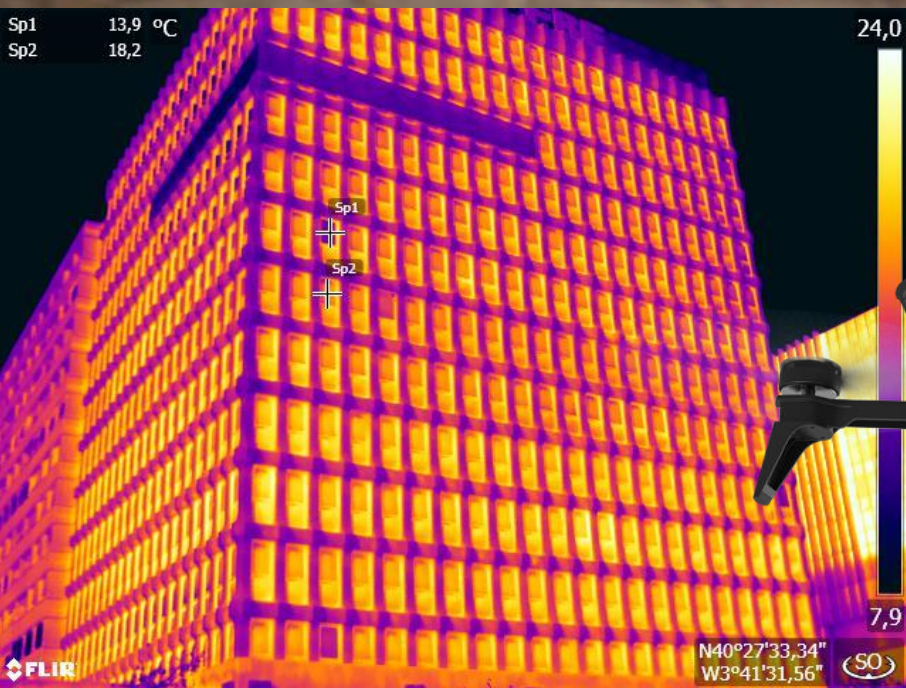


TERMOGRAFIA EMBARCADA EM DRONE

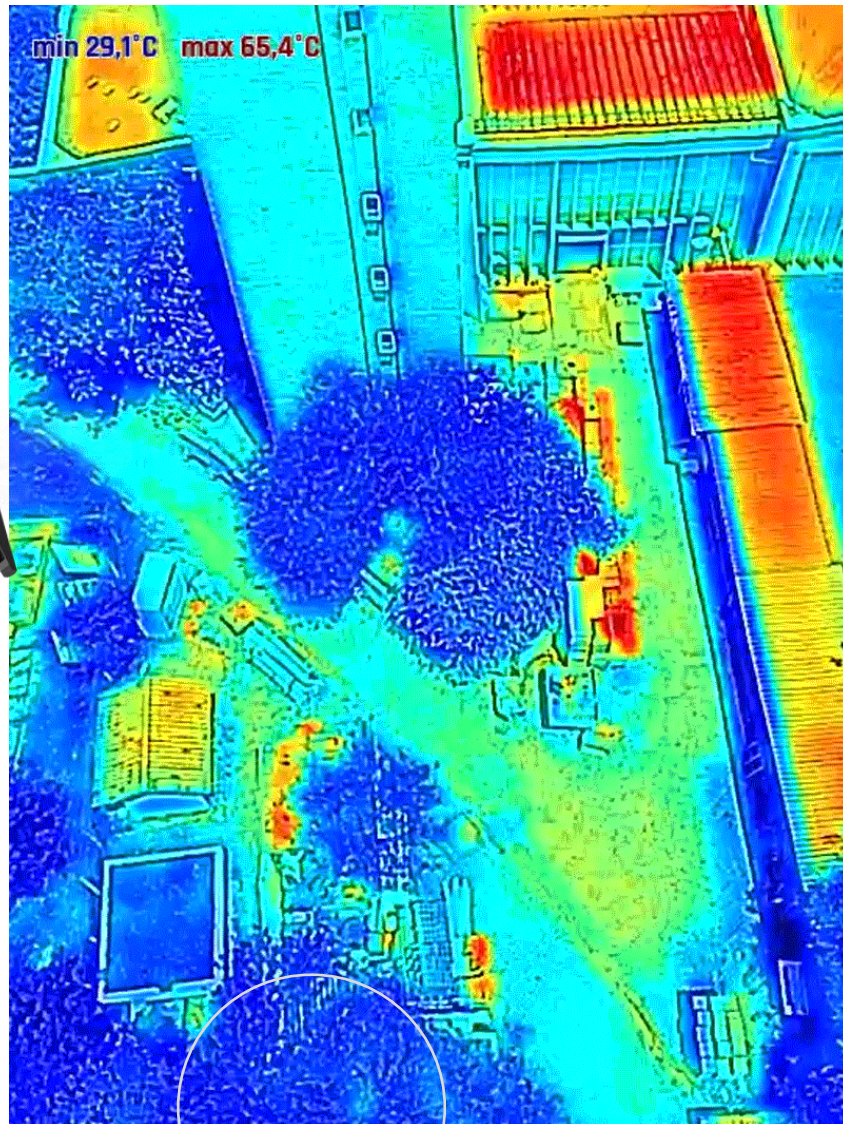


FERRAMENTA DE OTIMIZAÇÃO DA APLICAÇÃO DA TÉCNICA :

- ACESSIBILIDADE;
- ELIMINA A INFLUÊNCIA DO SOL;
- ELIMINA A INFLUÊNCIA DO VENTO;
- ACELERA O PROCESSO DE ANÁLISE;
- GRANDE PARTE DOS ESTUDOS ACADEMICOS SÃO REALIZADOS COM A APLICAÇÃO DA TÉCNICA SÃO ALOCADA NO CHÃO;
- A APLICAÇÃO DA TÉCNICA É MAIS EXPLORADA NO CAMPO DA AGRICULTURA, INFRAESTRUTURA E ENERGIA.
- NECESSIDADE DE EXPLORAÇÃO DA TÉCNICA NA CONSTRUÇÃO CIVIL.



TERMOGRAFIA EMBARCADA EM DRONE





Estudos sobre o tema na USP

- 3 ETAPAS:

Laboratorial

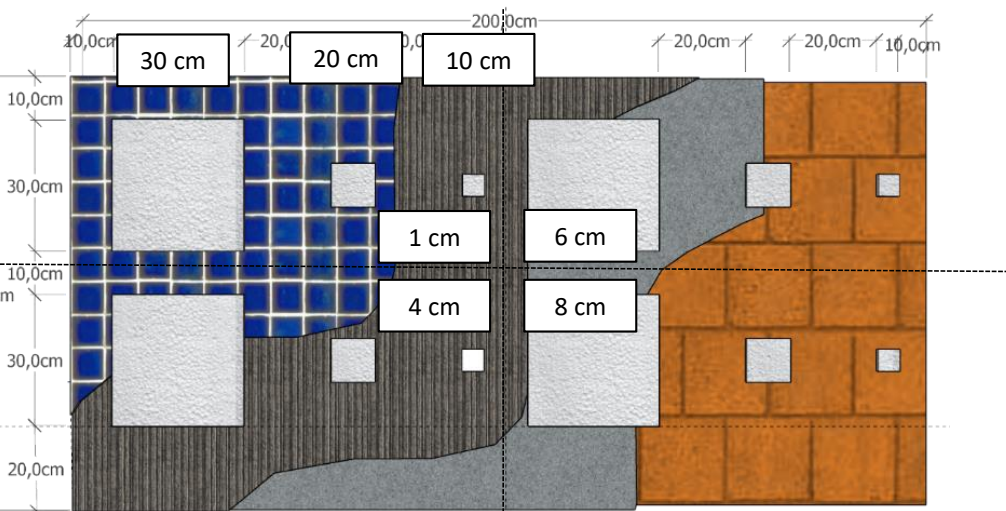
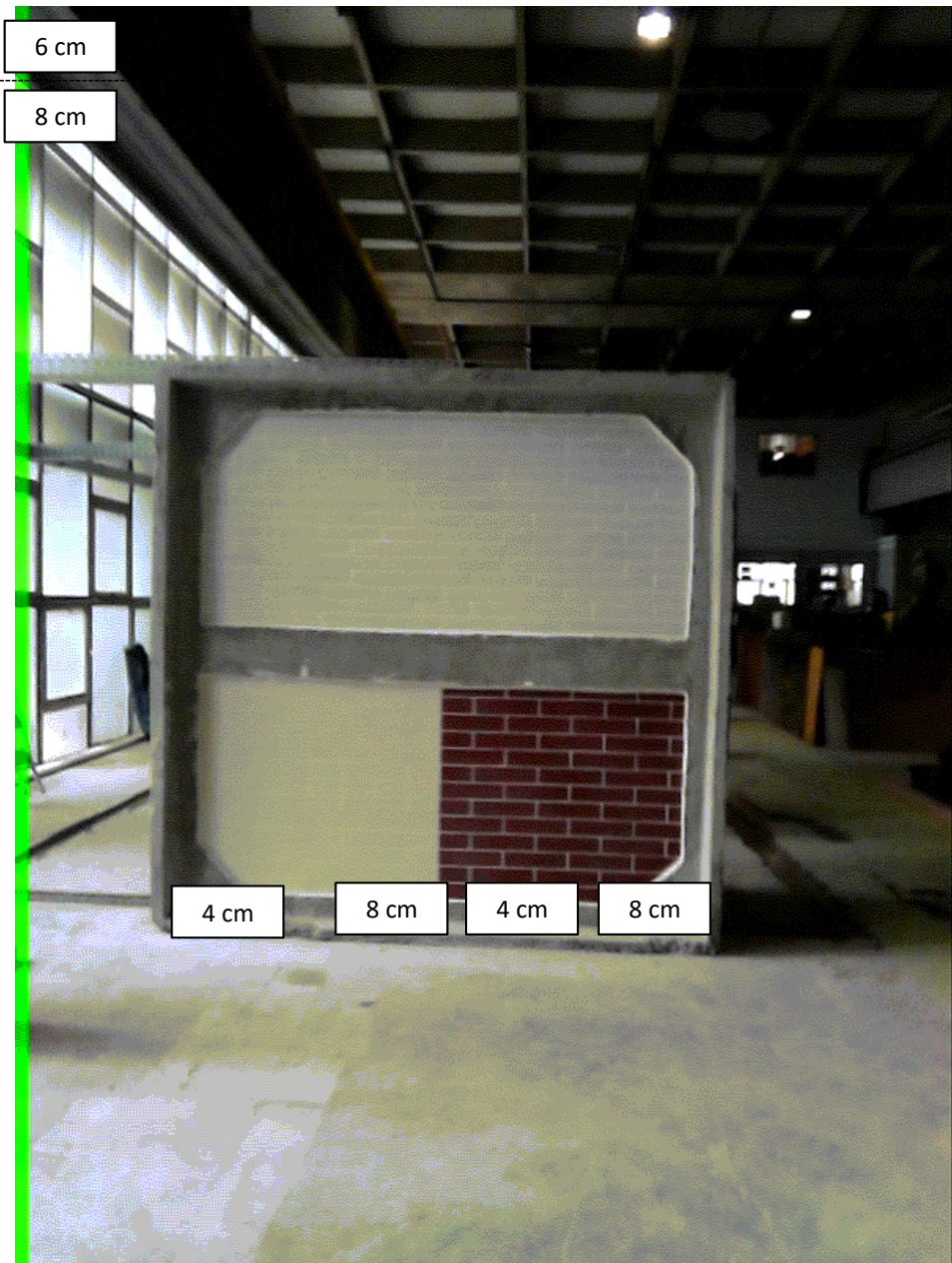
Estudo de Campo

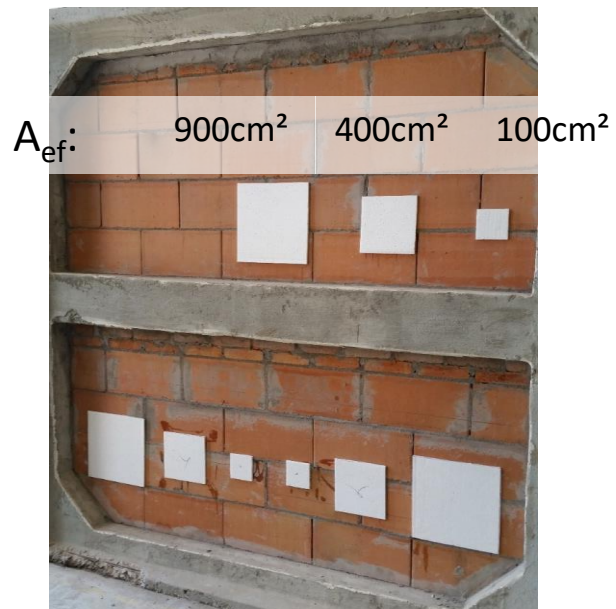
Estudos de Caso

- **Laboratorial:** Ensaios e desenvolvimento das diretrizes para análise;
- **Estudo de Campo:** Aplicação dos conhecimentos adquiridos em campo;
- **Estudos de caso:** Aplicação da experiência em casos reais.

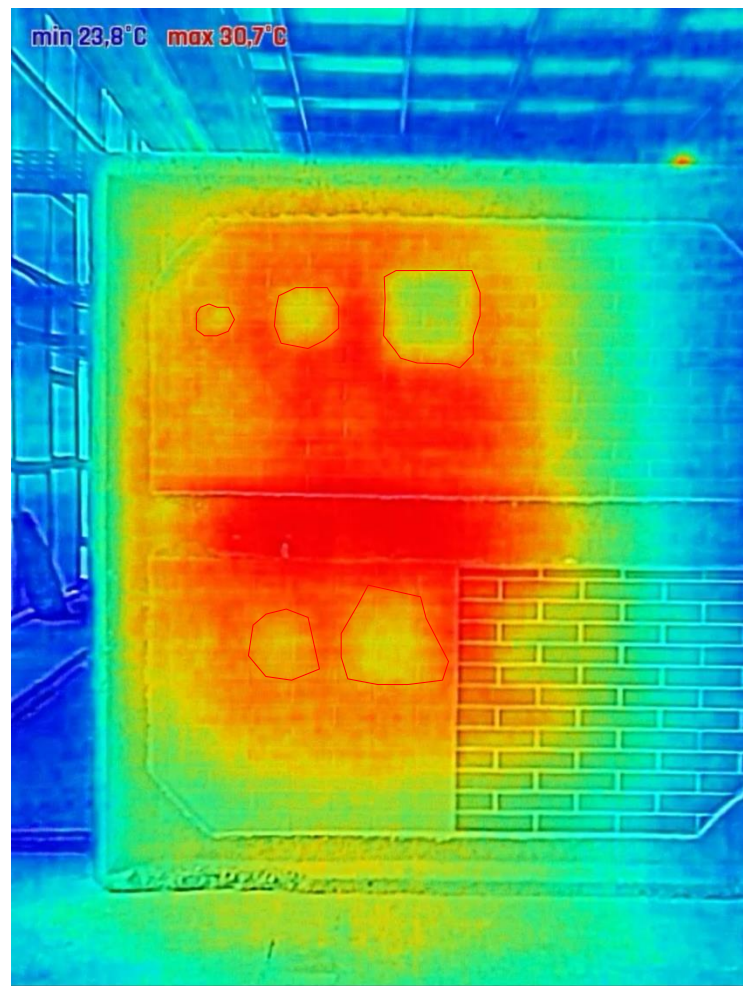


CONFIABILIDADE - TERMOGRAFIA INFRAVERMELHA

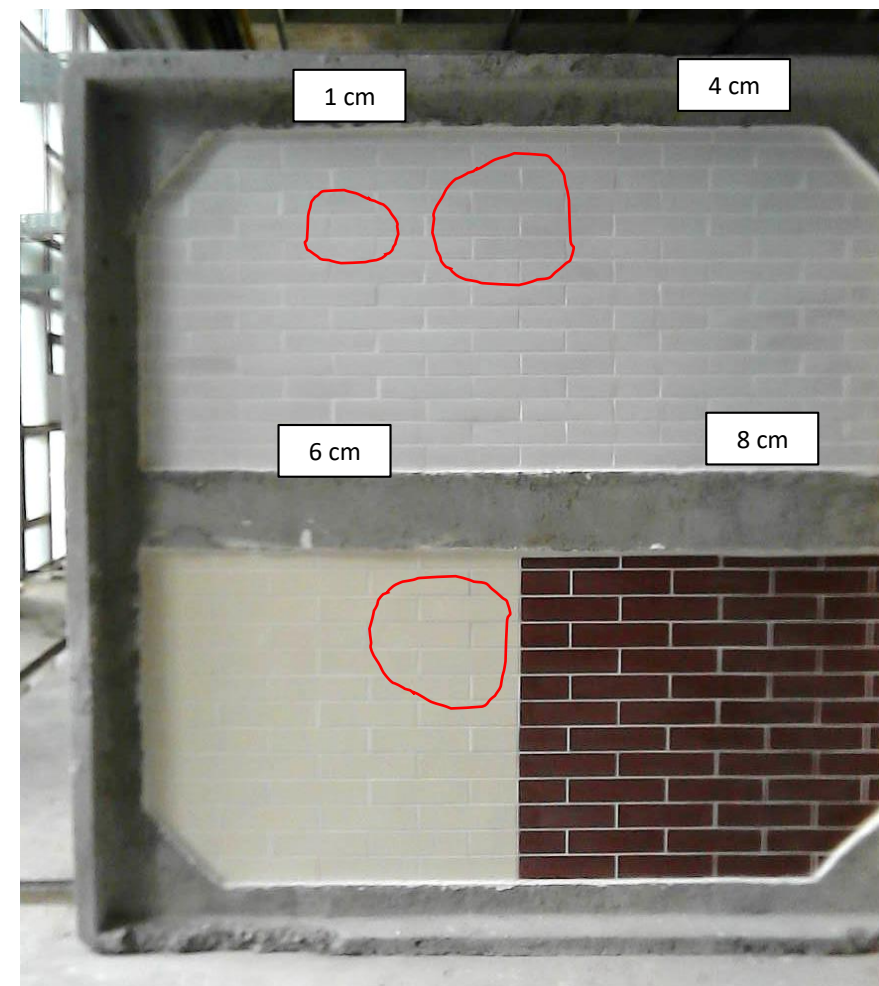




Termografia



Som cavo

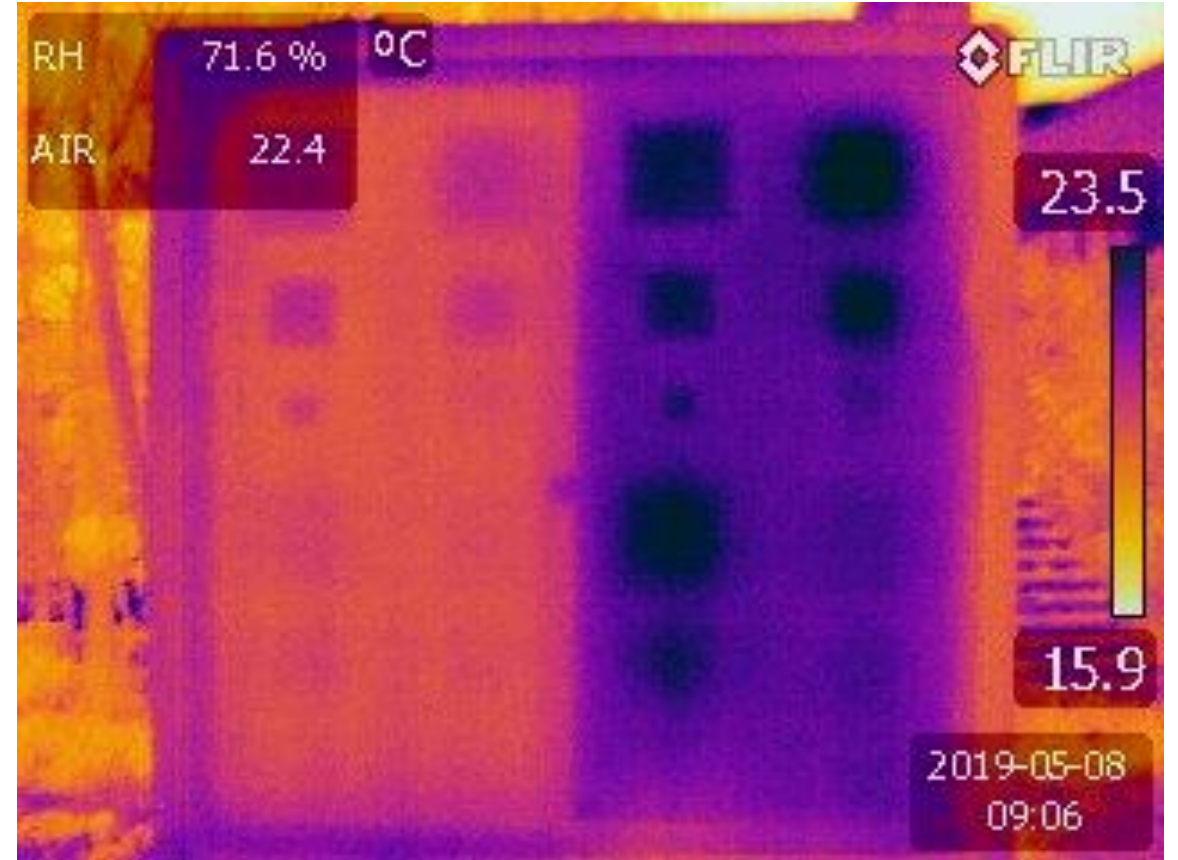
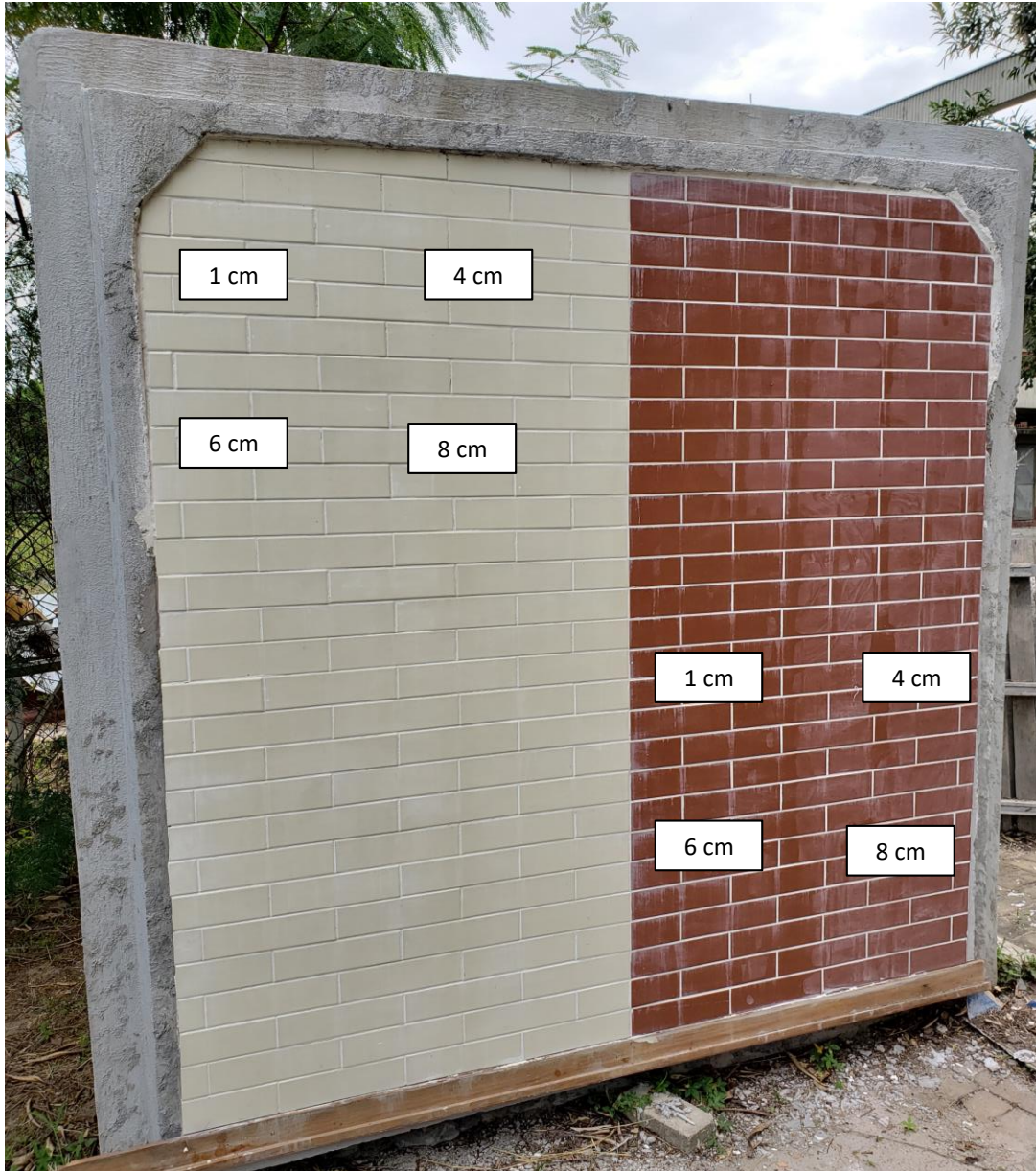


**CONFIABILIDADE
SUPERIOR AO
SISTEMA
TRADICIONAL**

Metodologia passiva



Metodologia passiva



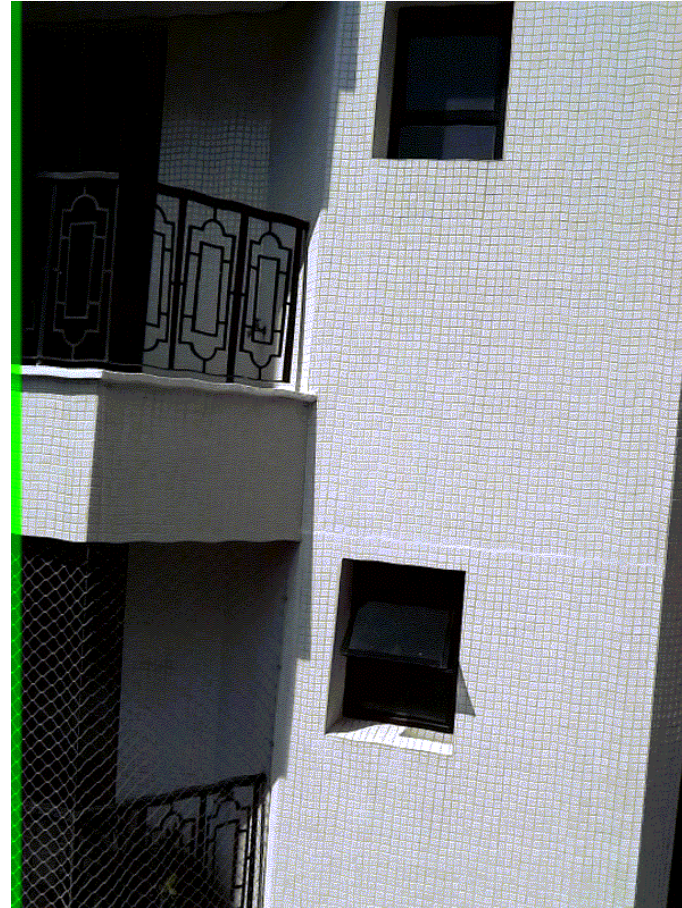
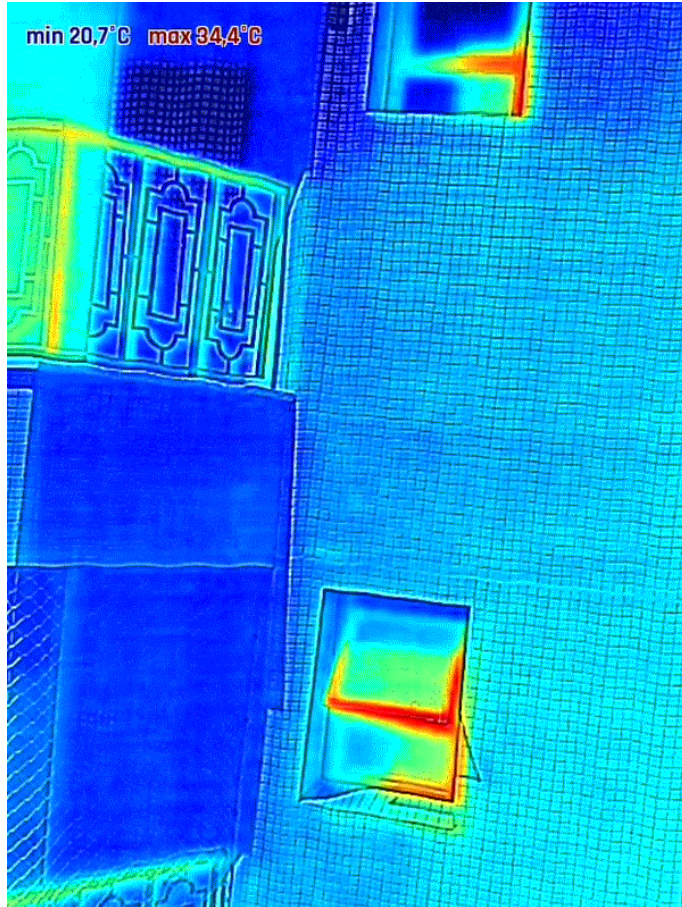
Estudos de casos

Barra Funda



Estudos de casos

Santo Amaro



Mapeamento e quantificação



LEGENDA DAS PATOLOGIAS

-  Fissura
-  Falha no Rejunte
-  Som Cavo
-  Deslocamento
-  Local não visto
-  Anormalidade detectada por termografia

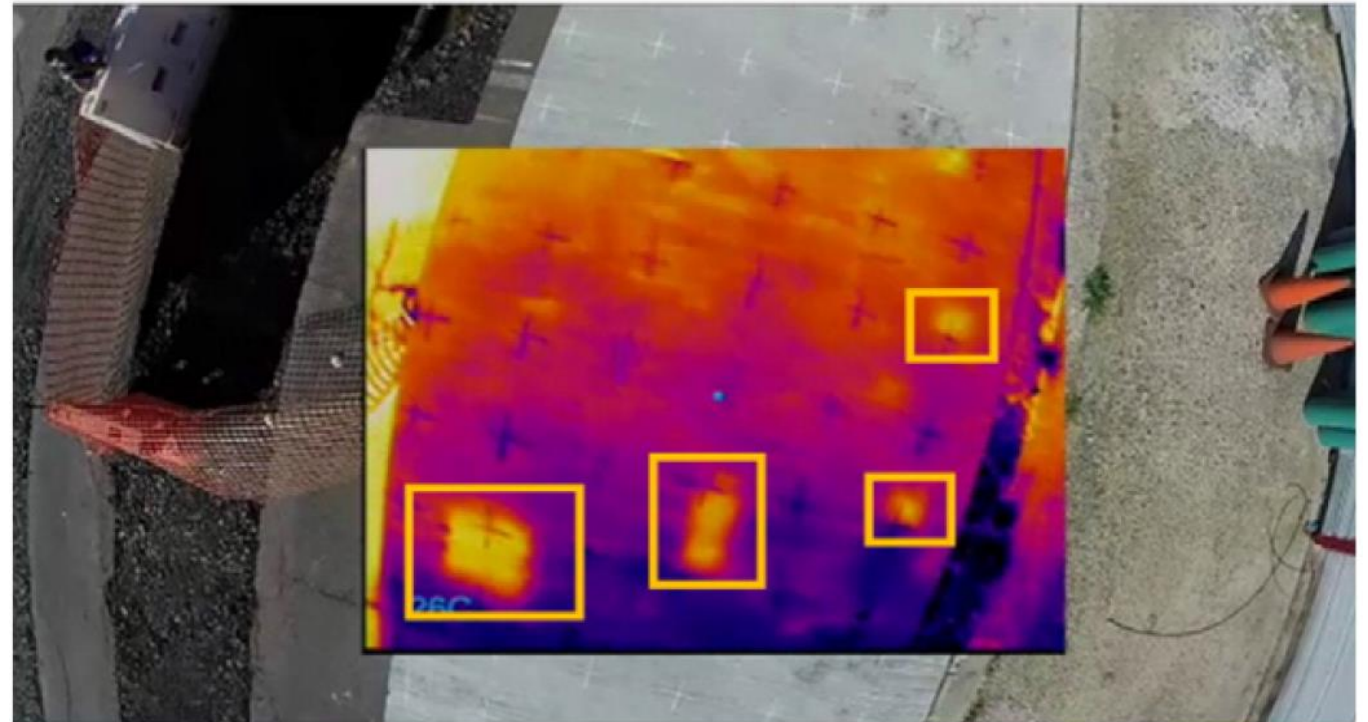
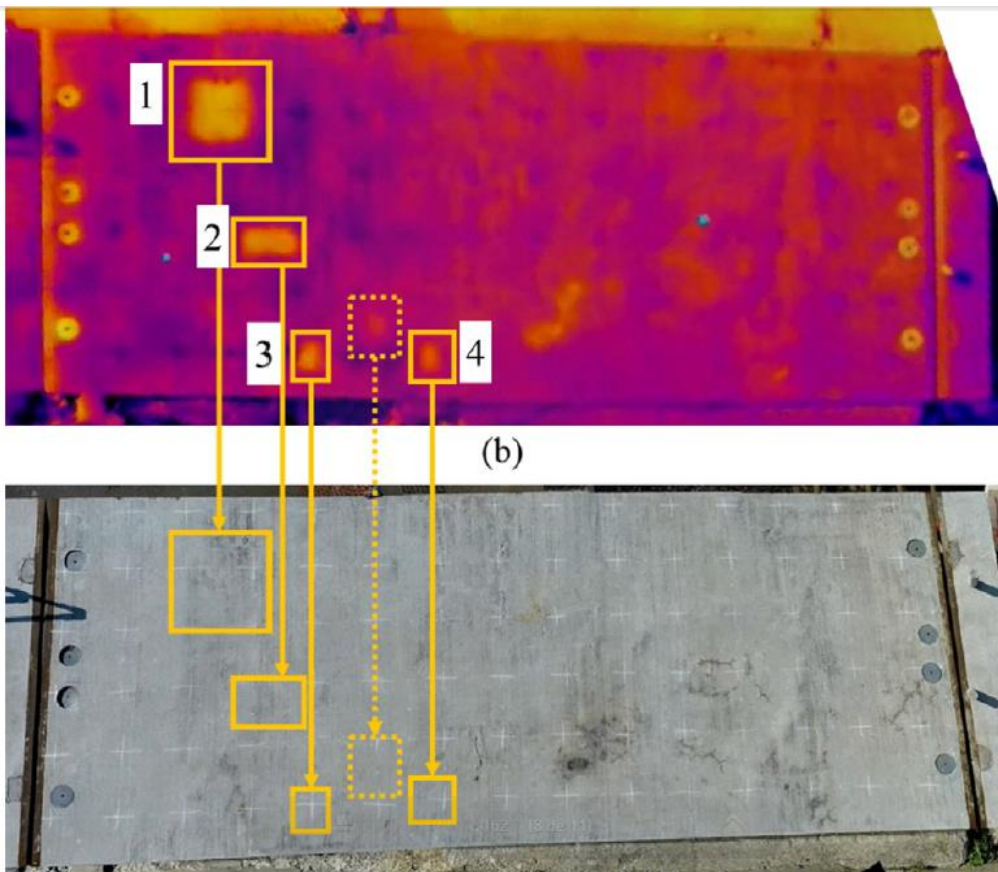
O métodos tradicional identificou mais problemas nas zonas de interface e menos nas superfícies planas



OUTRAS APLICAÇÕES

ESTADOS UNIDOS:

- Estudaram destacamento em tabuleiros de pontos;



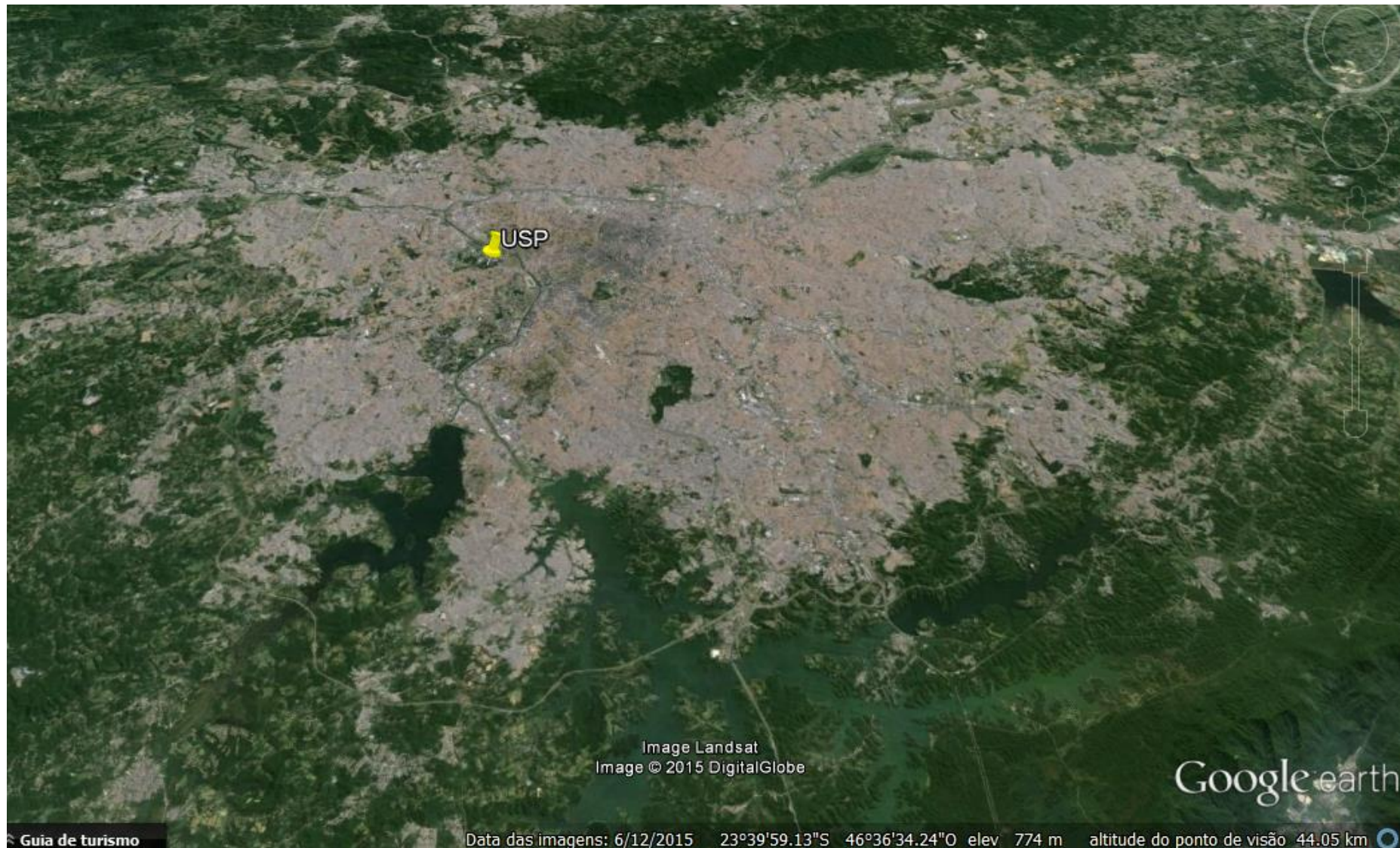
Sobre a inovação :

- Qual é o problema existe? *Avaliação de áreas pouco acessíveis*
- Quais as possibilidades? *Facilitar o acesso*
- Quem é o cliente? *Construtoras / síndicos / administradoras de condomínio*
- O que é valor para o cliente? *Preço*
- *Qual o desafio? confiabilidade*

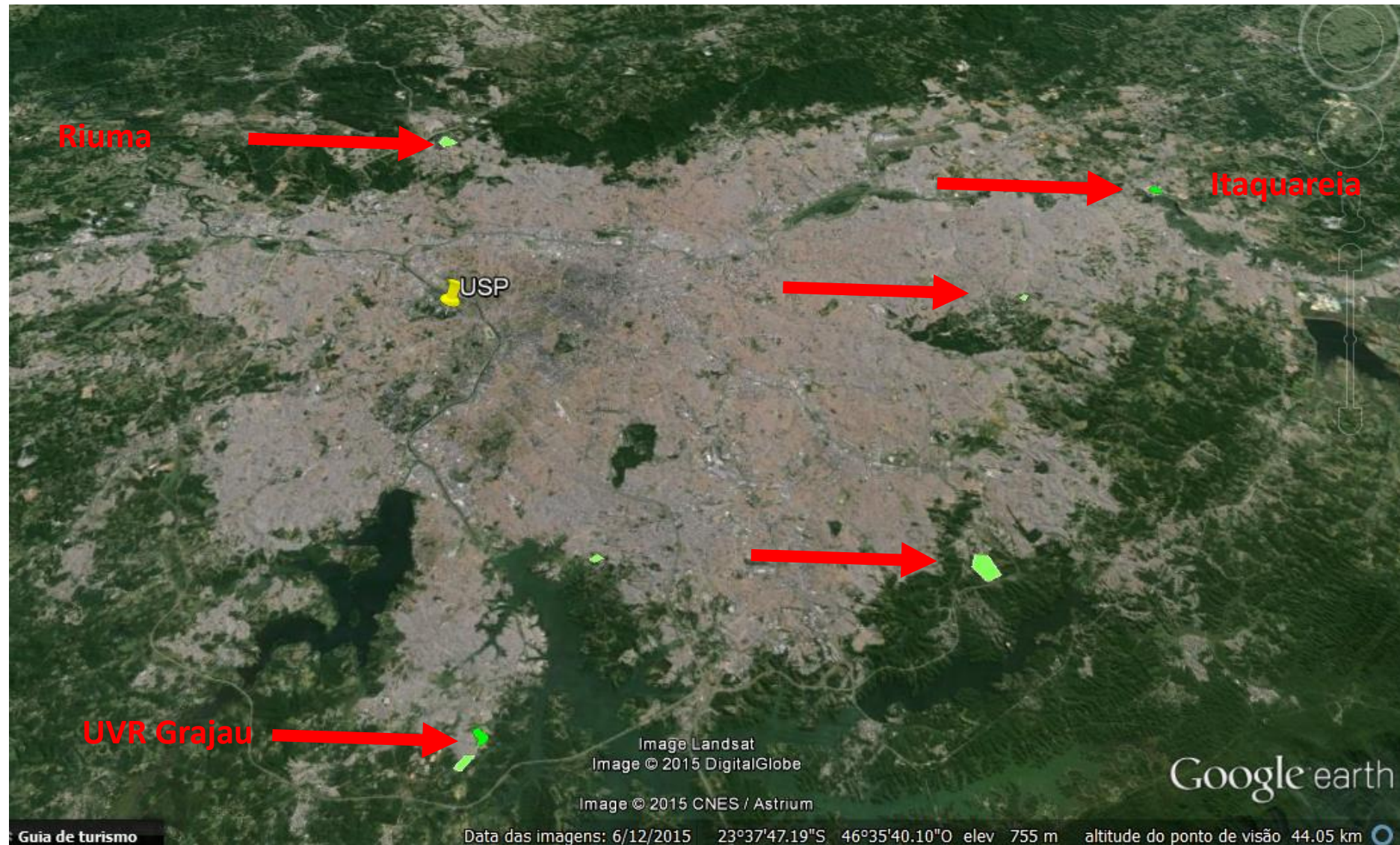
Drivers das Inovações na Construção Civil:

- **Segurança**
- Aumento de Produtividade
- Melhora de desempenho/durabilidade
- Incorporação de outras funções
- **Redução de impactos e aumento da sustentabilidade**

Resíduos da Cidade de São Paulo



Resíduos da Cidade de São Paulo – Aterros Licenciados



Geração de Resíduos em São Paulo

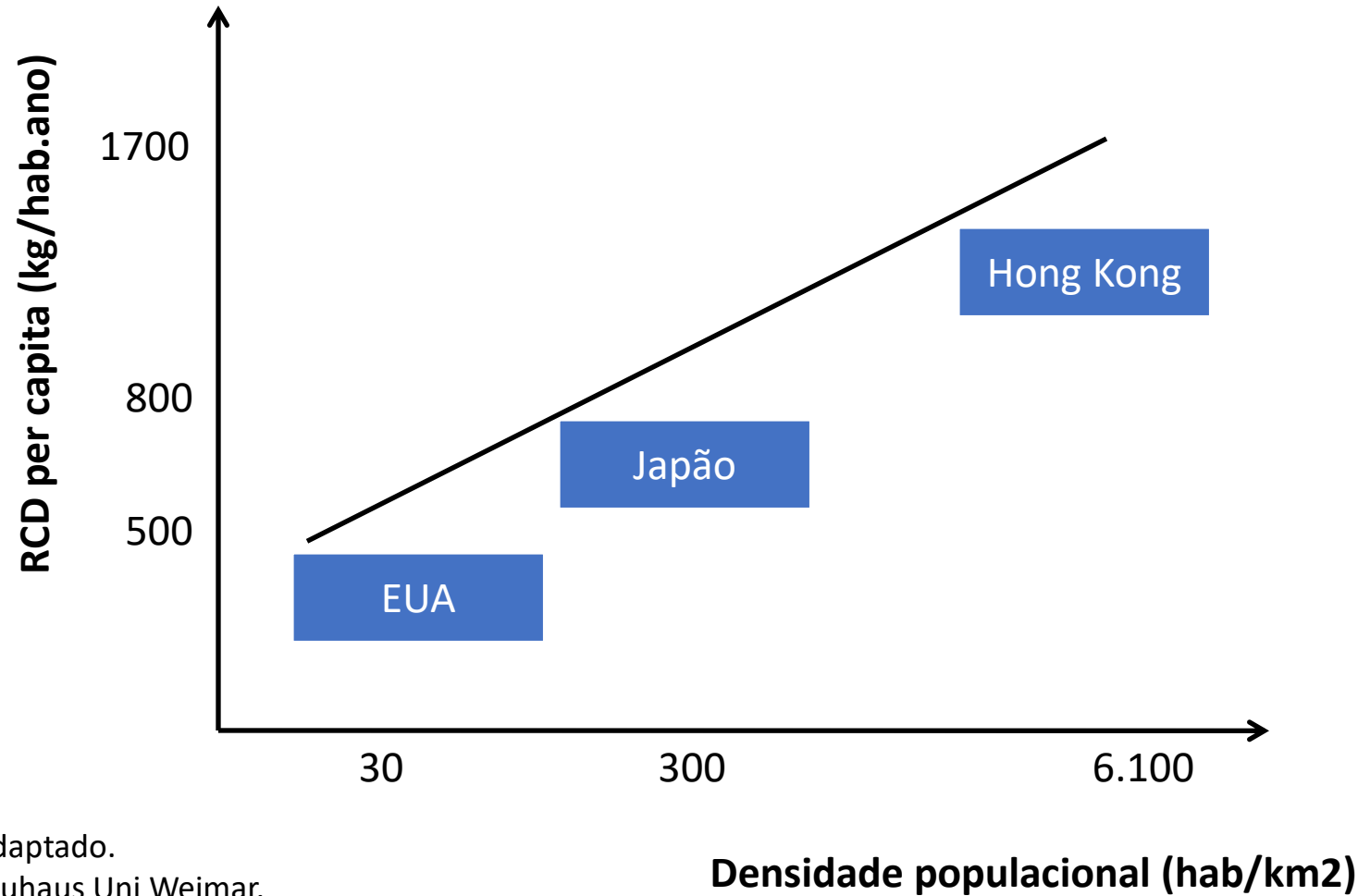
Fonte: ABRELPE

RSU x RCD	2013	2014	2015
RSU (milhões ton/ano)	76,4	78,6	79,9
RCD (milhões ton/ano)	42,9	44,6	45,2
%	56,1%	56,8%	56,5%

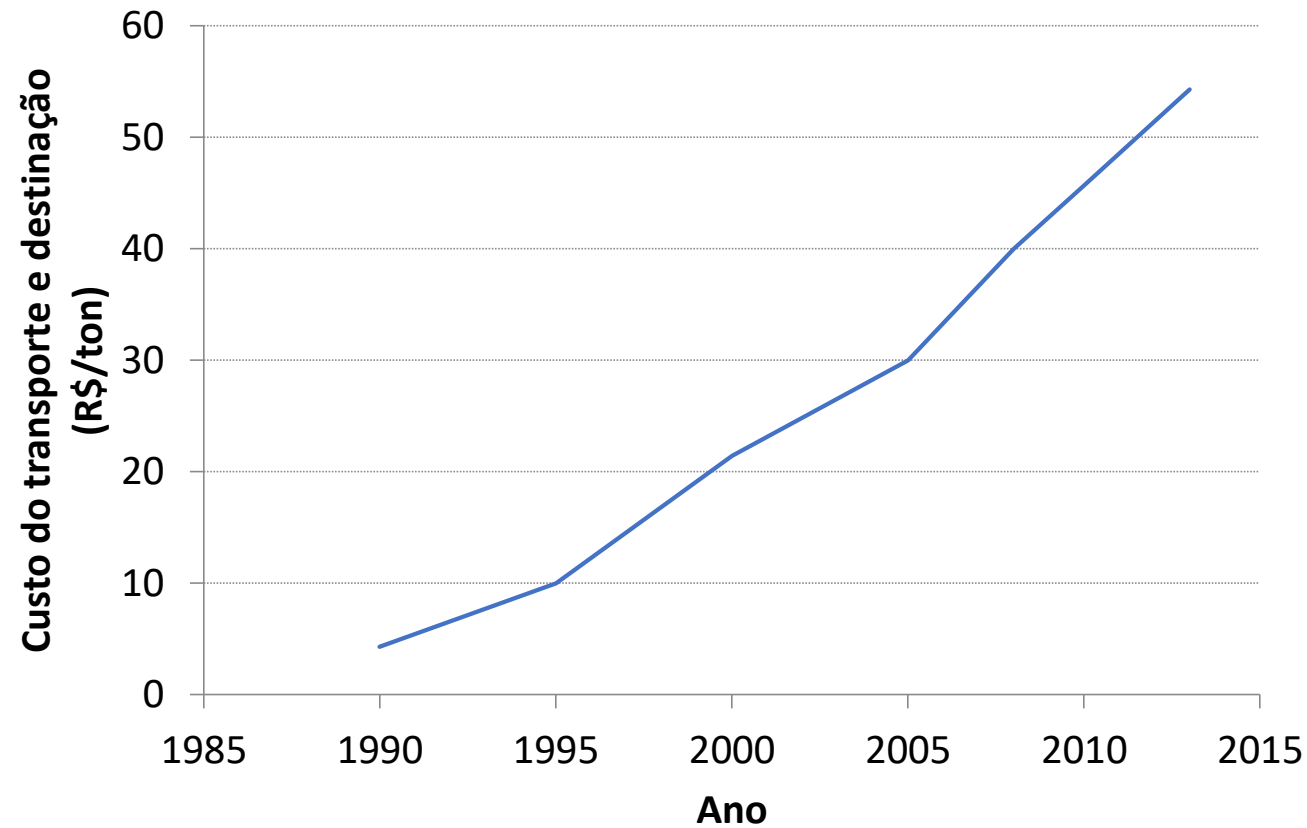
Mais da metade de todos os resíduos dispostos em aterros são classificados como RCD

País	Kg/hab./ano	Fonte
Suécia	136 – 680	TOLSTOY, BÖRKLUND & CARLSON (1998); EU (1999)
Holanda	820 – 1300	LAURITZEN (1998); BROSSINK; BROUWERS & VAN; KESSEL (1996); EU (1999)
EUA	463 – 584	EPA (1998); PENG, GROSSKOPF, KIBERT (1994)
UK	880 – 1120	DETR (1998); LAURITZEN (1998)
Bélgica	735 – 3359	LAURITZEN (1998), EU (1999)
Dinamarca	440 – 2010	
Itália	600 – 690	
Alemanha	963 – 3658	
Japão	785	KASA (1998)
Portugal	325	EU (1999); RUIVO E VEGA (apud MARQUES NETO, 2009)
Brasil	219	Abrelpe (2015)

RCD per capita x densidade populacional



Evolução dos Custos do transporte e Destinação de resíduos Classe A na cidade de São Paulo



* o custo da disposição de resíduo na cidade de são paulo já é, em média, 20% do cimento

* Uma importante parcela dos resíduos destinados corretamente para as construtoras não chegam a o destino preestabelecido

Aterros Comerciais - Grajau



Grajaú em 2009 com cava de 30m de profundidade



Grajau em 2005 como exploração de areia

Aterros Comerciais - Grajau



Aterro Grajau em 2011
com 02 curvas de nível



Aterro Grajau em 2019
Com uma cava

Aterros Comerciais - Grajau



Aterro Grajau em 2014
com 05 curvas de nível



Aterro Grajau em 2014
com 03 curvas de nível

Aterros Comerciais



Aterro Grajau em 2015 com 07 curvas de nível e cota superior a 40m no ponto mais alto.
Já foram aterrados mais de 7 milhões de toneladas de resíduos de construção



Usina de reciclagem

Resíduos da Cidade de São Paulo

Portuária 1 (RJ)	51,7 Kg/pessoa/dia
refinaria	29,7 Kg/pessoa/dia
metrô	23,1 Kg/pessoa/dia
edifício	57,2 Kg/pessoa/dia
estádio	8,4 Kg/pessoa/dia
Portuária 2 (SP)	21,0 Kg/pessoa/dia
hidrelétrica	23,7 Kg/pessoa/dia

Resíduos em Obras de Infraestrutura - Portuária

Obra Portuária

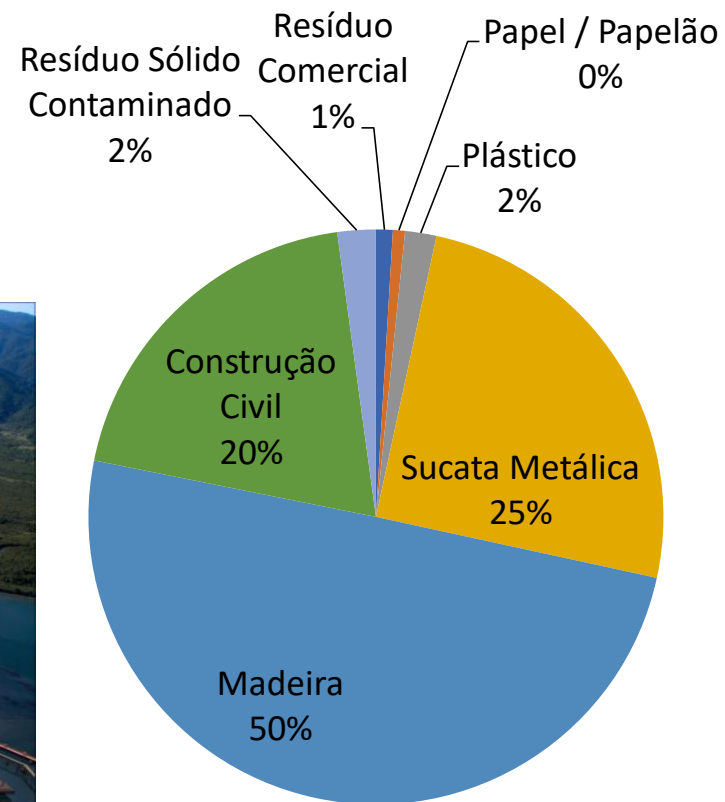
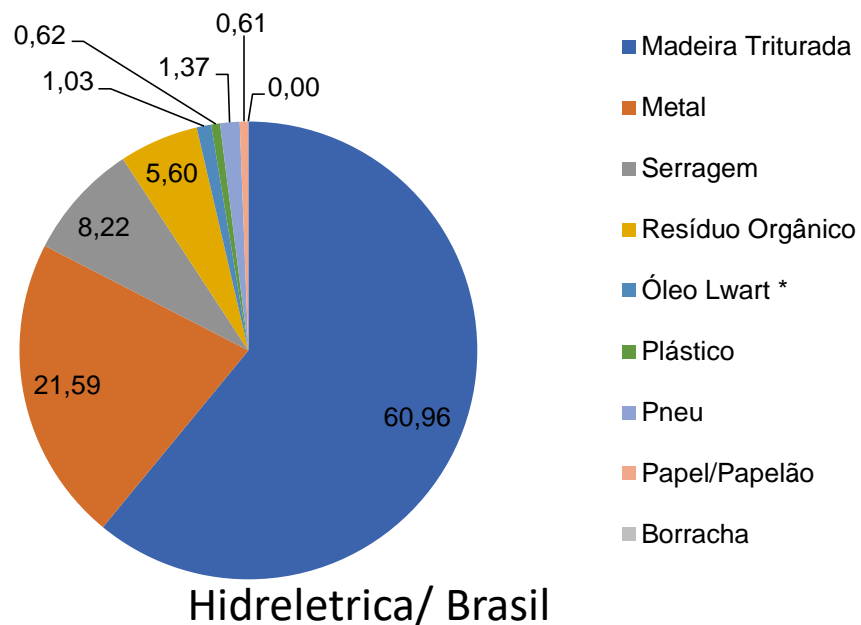


Foto:Cláudio Tomás Carvalho (Ibracon)

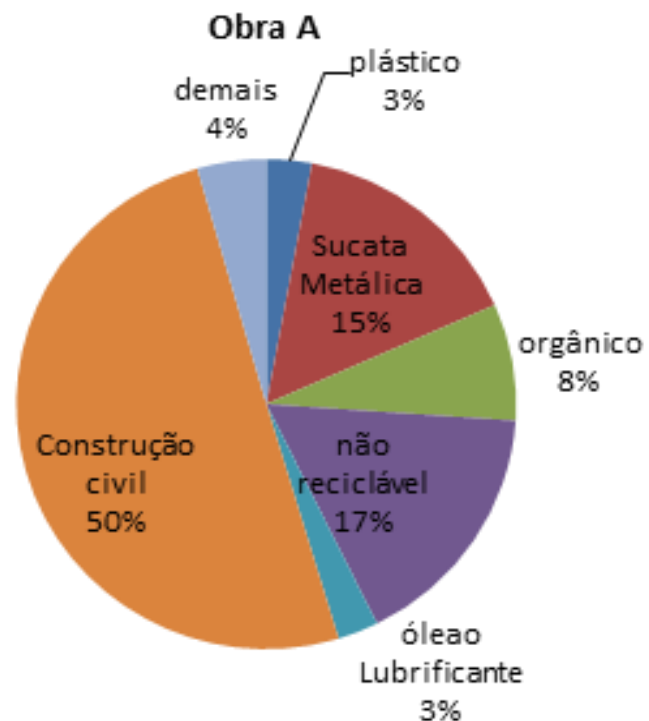
Resíduos em Obras de Infraestrutura

Média Acumulada 2013 (%)



Os indicadores existentes até o momento não dão o suporte para previsão em novas obras. Faz-se necessário o levantamento de mais dados

Refinaria / Brasil



Barreiras ao Uso:

- **Heterogeneidade**
- **Contaminação**
- **Presença de finos**
- **Absorção de água**
- **Influência na Resistência**
- **Aplicações de pouca responsabilidade**



Grande Variabilidade das propriedades do material reciclado - tradicional



- Separação por cor
- Contaminação com madeira
- Variação na absorção d'água, forma e teor de pulverulentos

Grande Variabilidade das propriedades do material reciclado - tradicional

For the last two decades, much research has been performed to develop techniques to clean the waste. Magnetic and eddy current separation show good performance for removing ferrous and non-ferrous metals (Xing; Hendrix, 2006). Angulo *et al.* (2013) show that optic separation is efficient to differentiate between red ceramic and gray phases (cement, mortar, concrete and natural aggregate). Schnellert and Muller (2013) used wet jigging and found good results when sorting bricks, asphalts, concrete and gypsum particles, and Cazacliu *et al.* (2014) noted that air jigging also has the potential to separate construction waste with a similar envelope density as brick (2.26 kg/m³), concrete (2.39 kg/m³), and gypsum (1.86 kg/m³).

Unfortunately, most of those experiments were conducted in the laboratory. When conducted at real scales, most of the density-based techniques do not show good performance; meanwhile, the particles' water absorption influences their density and color, make the separation process more difficult and in some cases, impossible.

Grande Variabilidade das propriedades do material reciclado - tradicional

Moreover, most of the techniques used are based on mineral processing knowledge, where the mineral concentration is necessary for industrial activities and each step is directed to reflect the added value with price increases of more than 100 times (iron chain and aluminum prices increase approximately 300 and 150 times, respectively, from the mineral oxides to processed alloys). Despite this, recycled aggregate has a considerably lower added value along the production chain, and an increase of no more than 5 times has been identified in Brazil when comparing “clean” and “dirty” recycled aggregate. When comparing aggregate to concrete, the added value is higher but is still no more than a 10-fold increase.

Planta de Reciclagem em São Paulo



Figura 2: The plant used as case of study

Fonte: Maranhão *et. Al.* (2016)

Resíduos da Cidade de São Paulo 20mm – 40mm (retido 9,5mm)

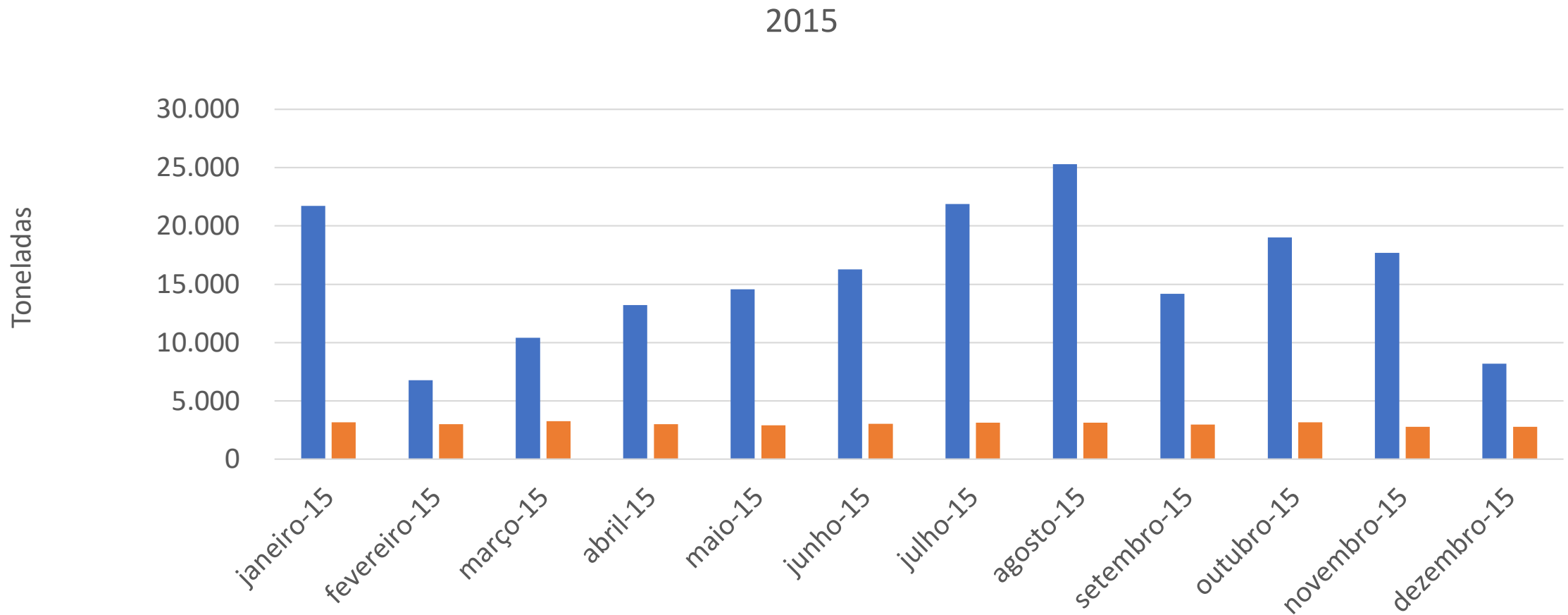


Figura 2: The plant used as case of study

Fonte: Maranhão *et. Al.* (2016)

Resíduos da Cidade de São Paulo 20mm – 40mm (retido 9,5mm)

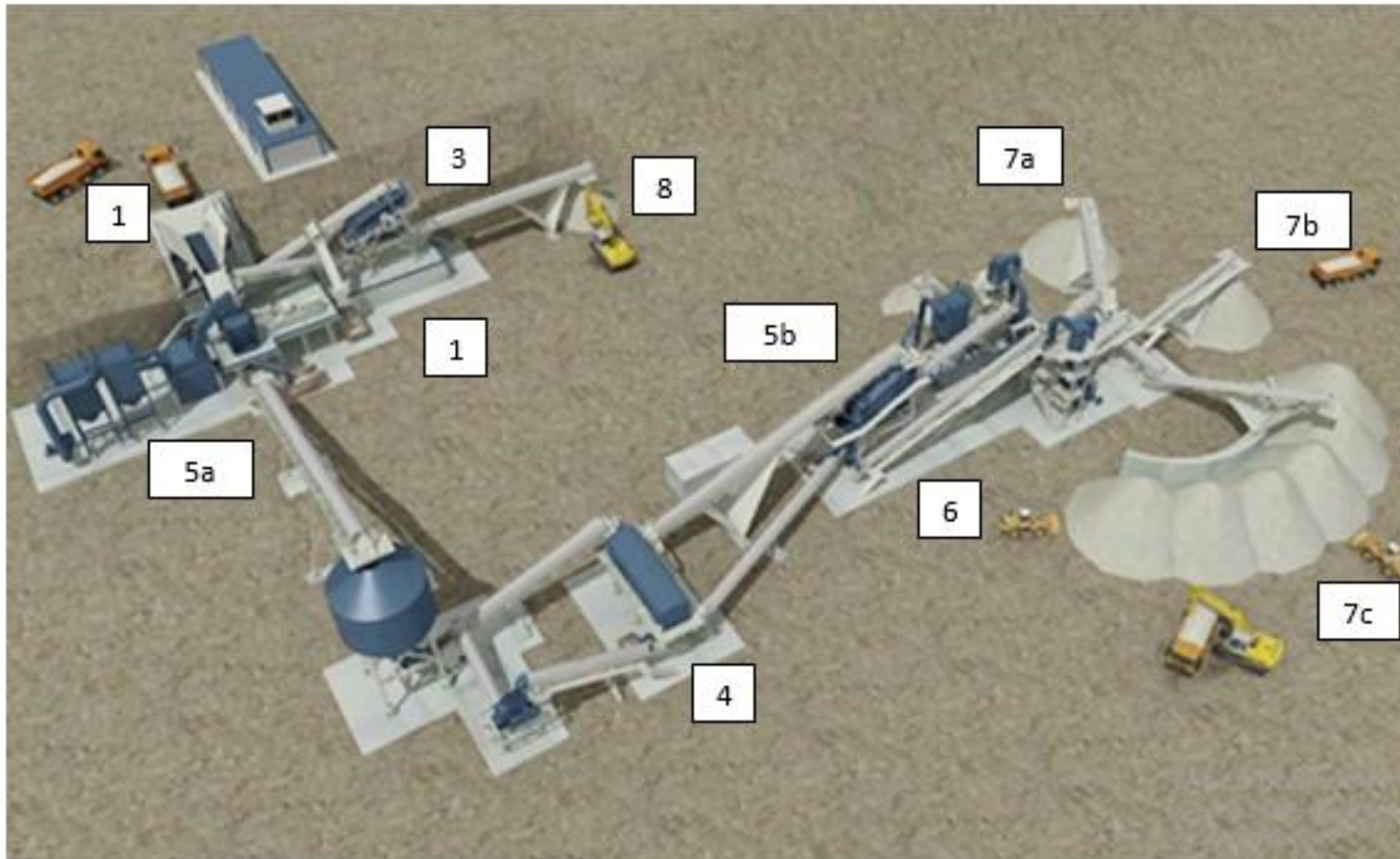


Figura 1: Illustration of the recycling plant used as case of study.

Resíduos da Cidade de São Paulo 20mm – 40mm (retido 9,5mm)

cerâmica

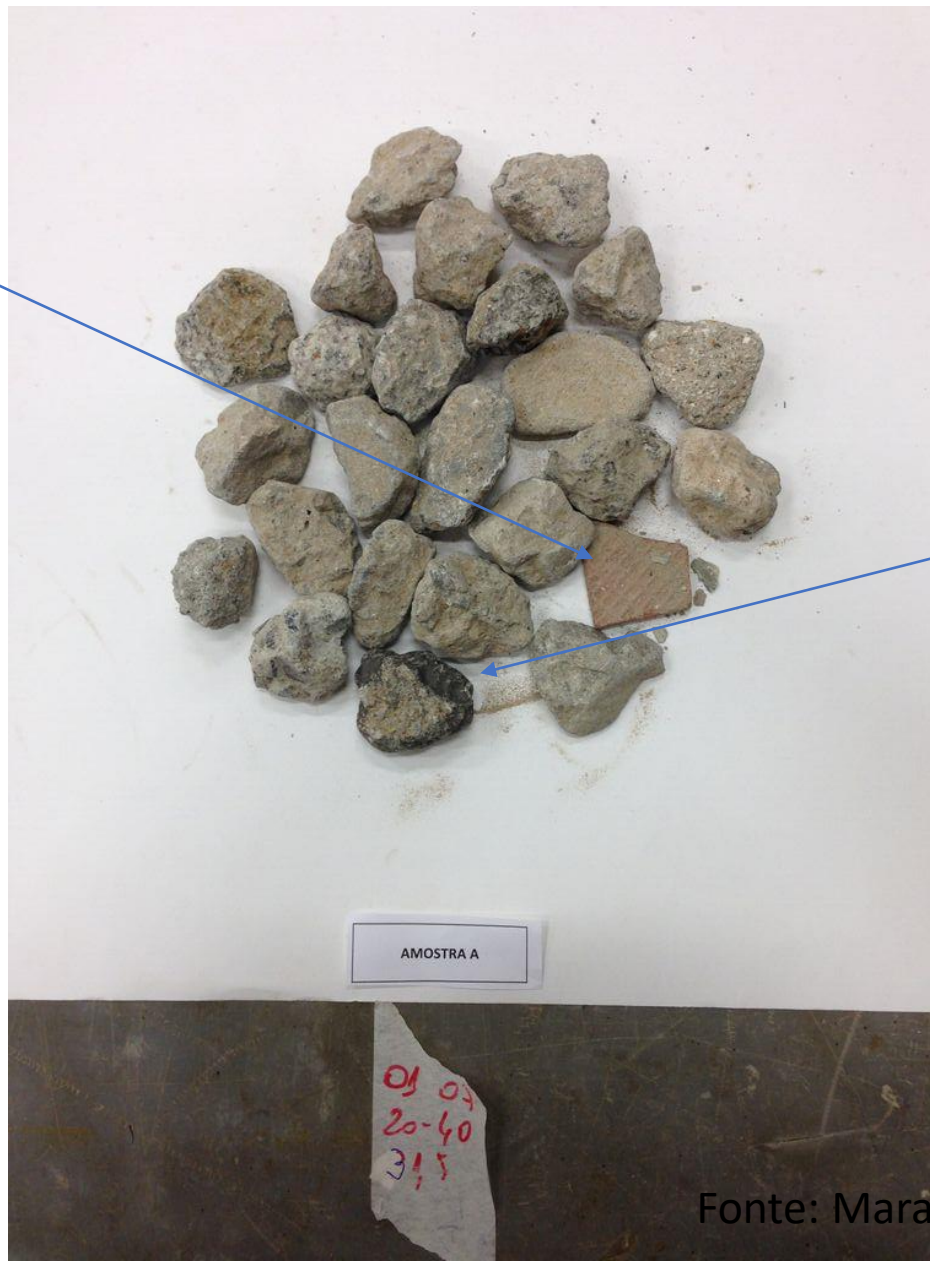


Asfalto

Fonte: Maranhão *et. Al.* (2016)

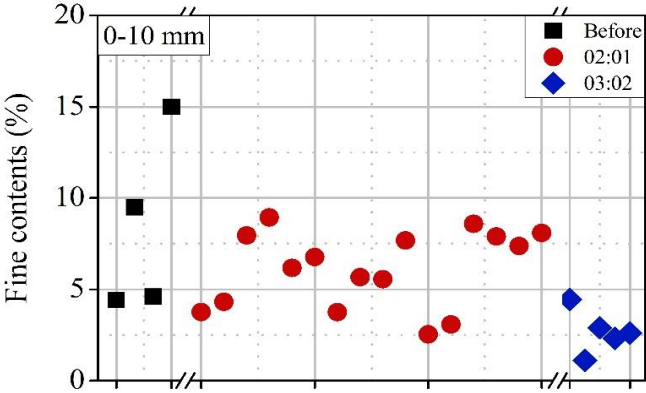
Resíduos da Cidade de São Paulo – 20mm – 40mm (retido 31,5mm)

cerâmica

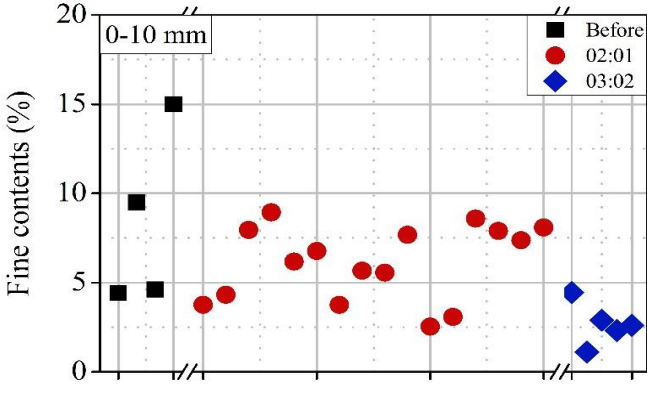


Asfalto

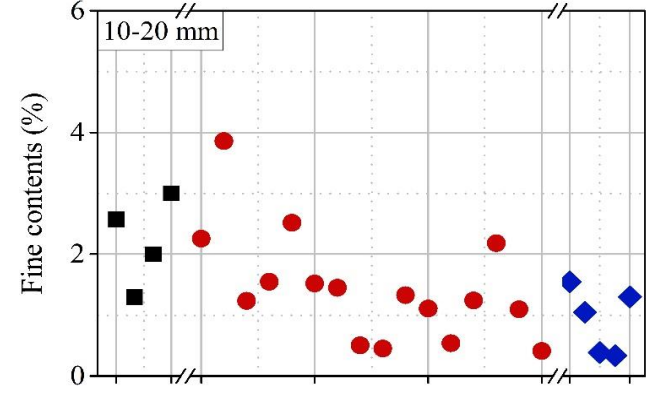
Resíduos da Cidade de São Paulo – 20mm – 40mm (retido 31,5mm)



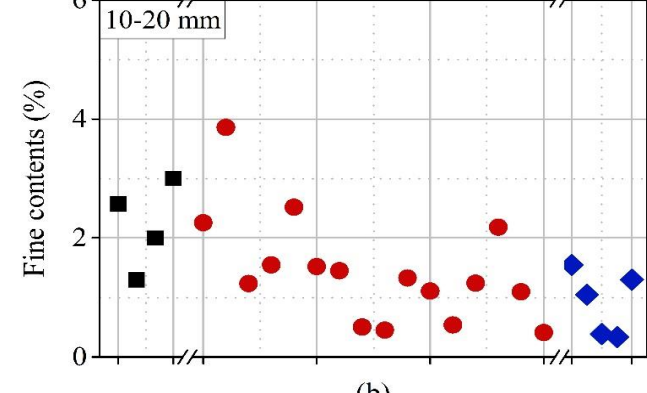
(a)



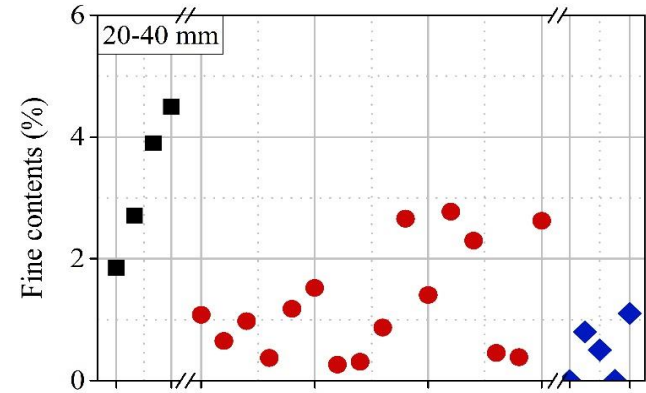
(a)



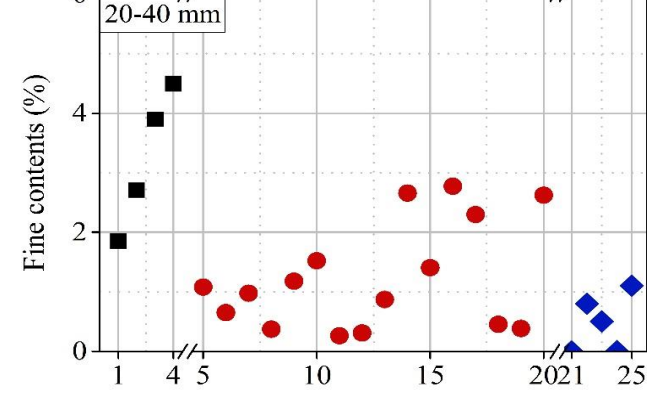
(b)



(b)



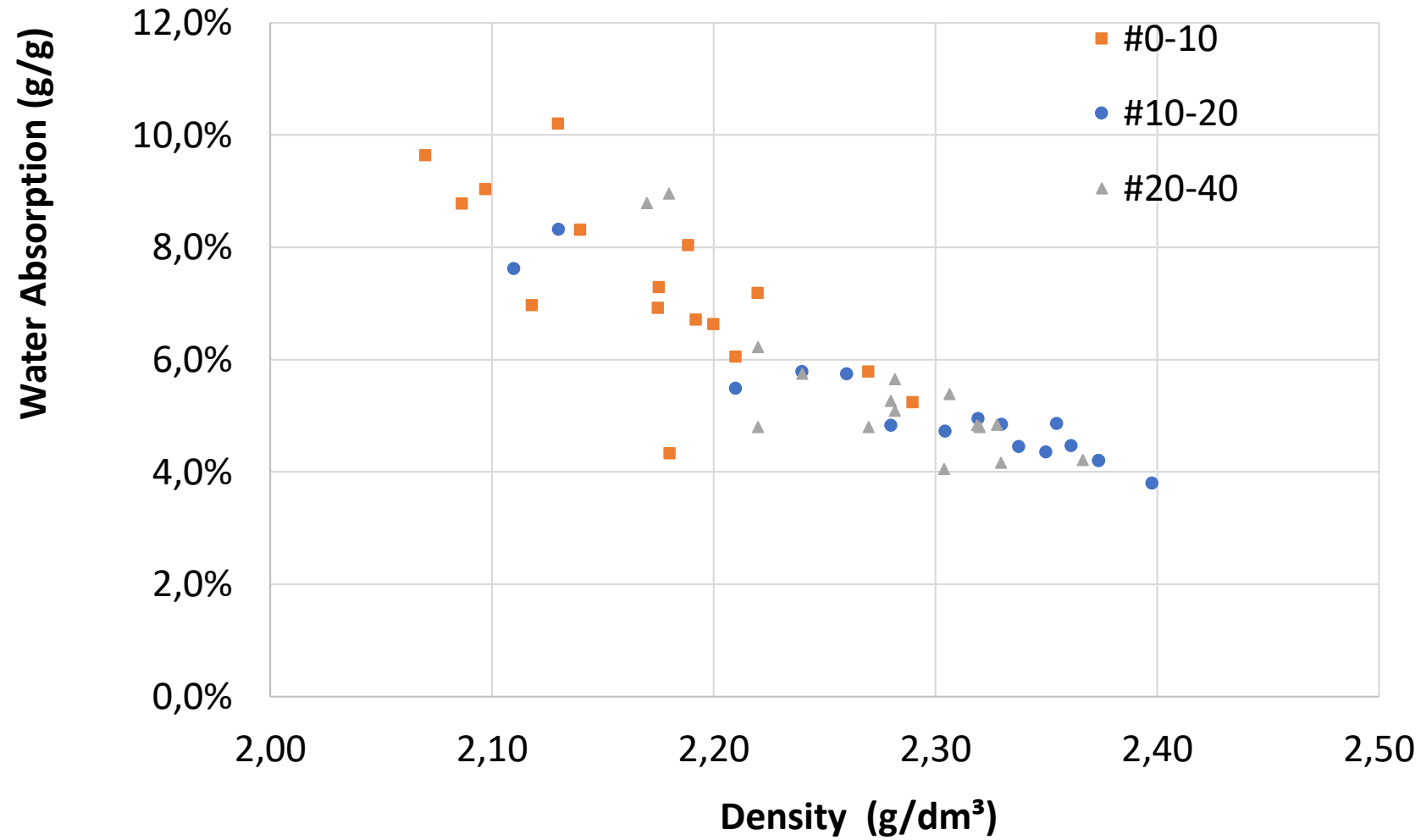
(c)



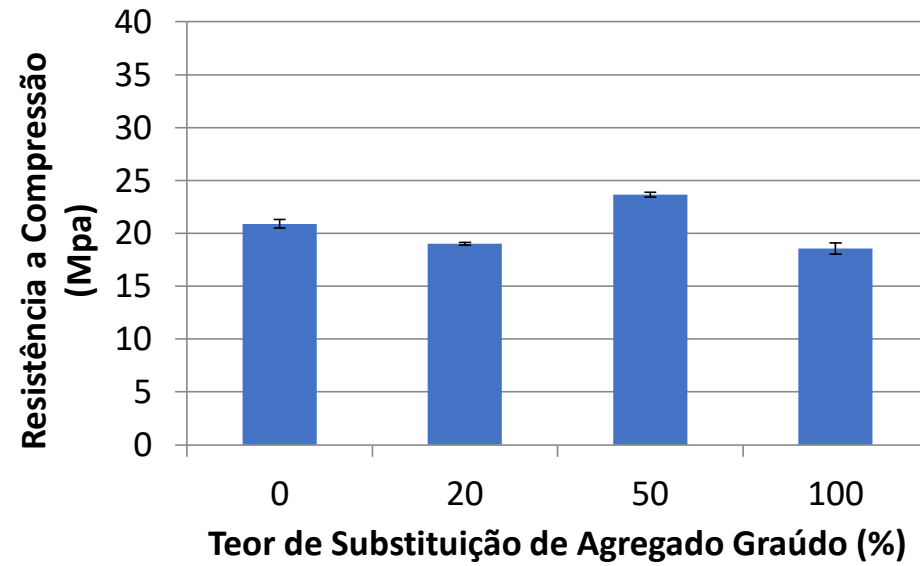
(c)

Fonte: Maranhão *et. Al.* (2019)

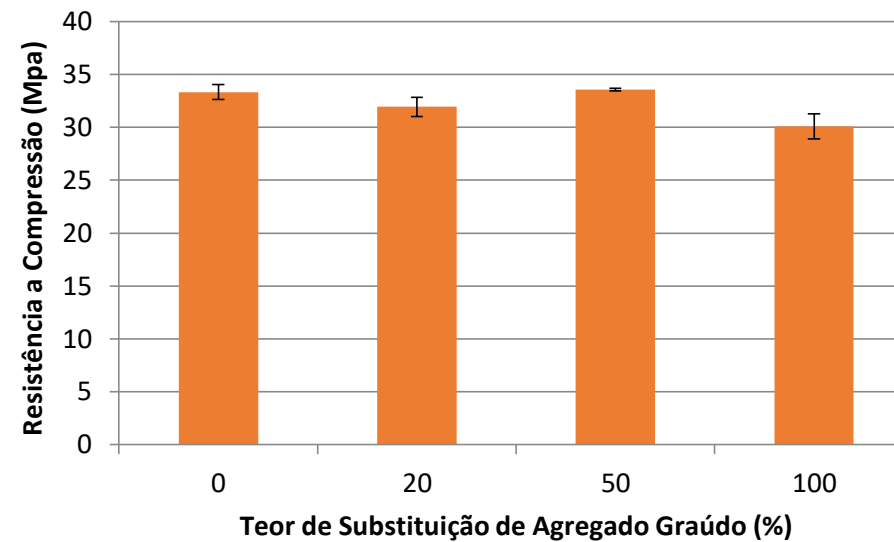
Resíduos da Cidade de São Paulo – 20mm – 40mm (retido 31,5mm)



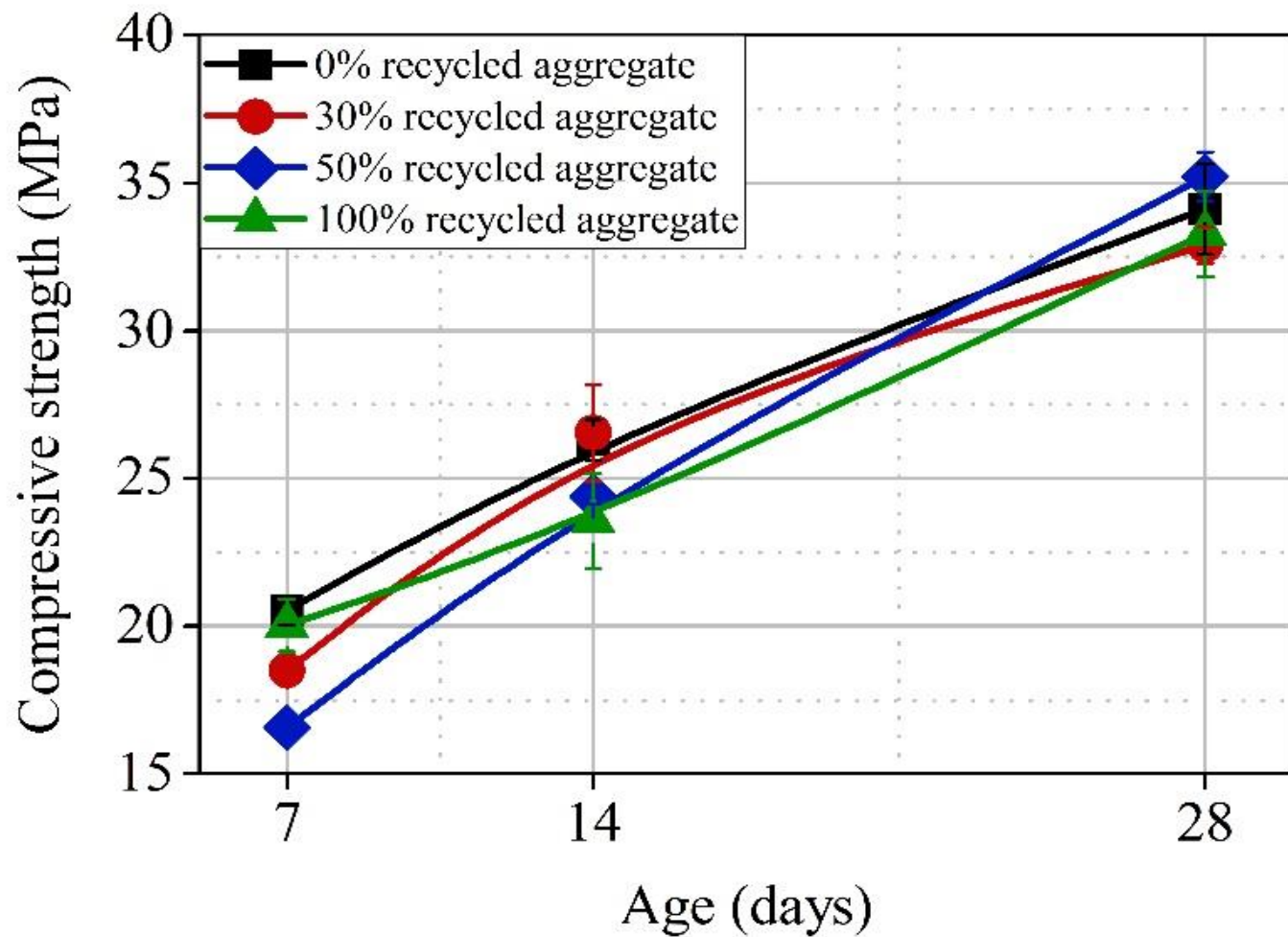
Resíduos da Cidade de São Paulo



A obtenção de concretos com resistência acima dos 30MPa não se configurou um problema



Resíduos da Cidade de São Paulo



Resíduos da Cidade de São Paulo

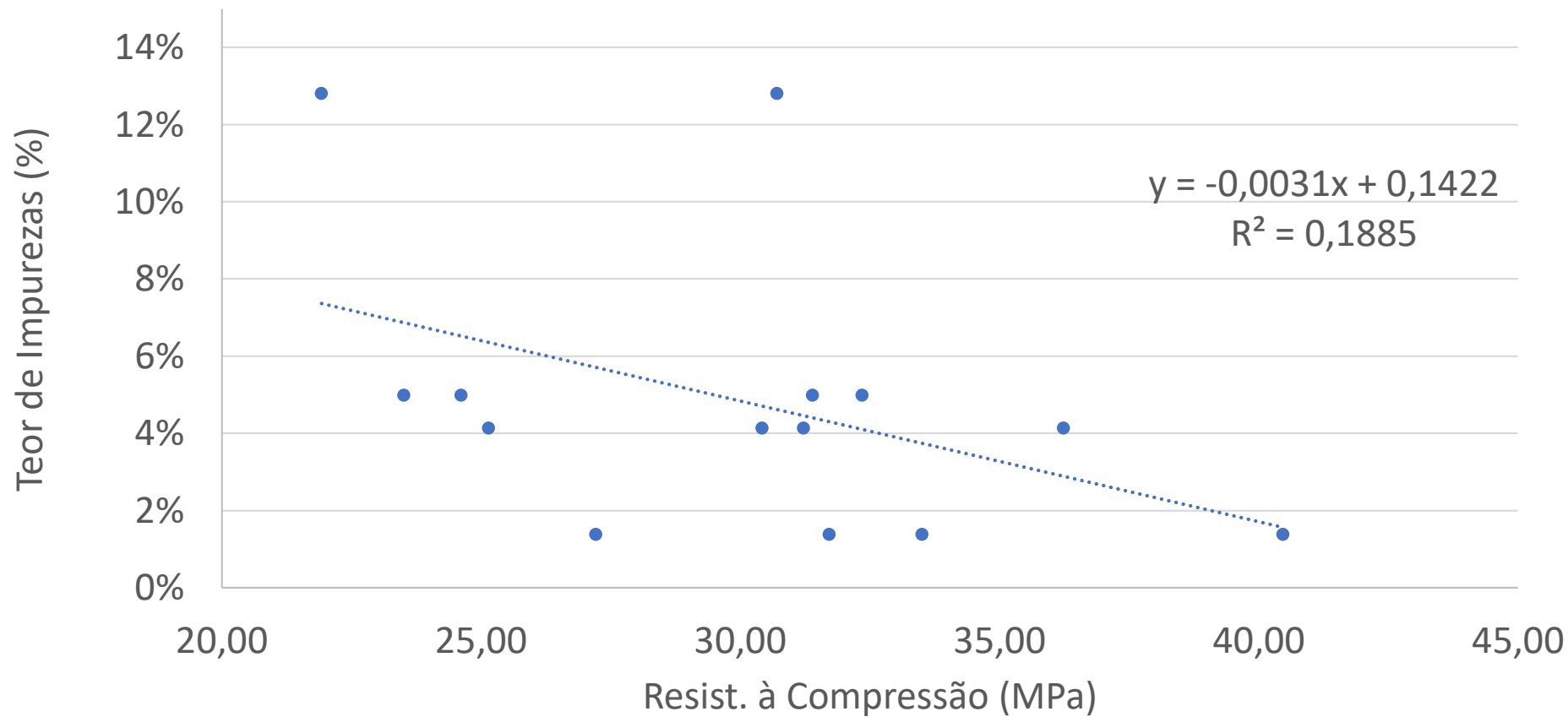


A composição de resíduos com alta porosidade (cerâmica), hidrofóbico (asfalto), boa qualidade (concreto) e uma retirada dos finos tem reduzido a variabilidade dos produtos finais



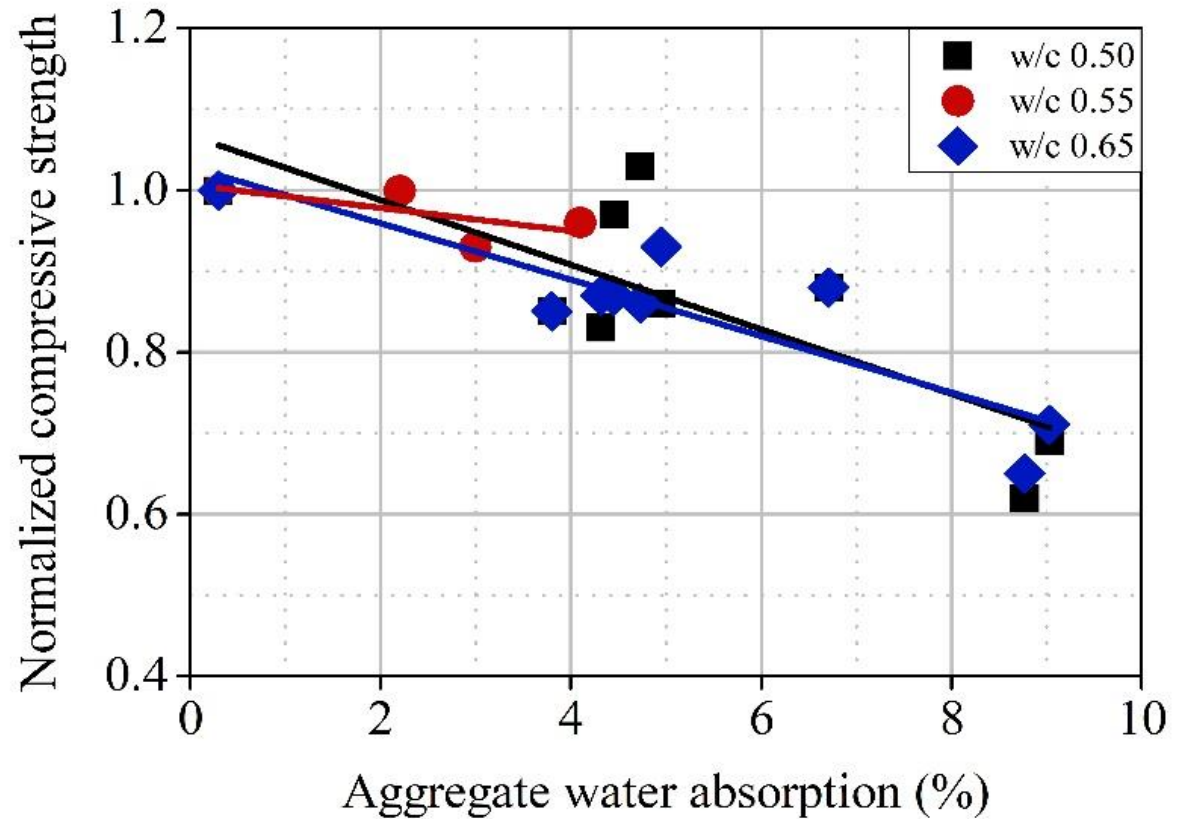
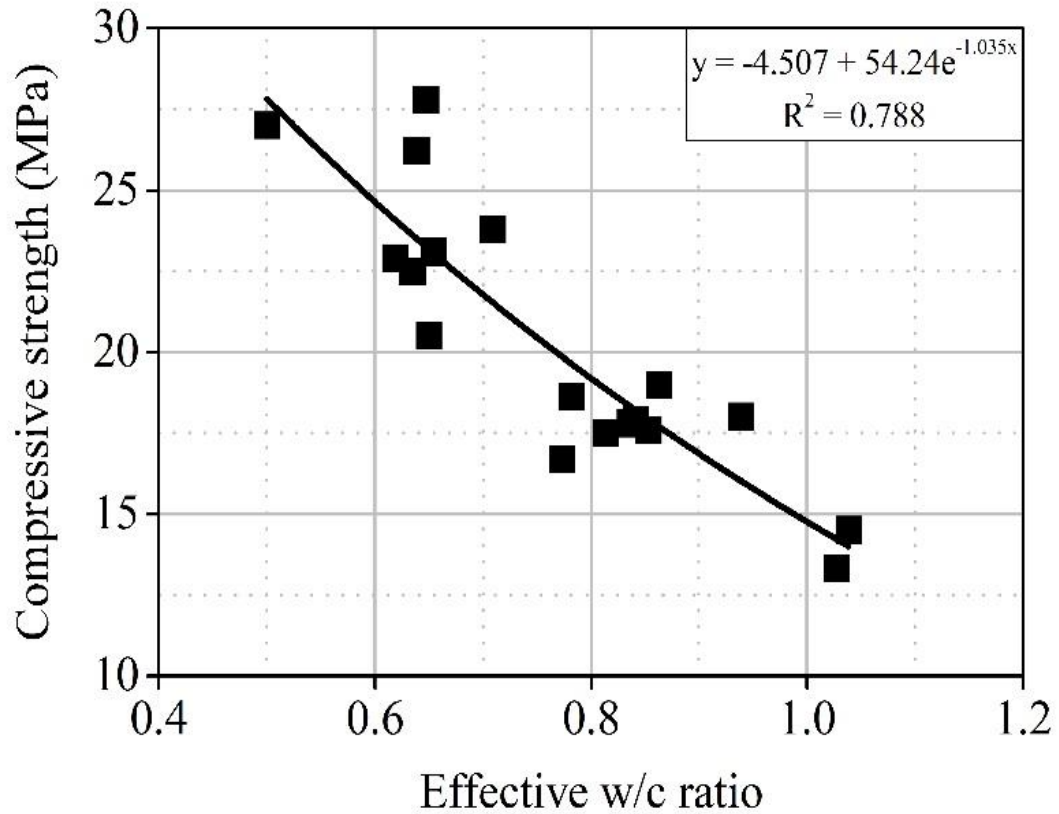
Resíduos da Cidade de São Paulo

R.C x Teor de Impurezas



Não se encontrou uma correlação clara entre o teor de impurezas e a resistência a compressão

Resíduos da Cidade de São Paulo



normalizing the concrete compressive strength by each w/c ratio used in the experiment, ..., it is observed that aggregates with water absorption lower than 5% do not cause reduction in concrete compressive strength higher than 20%. A clear explanation needs more investigation. However, results suggest that water absorption in the range from 0.3-5.0%, only a part of the water absorbed during the pre-saturation effectively modifies the w/c ratio of concrete design.

Possíveis Aplicações – limitações normativas

NORMA
BRASILEIRA

ABNT NBR
15116

Primeira edição
31.08.2004

Válida a partir de
30.09.2004

Agregados reciclados de resíduos sólidos da construção civil – Utilização em pavimentação e preparo de concreto sem função estrutural – Requisitos

Tabela 2 — Requisitos específicos para agregado reciclado destinado a pavimentação

Aplicação	ISC (CBR) %	Expansibilidade %	Energia de compactação
Material para execução de reforço de subleito	≥ 12	≤ 1,0	Normal
Material para execução de revestimento primário e sub-base	≥ 20	≤ 1,0	Intermediária
Material para execução de base de pavimento ¹⁾	≥ 60	≤ 0,5	Intermediária ou modificada

¹⁾ Permitido o uso como material de base somente para vias de tráfego com $N \leq 10^6$ repetições do eixo padrão de 8,2 tf (80 kN) no período de projeto.

Tabela 3 — Requisitos para agregado reciclado destinado ao preparo de concreto sem função estrutural

Propriedades	Agregado reciclado classe A				Normas de ensaios	
	ARC		ARM		Agregado graúdo	Agregado miúdo
	Graúdo	Miúdo	Graúdo	Miúdo		
Teor de fragmentos à base de cimento e rochas (%)	≥90	-	<90	-	Anexo A	-
Absorção de água (%)	≤ 7	≤ 12	≤ 12	≤ 17	ABNT NBR NM 53	ABNT NBR NM 30
Contaminantes - teores máximos em relação à massa do agregado reciclado (%)	Cloretos	1			ABNT NBR 9917	
	Sulfatos	1			ABNT NBR 9917	
	Materiais não minerais ¹⁾	2			Anexo A	Anexo B
	Torrões de argila	2			ABNT NBR 7218	
	Teor total máximo de contaminantes	3			-	
Teor de material passante na malha 75 µm (%)	≤10	≤ 15%	≤ 10%	≤ 20%	ABNT NBR NM 46	

¹⁾ Para os efeitos desta Norma, são exemplos de materiais não minerais: madeira, plástico, betume, materiais carbonizados, vidros e vidrados cerâmicos.

Possíveis Aplicações – limitações normativas

NORMA
BRASILEIRA

**ABNT NBR
15116**

Primeira edição
31.08.2004

Válida a partir de
30.09.2004

Agregados reciclados de resíduos sólidos da construção civil – Utilização em pavimentação e preparo de concreto sem função estrutural – Requisitos

Tabela 4 — Determinação do tipo e frequência de execução de ensaios

Propriedades	Método de ensaio	Frequência de ensaios	
		Concreto sem função estrutural	Camada de pavimento
Composição granulométrica	ABNT NBR 7181	Não se aplica	A cada lote
	ABNT NBR NM 248	A cada lote	Não se aplica
Teor de material passante na peneira 75 µm	ABNT NBR NM 46	A cada lote	Não se aplica
Absorção de água	Agregado graúdo ABNT NBR NM 53	A cada lote	Não se aplica
	Agregado miúdo ABNT NBR NM 30		
Torrões de argila e materiais friáveis	ABNT NBR 7218	A cada lote	Não se aplica
Índice de forma (agregado graúdo)	ABNT NBR 7809	Não se aplica	A cada lote
Índice de suporte Califórnia e expansibilidade	ABNT NBR 9895	Não se aplica	A cada lote
Composição do agregado graúdo	Anexo A	A cada lote	
Percentual de materiais não minerais no agregado miúdo	Anexo B	A cada lote	
Teor de cloretos	ABNT NBR 9917	Uma vez por mês ou 6 000 m ^{3 1)}	Não se aplica
Teor de sulfatos	ABNT NBR 9917	Uma vez por mês ou 6 000 m ^{3 1)}	

¹⁾ O que primeiro ocorrer.

Resíduos da Cidade de São Paulo



Os agregados reciclados já estão sendo regularmente utilizados para a fabricação de peças

Resíduos da Cidade de São Paulo



Produto produzido com agregados reciclado
produzidos na unidade de processamento mostrada

Resíduos da Cidade de São Paulo



Produto produzido com agregados reciclado produzidos na unidade de processamento mostrada

Drivers das Inovações na Construção Civil:

- Qual é o problema existe? *Disposição de resíduos*
- Quais as possibilidades? *Separação na origem*
- Quem é o cliente? *Construtoras / lojas de materiais de construção*
- O que é valor para o cliente? *Preço /sustentabilidade*
- *Qual o desafio? Variabilidade e preconceito*

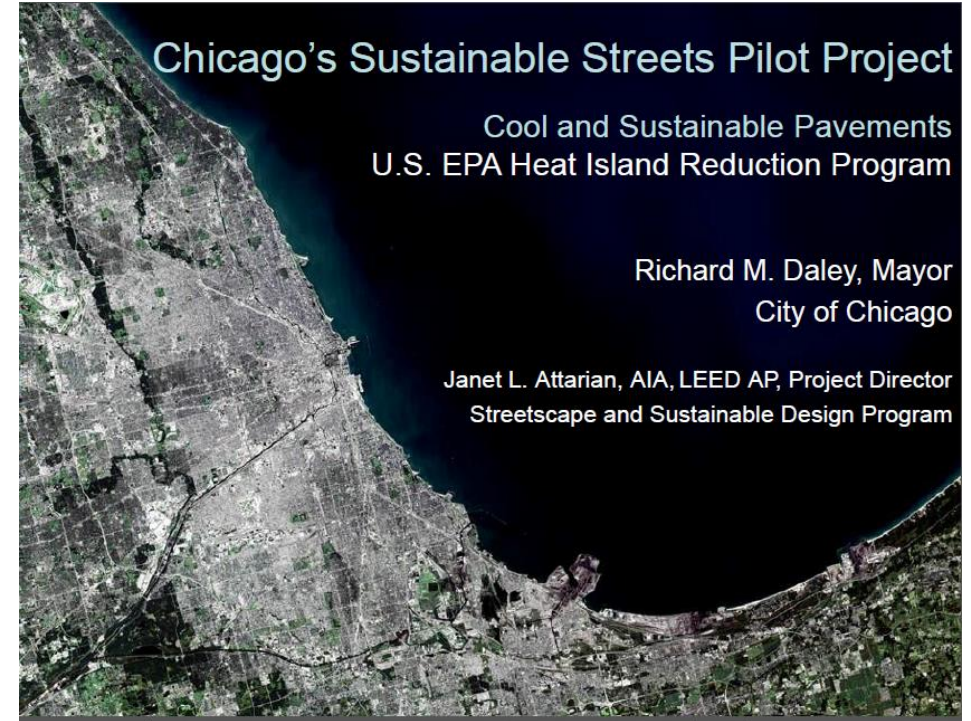
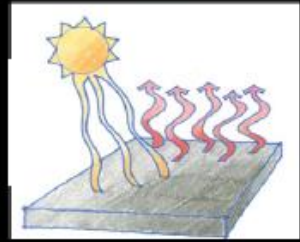
Drivers das Inovações na Construção Civil:

- Aumento de Produtividade
- Melhora de desempenho/durabilidade
- Incorporação de outras funções
- Redução de impactos e aumento da sustentabilidade

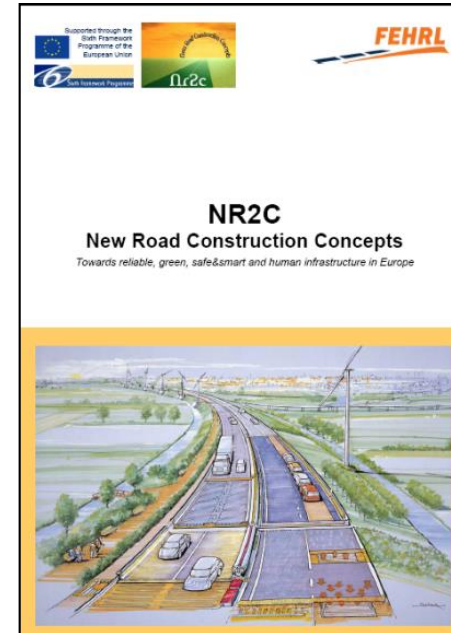
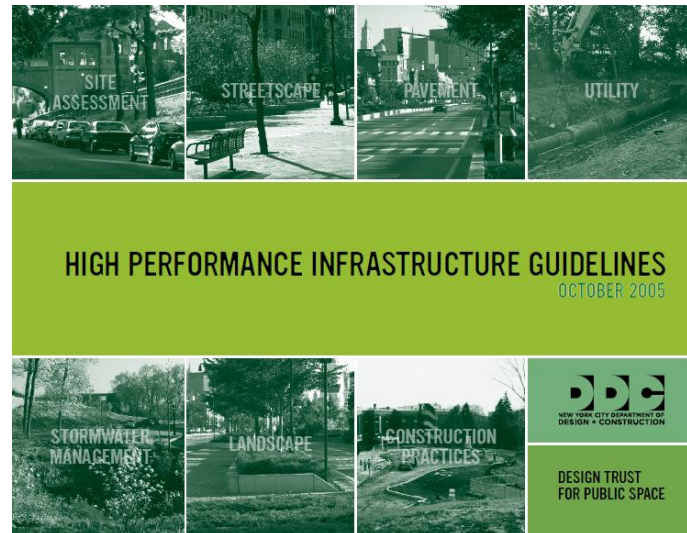
RUAS DO FUTURO

How Complete is your Street?

- Energy Efficiency
- Waste Management
- Air Quality
- Site Selection
- Beauty and Community
- Urban Heat Island
- Stormwater Management
- Water Efficiency
- Alternative Transportation
- Education



Iniciativas Globais



Integradas


Outras iniciativas Globais

EVALUATION OF TITANIUM DIOXIDE AS A PHOTOCATALYST FOR REMOVING AIR POLLUTANTS

Prepared For:
California Energy Commission
Public Interest Energy Research Program

Prepared By:
Lawrence Berkeley National Laboratory

January 2008
CEC-600-2007-112



Arnold Schwarzenegger
Governor

PIER FINAL PROJECT REPORT

Prof. Jimmy Cht-Mei Yu
Director of Environmental Science Programme
Room 142, Science Centre
The Chinese University of Hong Kong
Shatin
Hong Kong
Phone: (852) 2609 6268 Fax: (852) 2603 5057
E-mail: jimmy@cuhk.edu.hk

Ambient Air Treatment by Titanium Dioxide (TiO₂) Based
Photocatalyst in Hong Kong
(Tender Ref. AS 00-467)

Technical Report
Prepared for the Environmental Protection Department, HKSAR
February 2002

香港中文大學 化學系
Department of Chemistry
The Chinese University of Hong Kong

Study of NO_x-Reducing Coatings by London Borough of Camden

**IASPC Conference: Tuesday 22nd June 2010
School of Oriental and African Studies, London.**

Gloria Esposito
London Borough of Camden

Dr Benjamin Barratt
Environmental Research Group, King's College London



A Life+ Demonstration Programme

PHOTOPAQ
Demonstration of Photocatalytic remediation Processes on Air Quality

Recent photocatalytic applications in Belgium, purifying the air through the pavement

Anne Beeldens, [Elia Boonen](#)
Belgian Road Research Centre
e.boonen@brrc.be

PhotoPAQ Workshop Corsica, May 16th 2012



Aire Limpio Qatar Best Practices

We care about the air you breathe



Parciais:

Nanopartículas

W Nanopartícula – Wikipédia

Seguro | https://pt.wikipedia.org/wiki/Nanopartícula

Apps Brasil Gmail - santa cruz - CoralNET | Santa Cru Information Pack of Metal Militia Web Ra Sites Sugeridos Outros favoritos

Não autenticado Discussão Contribuições Criar uma conta Entrar

Artigo **Discussão** Ler Editar Editar código-fonte Ver histórico Pesquisar na Wikipédia

[ocultar]

A Wikipédia em português chegou a **1 000 000** de artigos em 26 de junho de 2018.

Leia o texto completo de nosso comunicado.

WIKIPÉDIA
A enciclopédia livre

1.000.000 DE ARTIGOS

Nanopartícula

Origem: Wikipédia, a enciclopédia livre.

Nanopartículas são **partículas** cujo tamanho situa-se entre 1 e 100 **nanômetros** (nm). Em **nanotecnologia**, uma partícula é definida como um pequeno objeto que se comporta como uma unidade inteira em termos de seu transporte e propriedades. As partículas são classificadas de acordo com o **diâmetro**.^[1] Partículas ultrafinas são o mesmo que nanopartículas e medem entre 1 e 100 nm; partículas finas medem de 100 a 2500 nm; já as partículas grossas medem de 2.500 a 10.000 nm.

Nanopartículas podem ou não exibir propriedades relacionadas com o tamanho, as quais diferem significativamente daquelas observados em partículas finas ou materiais volumosos.^{[2][3]} Embora o tamanho da maioria das **moléculas** se encaixe no esquema acima, as moléculas individuais não são geralmente referidos como nanopartículas.

Índice [esconder]

- Elementos de definição
- Aplicação
- Referências
- Ver também
- Ligações externas

Este artigo é parte de uma série sobre **Nanomateriais**



Nanotubos de carbono

Síntese · Química · Propriedades mecânicas · Propriedades ópticas · Aplicações · Cronologia

Outros fulerenos

Buckminsterfulereno · Fulereno C70 · Fulerenos superiores e inferiores · Química · Impacto na saúde · Na cultura popular · Alótropos de carbono

13:12 24/07/2018

95%

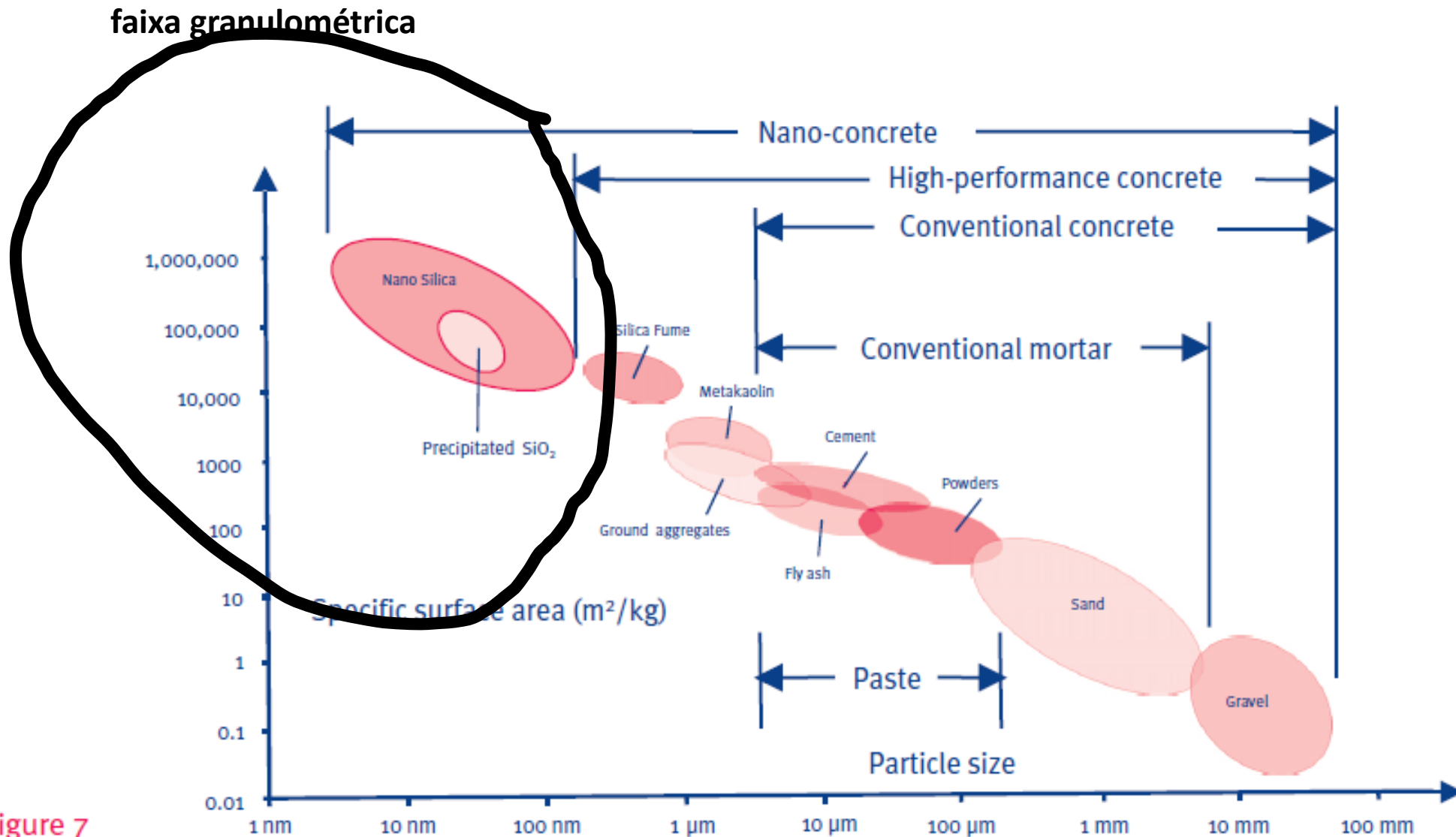


figure 7

Ingredients of a number of building materials, including their particle size and specific surface area, based on a graph by Prof. Dr. Dr. H. Pöllmann, Martin-Luther-University of Halle-Wittenberg, Germany.

Photocatalytic hydrophobic concrete coatings to combat air pollution

M. Faraldos^{a,b,*}, R. Kropp^a, M.A. Anderson^{a,c}, K. Sobolev^d

^a Water Science and Engineering Laboratory, University of Wisconsin-Madison, USA

^b Instituto de Catálisis y Petroleoquímica, CSIC, Spain

^c IMDEA Energía, Madrid, Spain

^d University of Wisconsin-Milwaukee, USA

ARTICLE INFO

Article history:

Received 24 March 2015

Received in revised form 27 May 2015

Accepted 15 July 2015

Available online xxx

Keywords:

Concrete

Hydrophobic

Photocatalysis

Self-cleaning

Air pollution

NO_x

Siloxane

ABSTRACT

Several low cost, user-friendly photocatalytic surface coatings were applied to cementitious surfaces and tested as a remediation technique for transportation NO_x emissions and organic pollutants. All of the sols (aqueous suspensions of nanoparticles) coatings showed very high nitrogen oxide (NO) conversion (~90%) and Methylene Blue dye bleaching when applied to concrete surfaces, even when the coatings were extremely thin or diluted, independently on the deposition method (spraying or dip coating). A novel hydrophobic coating based on photocatalyst nanoparticles suspended in a siloxane sealant showed similar conversion at low NO concentrations but required a greater loading of TiO₂. At high NO concentrations the hydrophobic coating was less effective, even at greater TiO₂ loadings, suggesting that the adsorption is the rate limiting step in this conversion process. A threshold of 1% TiO₂ loading in hydrophilic coating and 5% in the case of hydrophobic was needed to obtain a quantitative NO_x conversion. A home-made TiO₂ sol showed lower NO_x photodegradation but a more homogeneous and bonded layer.

© 2015 Elsevier B.V. All rights reserved.

De todas as nanopartículas possíveis de serem utilizadas nos concretos o TiO₂ é o que tem ganhado mais atenção por parte do meio técnico e científico

Research Article

Release of Volatile Compounds from Polymeric Microcapsules Mediated by Photocatalytic Nanoparticles

J. Marques,¹ L. F. Oliveira,¹ R. T. Pinto,¹ P. J. G. Coutinho,¹ P. Parpot,² J. R. Góis,³ J. F. J. Coelho,³ F. D. Magalhães,⁴ and C. J. Tavares¹

¹ Centre of Physics, University of Minho, 4800-058 Guimarães, Portugal

² Centre of Chemistry, University of Minho, 4710-057 Braga, Portugal

³ Chemical Engineering Department, Polo II, University of Coimbra, 3030-790 Coimbra, Portugal

⁴ LEPAE, Chemical Engineering Department, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465 Porto, Portugal

Correspondence should be addressed to C. J. Tavares; ctavares@fisica.uminho.pt

Received 14 January 2013; Accepted 24 January 2013

Academic Editor: Jianguo Yu

Copyright © 2013 J. Marques et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Service Life of Cementitious Photocatalytic Paints Newly Formulated

D. Enea^{1,a}, G. Alaimo^{1,b}, L. Bottalico^{2,c}, T. De Marco^{2,d}

¹University of Palermo – Department of Architecture, Viale delle Scienze, 90128, Palermo, Italy

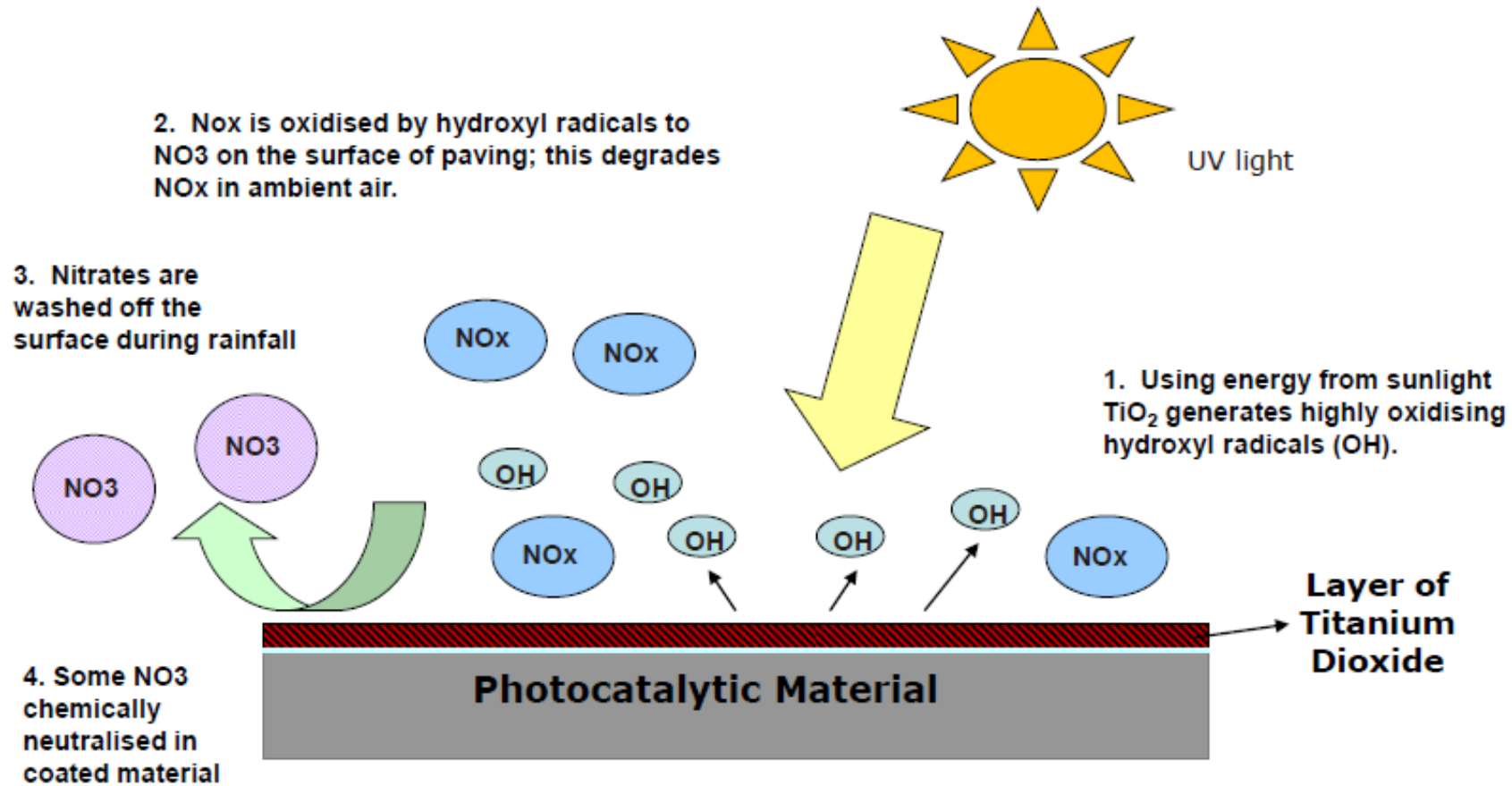
²C.T.G. S.p.A. - Italcementi Group, Bergamo, Italy

^agiuseppe.alaimo@unipa.it, ^bdaniele.enea@unipa.it, ^cl.bottalico@itcgr.net, ^dt.demarco@itcgr.net

Keywords: Durability, Photocatalytic paint, Color, NO_x

Abstract. The use of photocatalytic products for surface coating of buildings contributes to the sustainability of building interventions, due to the reduction of some atmospheric pollutants and self-cleaning attitude. The world market produces a wide range of coatings, applied in limited thickness, transparent and opaque, high initial performance, although data on their durability are still missing. The knowledge of the performance over time of such innovative products is necessary according to the new EU Regulation No. 305/2011, which introduced for construction works, the seventh requirement on their sustainability and particularly their durability. The study concerns the evaluation of the durability of white photocatalytic paint, TX Active® cement-based. The methodology is based on ISO 15686 and consists in monitoring the most significant selected parameters, during laboratory accelerated aging tests and natural environment exposure. Measured performance were the morphological appearance of the surface, the photocatalytic activity and the color. The results obtained demonstrate the efficiency in time and the maintenance of performance of the photocatalytic paint, above limits defined by standards and conservation of color.

How Photocatalytic Materials Work



AGLOMERADOS DE TiO₂

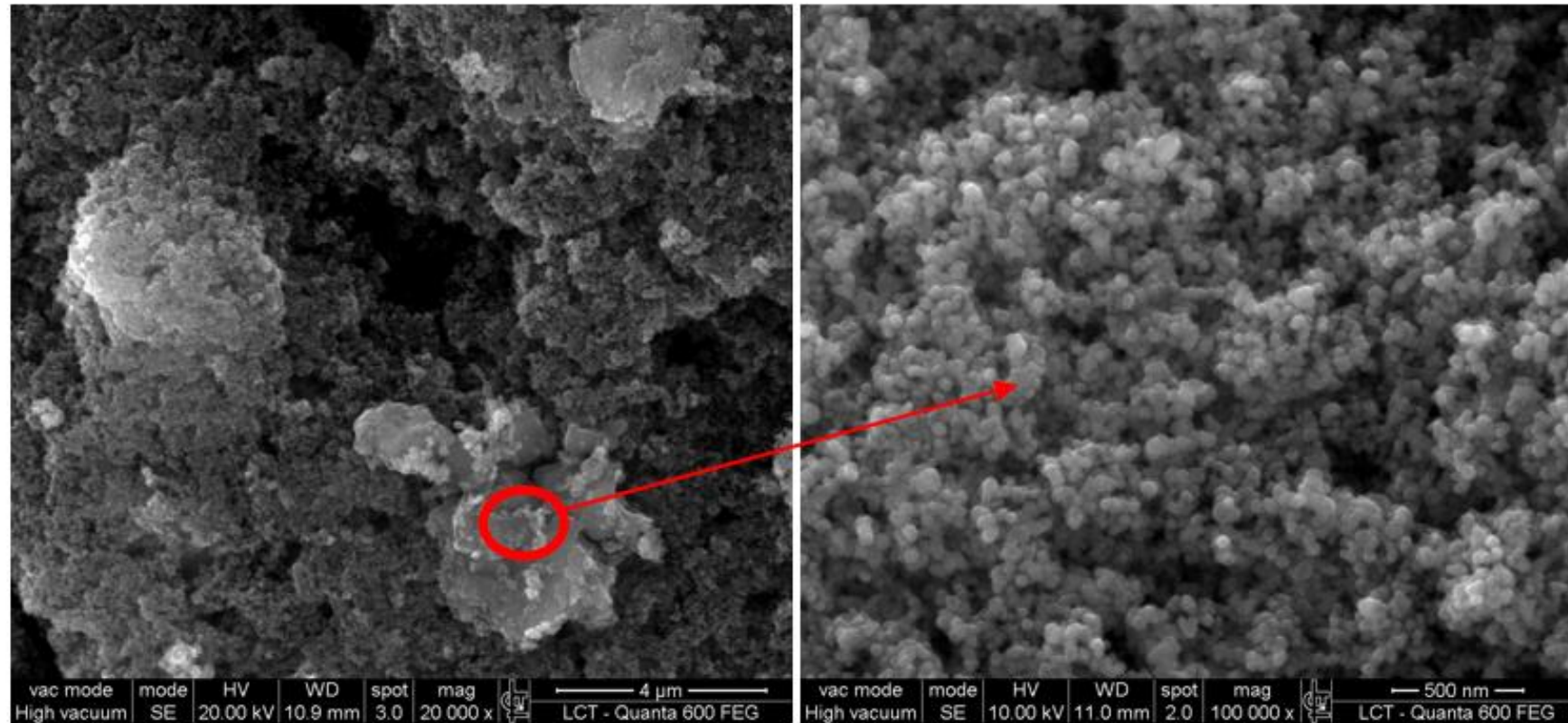
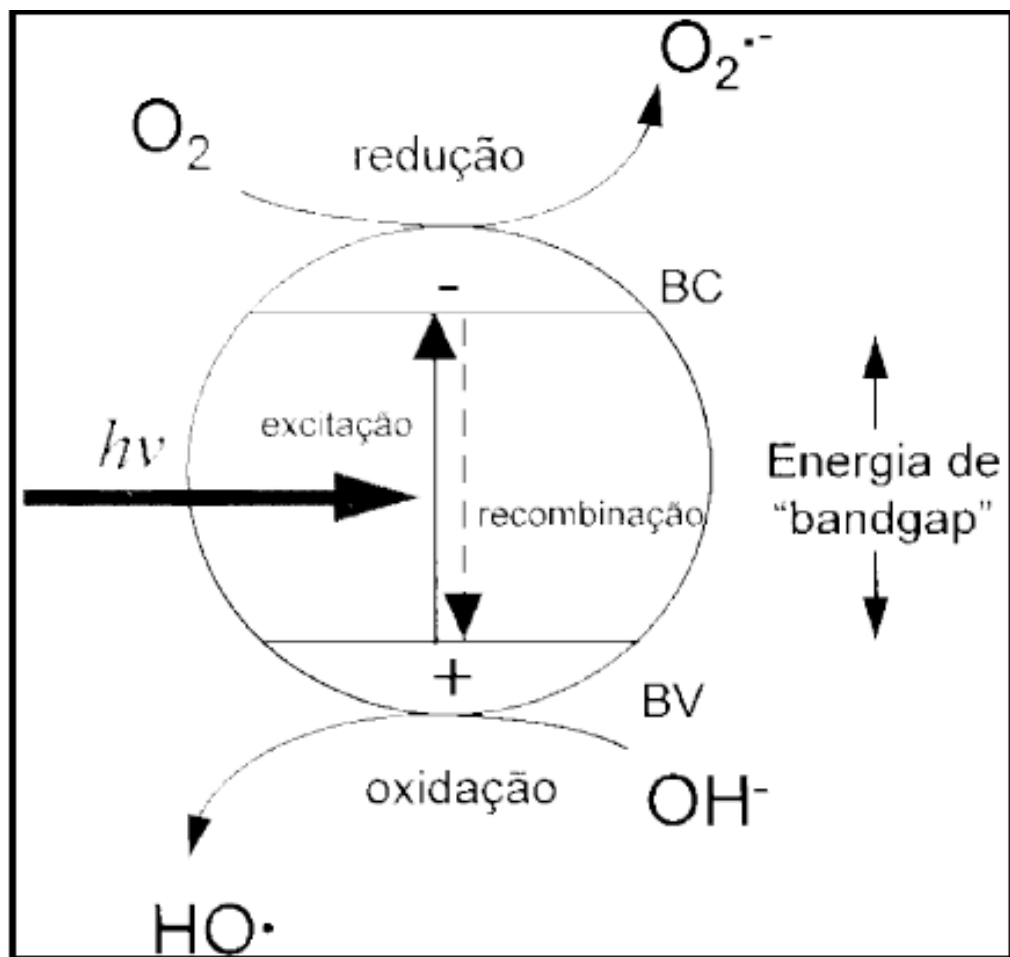


Figure 8: Agglomeration of TiO₂ particles on the composite surface. (a) Magnification of 20.000X and (b) magnification of 100.000x.

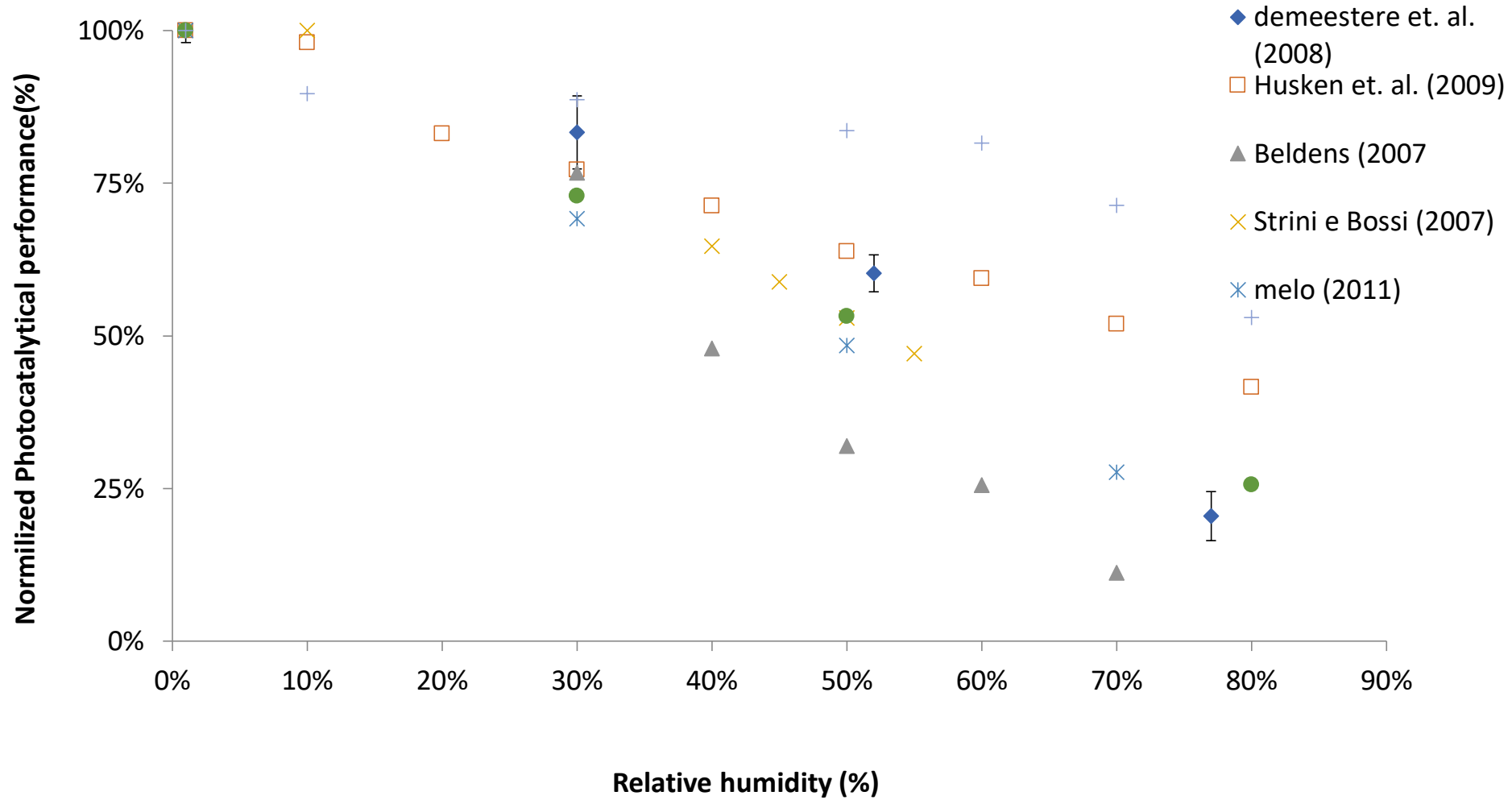
FUNCIONAMENTO DOS SEMICONDUTORES



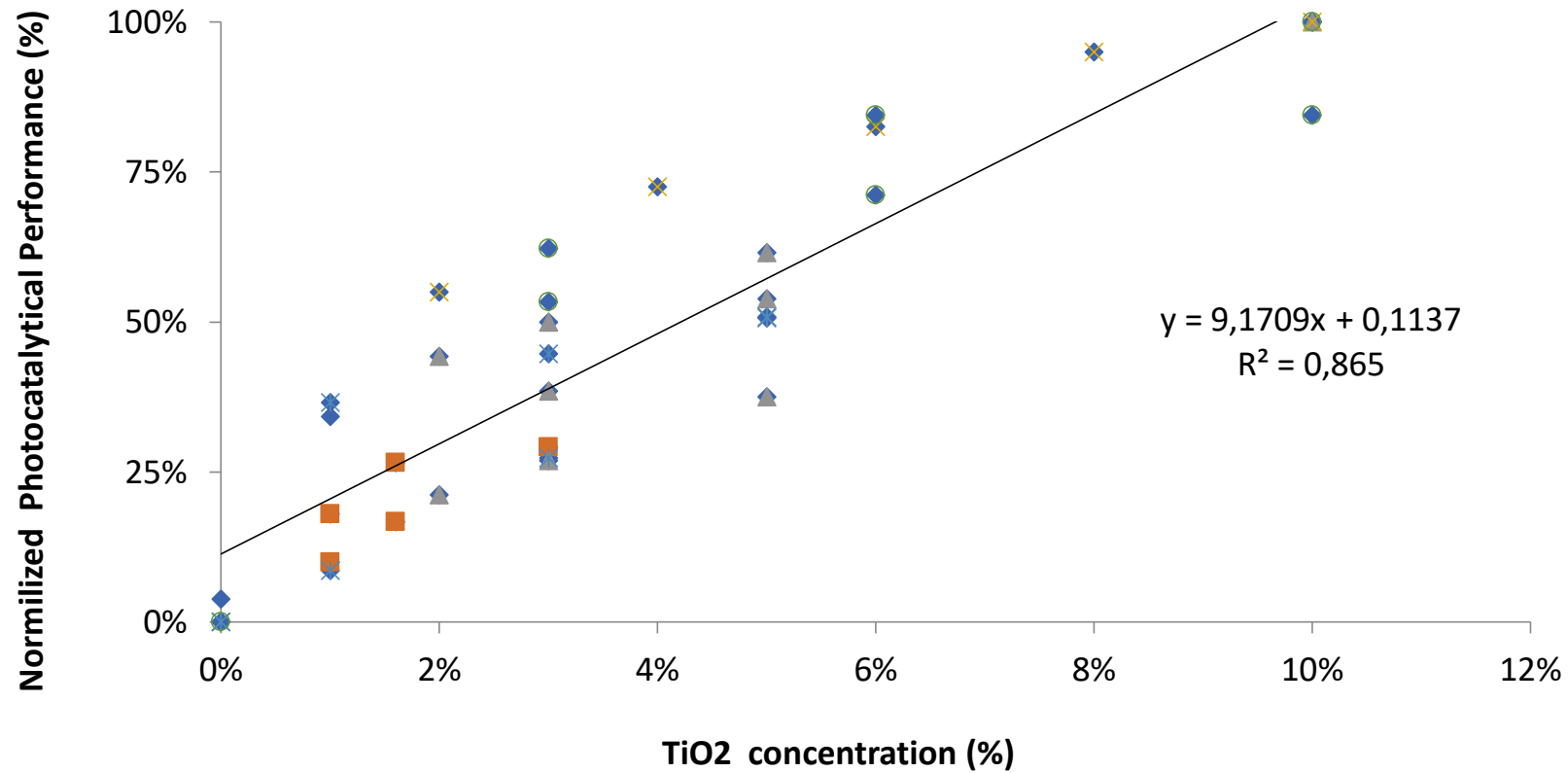
Fonte: Nogueira e Jardim (1998).

Legenda: BV: Banda de Valência e BC: Banda Condutora.

FOTOCATÁLISE COM TIO2

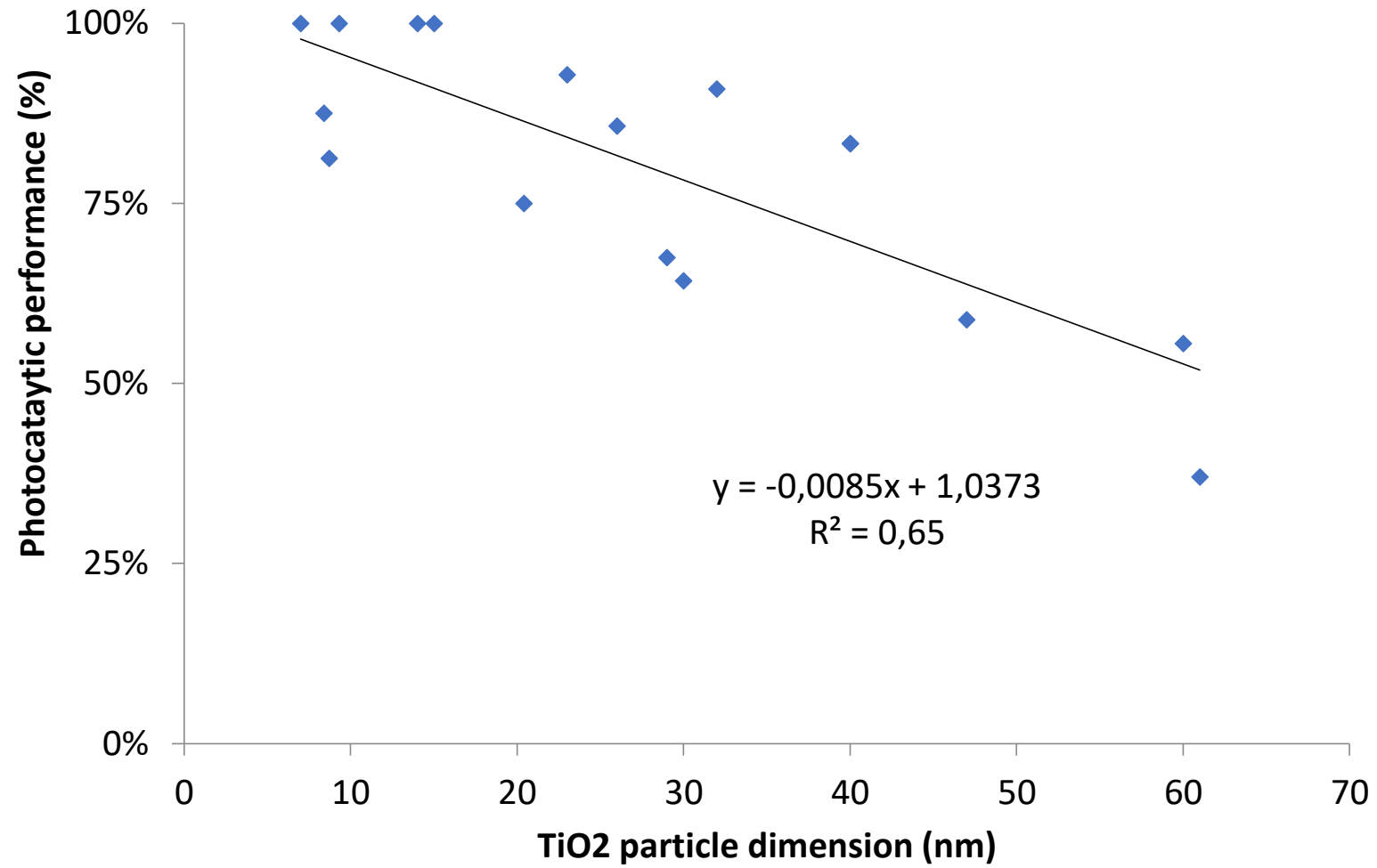


FOTOCATÁLISE COM TiO2



◆ Husken et. al (2009) ▲ Diamanti et. al (2008) × Poon e Cheung (2007) * Ruot et. al. (2009) ○ Melo (2011)

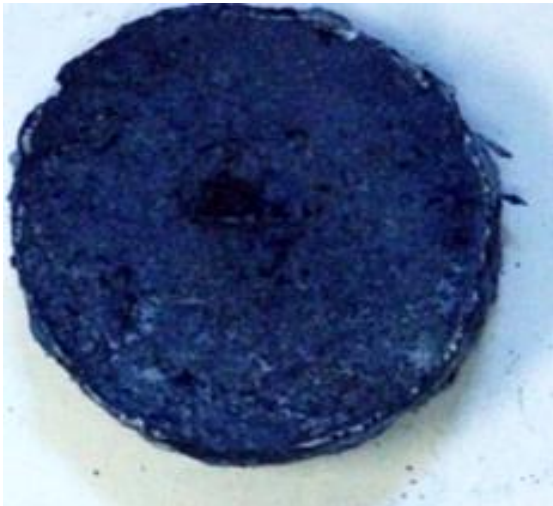
FOTOCATÁLISE COM TIO2



FOTOCATÁLISE COM TIO₂



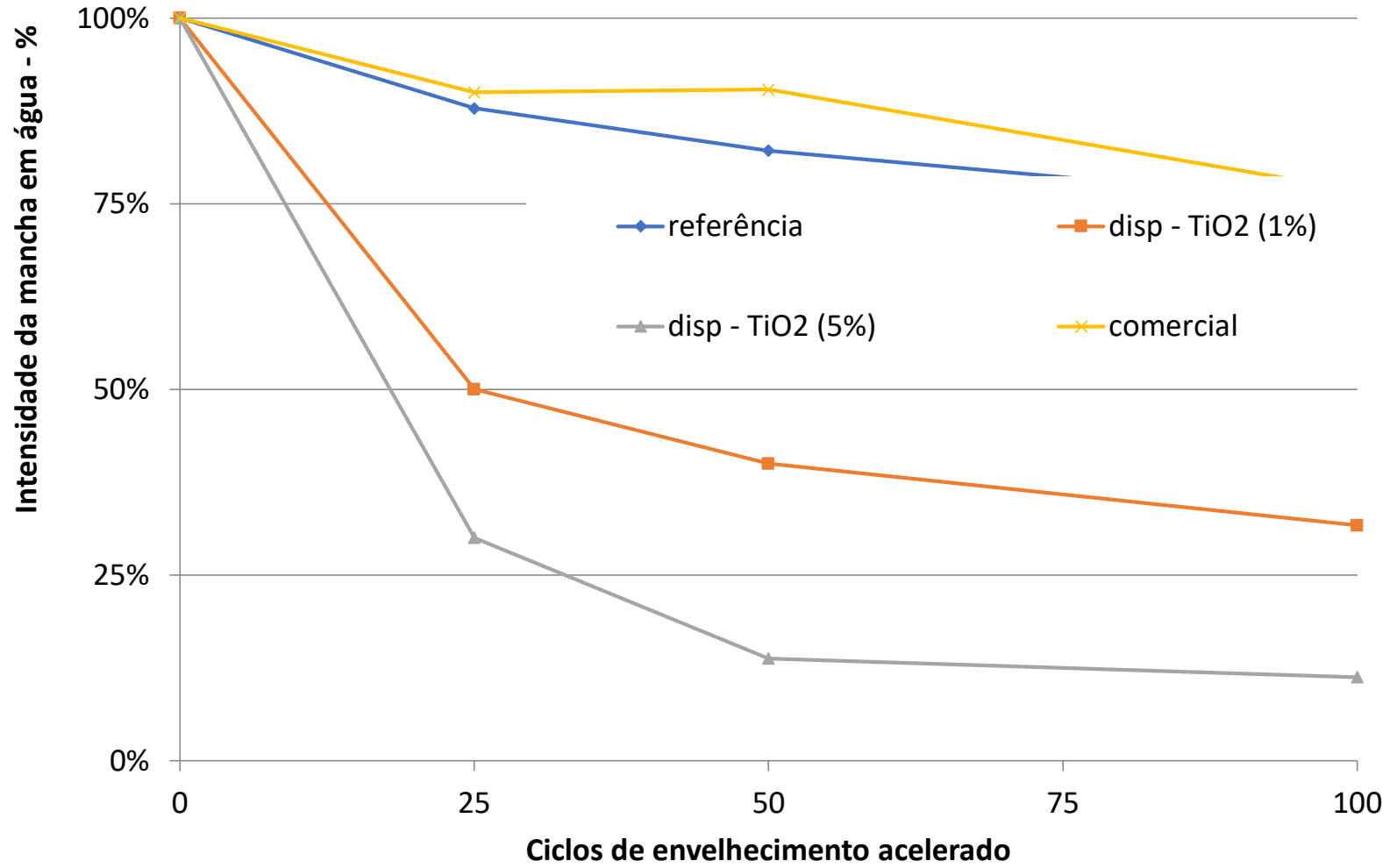
UV + lavagem



UV + lavagem



FOTOCATÁLISE COM TIO2



Autolimpante:

i. Produtos que desempenham mais de uma função



Alexandria Engineering Journal

Available online 21 February 2017

open access

In Press, Corrected Proof



Original Article

Sustainable self-cleaning treatments for architectural facades in developing countries

Ashraf Mansour Habib Mansour ^a, Salam K. Al-Dawery ^b

Show more

<https://doi.org/10.1016/j.aej.2017.01.042>

Get rights and content

Open Access funded by Faculty of Engineering, Alexandria University

Under a Creative Commons license



Uso de nanopartículas

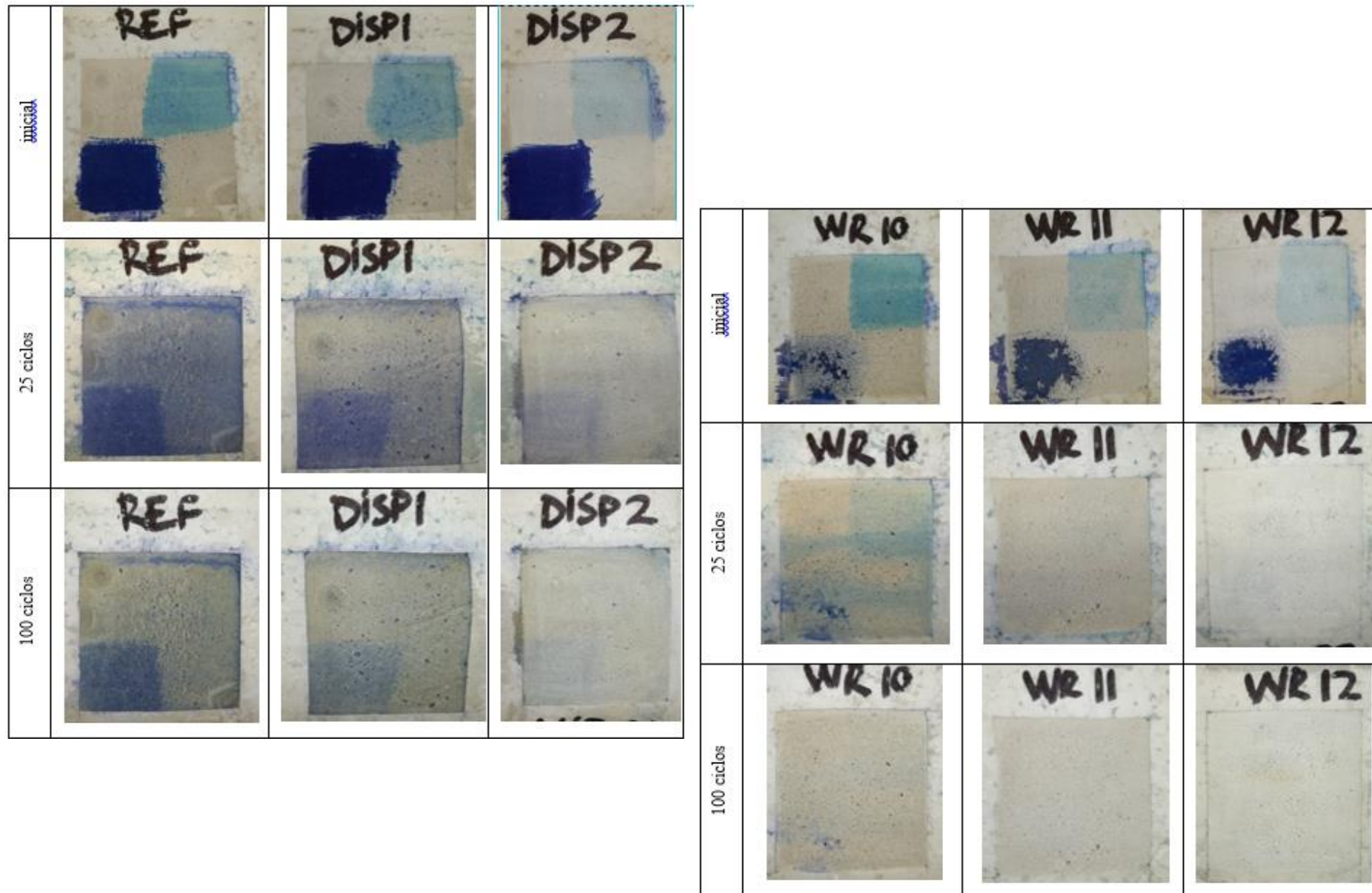
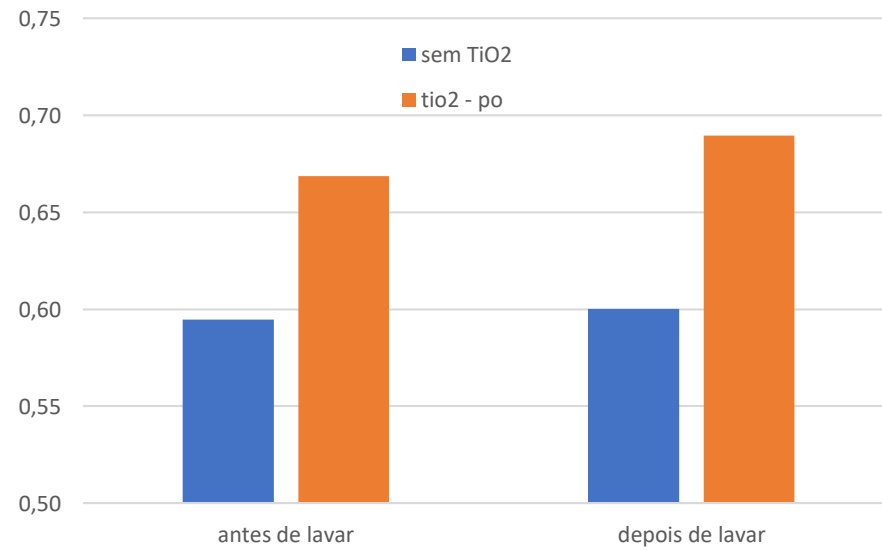
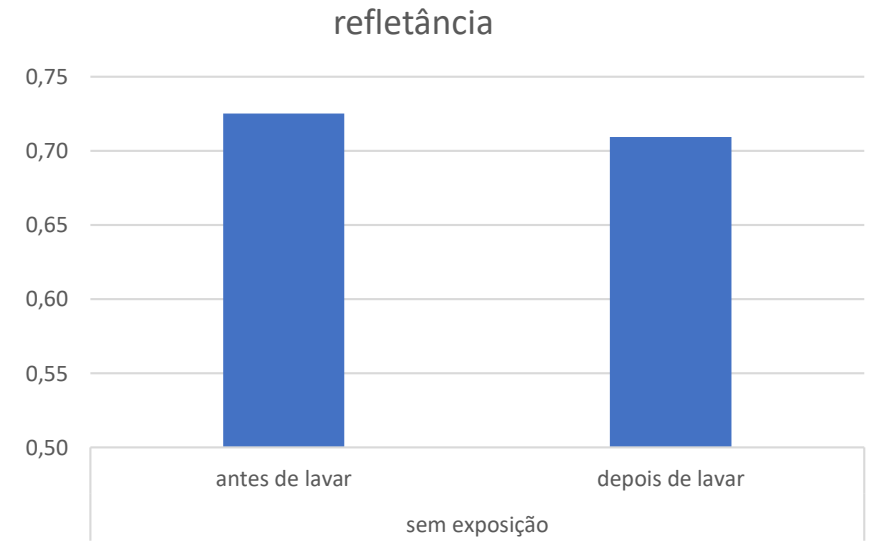


Figura 9: Ilustração da variação de intensidade da mancha ao longo dos ciclos de envelhecimento artificial acelerado em placas novas de corpos de tratados com hidrofueante e TiO₂.

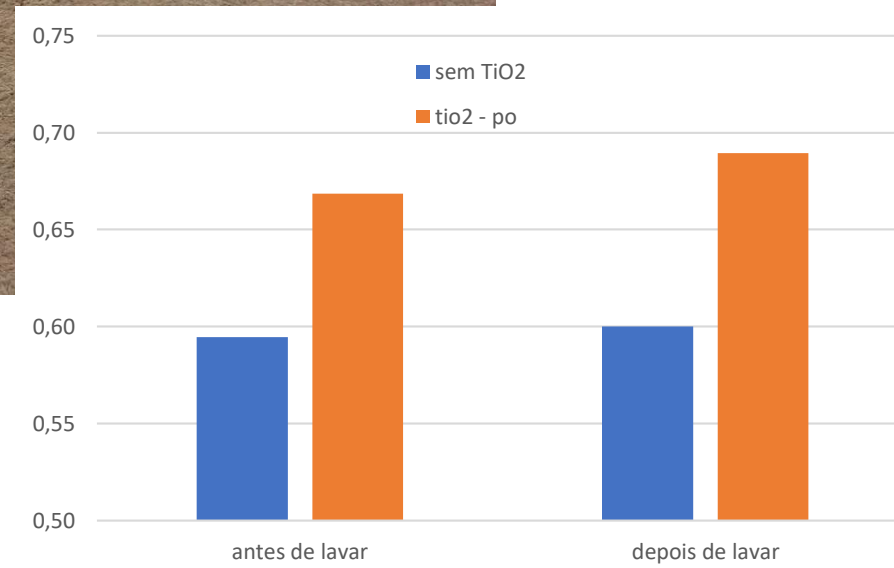
Uso de nanopartículas



Uso de nanopartículas



Uso de nanopartículas

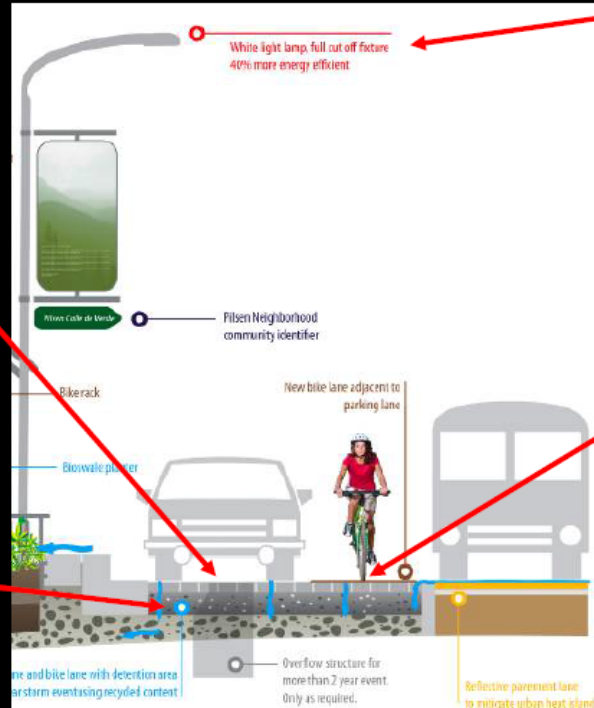


Uso de nanopartículas

Integrated Infrastructure Design Example: Blue Island Cross-section

Photocatalytic
for Air Quality

Permeable
Pavement for
Stormwater
Management



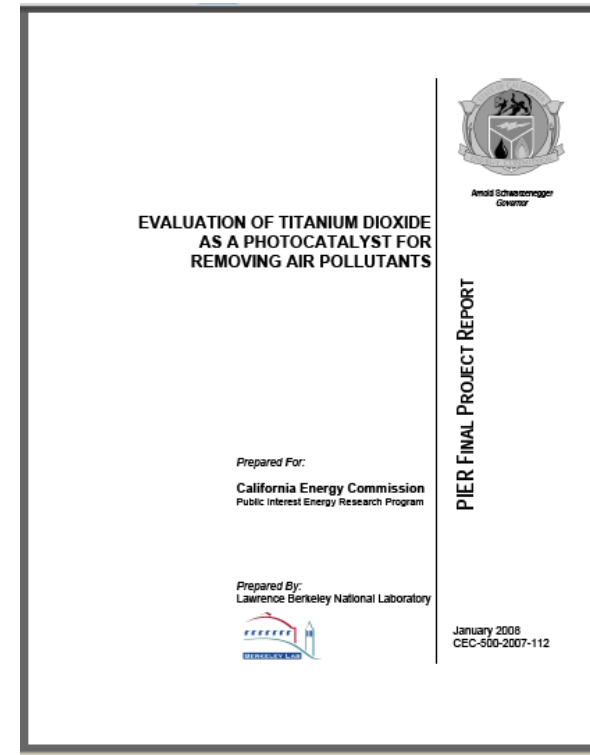
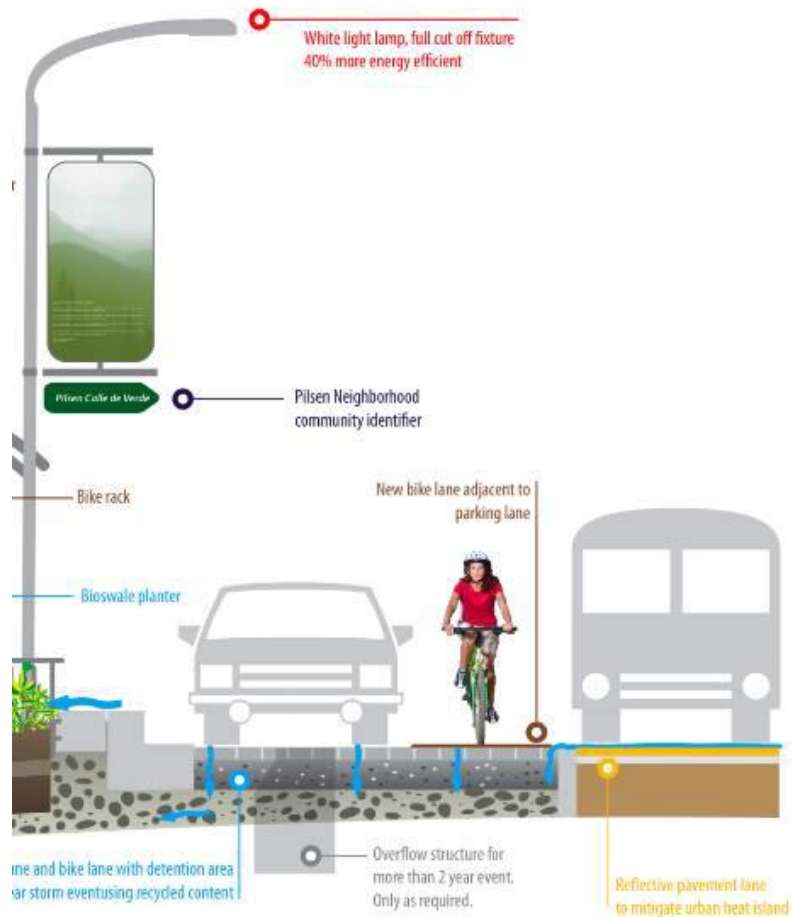
High SRI
for Lighting
and UHI

Bike/
Parking
Lane



Objetivos das inovações na indústria das construções:

- i. Produtos que desempenham mais de uma função
- ii. Redução de impactos



Universidade Estadual de Campinas – 13 a 19 de agosto de 2007

JORNAL DA UNICAMP

Economista cruza dados da Cetesb, do SUS e do Detran para avaliar efeitos das emissões na Grande São Paulo

A relação entre poluição veicular, saúde pública e combustível limpo

LUIZ SUGIMOTO
sugimoto@fotografia.unicamp.br

A viabilização de combustíveis que emitam menos poluentes é o caminho mais rápido para atenuar um sério problema de saúde pública: as doenças respiratórias relacionadas com os resíduos liberados pelos veículos. Esta é uma das constatações de um estudo que associa a emissão dos automóveis da Grande São Paulo com as internações de crianças e idosos dela decorrentes.

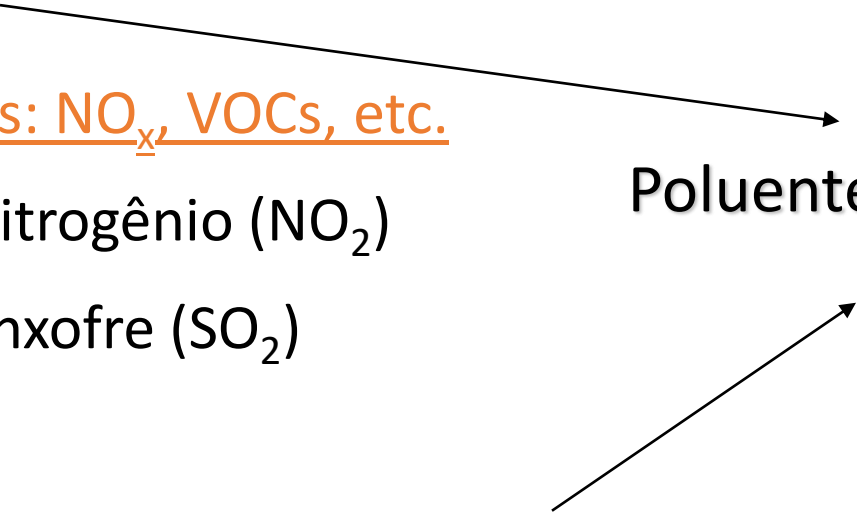
Segundo a economista Gheisa Roberta Telles Esteves, mesmo que a introdução de veículos limpos com zero de emissão (como os movidos a hidrogênio ou a eletricidade) começasse hoje, a substituição total da frota da Região Metropolitana de São Paulo demoraria mais de trinta anos. "Ja houve uma redução importante da poluição



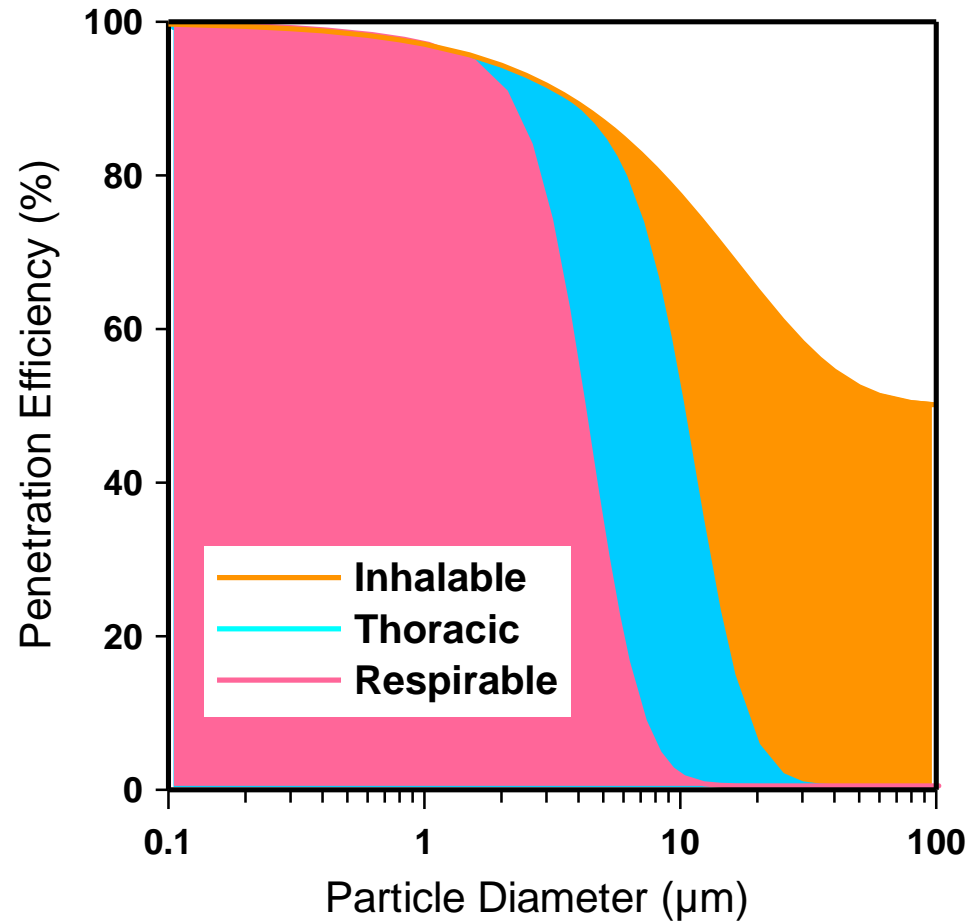
Os efeitos dos poluentes na saúde

Em sua tese de doutorado, Gheisa Esteves conta que o primeiro episódio notificado de mortes e de doenças respiratórias devido a aumentos súbitos da concentração de poluentes atmosféricos ocorreu em 1930, entre as cidades belgas de Huy e Liège, região com muitas indústrias. Um das condições desastrosas foi a ausência de ventos, o que dificultou a dispersão dos poluentes. Londres viveu um episódio similar em

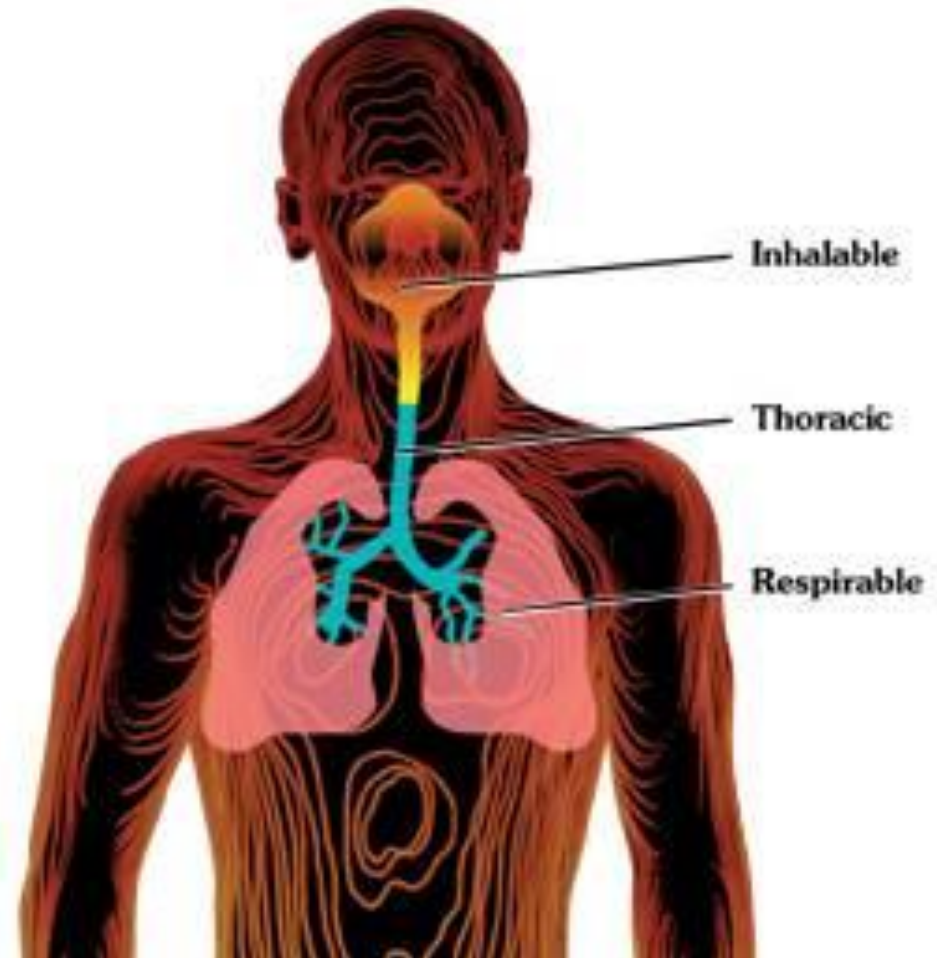
Cenário – Poluentes Importantes

- **Ozone (O_3)**
 - precursoress: NO_x , VOCs, etc.
 - Dióxido de Nitrogênio (NO_2)
 - Dióxido de Enxofre (SO_2)
 - **Material particulado(PM) – $PM_{2.5}$**
 - precurdores: SO_2 , NO_x , NH_3 , VOCs, etc.
 - monóxido de Carbono(CO)
- Poluentes de interesse
- 

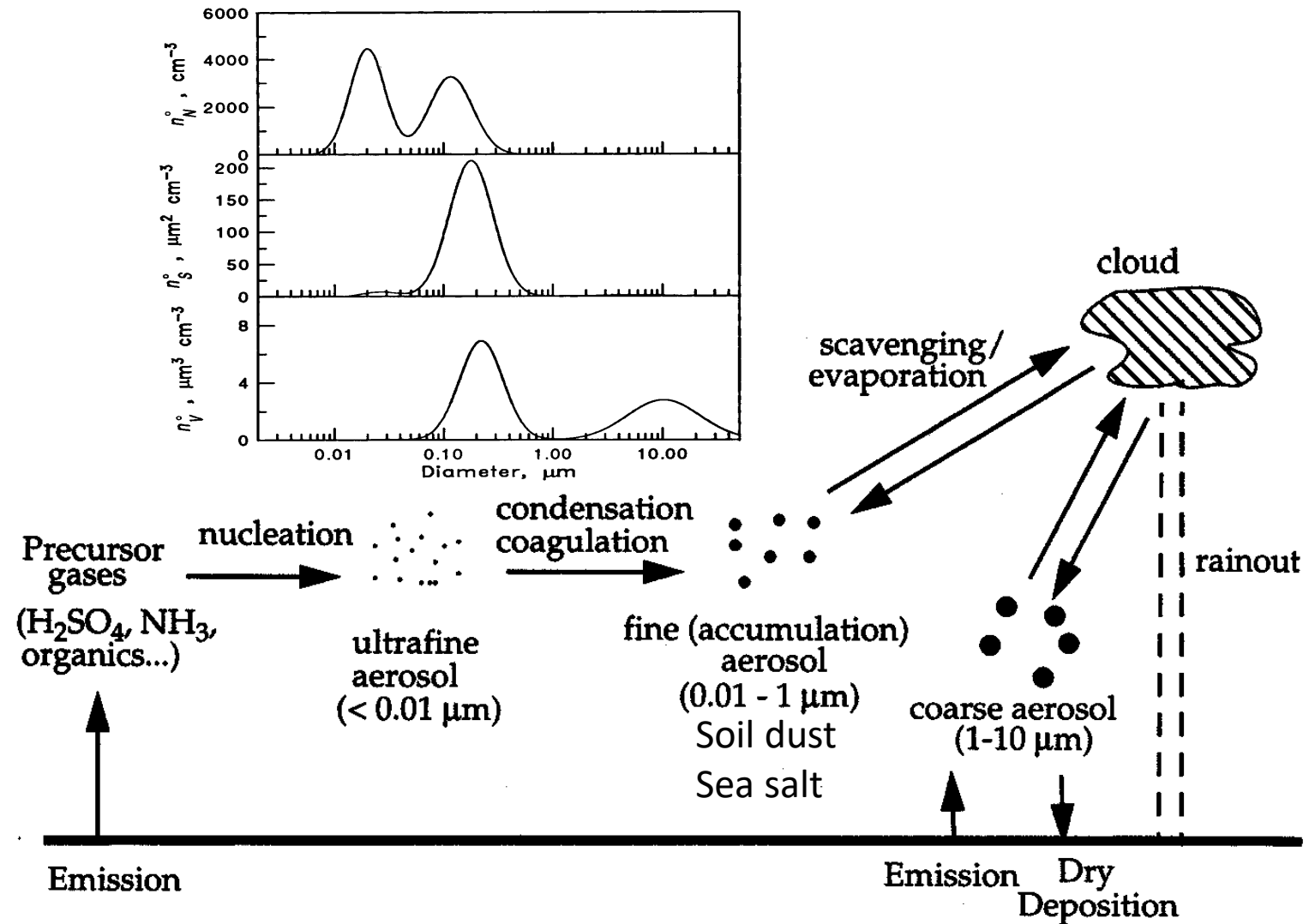
INHALABILITY AND SIZE!



- Total suspended particles (TSP)
- PM_{10} – thoracic particles
- $PM_{2.5}$ – respirable particles



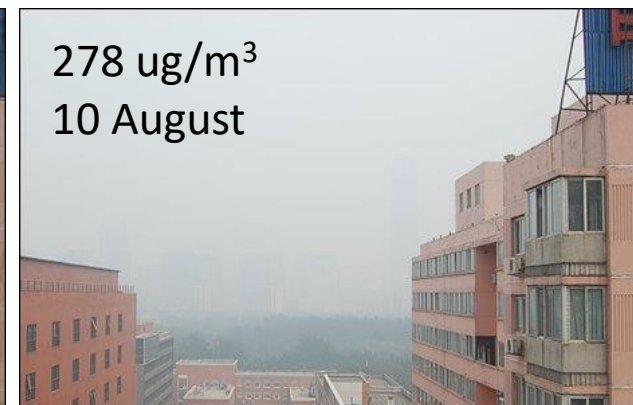
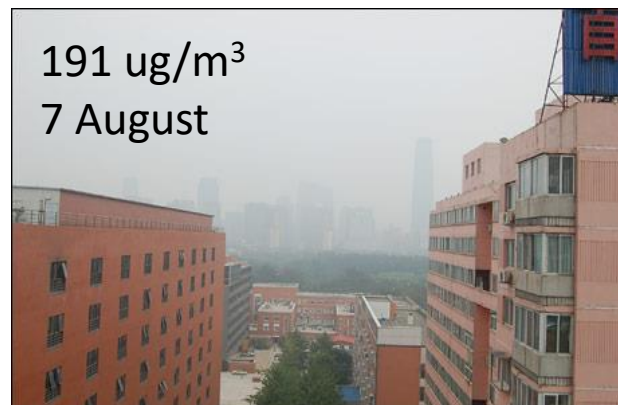
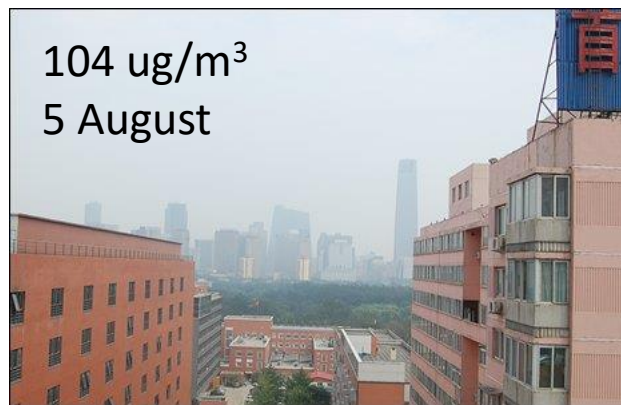
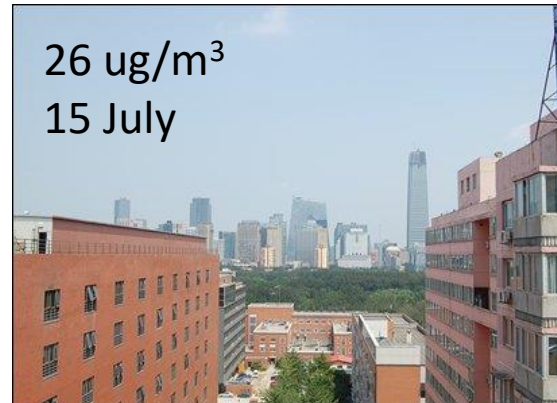
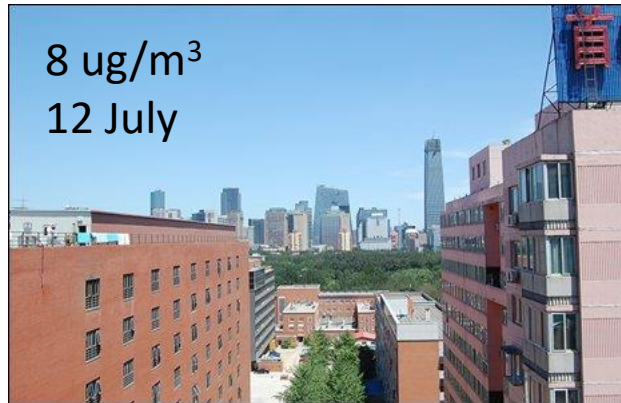
Cenário – Origem dos Poluentes



Environmental importance: health (respiration), visibility, climate, cloud formation, heterogeneous reactions, long-range transport of nutrients...

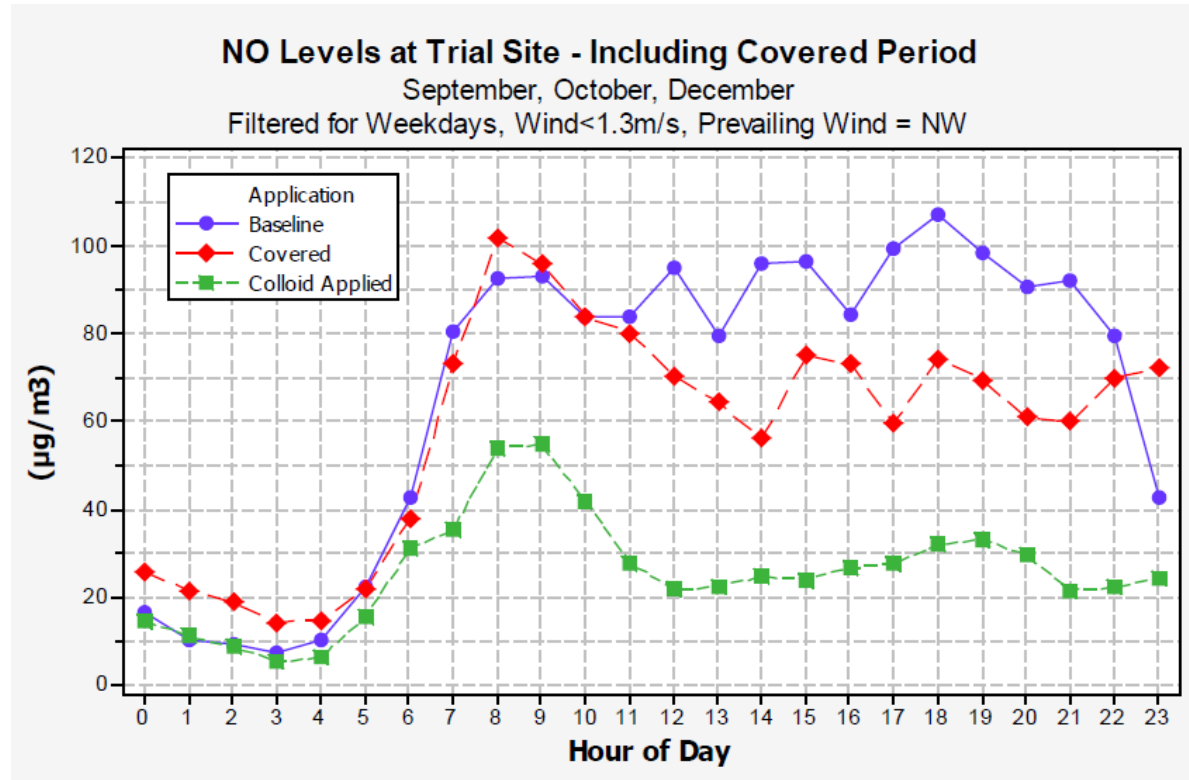
Cenário – Poluentes Importantes

Impacto dos Particulados: PM10 IN BEIJING 2008





Uso de nanopartículas



Study of NO_x-Reducing Coatings by London Borough of Camden

IASPC Conference: Tuesday 22nd June 2010
School of Oriental and African Studies, London.

Gloria Esposito
London Borough of Camden

Dr Benjamin Barratt
Environmental Research Group, King's College London



Gemeente Den Haag

Start innovative air cleaning Koningstunnel



Advanced Solar Photocatalytic Asphalt for Removal of Vehicular NO_x

Wenguang Fan ^a, Ka Yan Chan ^a, Chengxu Zhang ^a, and Michael K.H. Leung ^{a,*}

^aAbility R&D Research Centre, School of Energy and Environment, City University of Hong Kong, Hong Kong, P.R.China

Abstract

Conventional use of solar energy is to convert it into a useful form, e.g. heat or electricity. Alternatively, solar radiation can be used to activate photocatalyst for direct functional photocatalytic applications. In the present research, solar photocatalytic asphalt was developed for removal of vehicular nitrogen oxides (NO_x) to mitigate the roadside air pollution problem. Visible-light activated photocatalytic asphalt was fabricated by embedding carbon-modified titanium dioxide (C-TiO₂) onto asphalt surface under proper heat treatment. Material characterizations were conducted to study the surface and light absorption properties. Chamber tests of NO_x removal were conducted under the conditions that simulated the ambient environment under solar irradiation. The experimental results show that NO_x removal by C-TiO₂ photocatalytic asphalt is viable, and is better than the more commonly used P25. The parametric analysis also reveals that the material fabrication process can be optimized for making photocatalytic asphalt that is highly effective, durable and cost-effective. This study demonstrates successful use of solar radiation via photocatalysis for functional application that can solve environmental problem.

© 2017 The Authors. Published by Elsevier Ltd.

Peer-review under responsibility of the scientific committee of the World Engineers Summit – Applied Energy Symposium & Forum: Low Carbon Cities & Urban Energy Joint Conference.

Keywords: Solar Photocatalysis; Carbon Modified TiO₂ Nanomaterial; Road Construction; Air Pollutant; Surface Modification





ELSEVIER

Building and Environment

Volume 84, January 2015, Pages 125-133



Photocatalytic de-pollution in the Leopold II tunnel in Brussels: NO_x abatement results

M. Gallus ^a, V. Akylas ^b, F. Barmpas ^b, A. Beeldens ^c, E. Boonen ^c, A. Boréave ^d, M. Cazaunau ^e, H. Chen ^e, V. Daële ^e, J.F. Doussin ^f, Y. Dupart ^d, C. Gaimoz ^f, C. George ^d, B. Grosselin ^e, H. Herrmann ^g, S. Ifang ^a, R. Kurtenbach ^a, M. Maille ^f ... J. Kleffmann ^a  

 [Show more](#)

<https://doi.org/10.1016/j.buildenv.2014.10.032>

[Get rights and content](#)

5. Conclusions and perspectives

The European Life+ funded project PhotoPAQ was aimed at demonstrating the possible usefulness of photocatalytic surface coatings for air purification purposes in an urban environment. During the period June 2011–January 2013, three field campaigns were organized in the Leopold II tunnel in Brussels, in which photocatalytic cementitious coating materials were applied on the side walls and ceiling of tunnel test sections of 70 m and 160 m length using artificial UV lighting systems in two of the campaigns. The photocatalytic air remediation of NO_x inside the tunnel section was assessed using averaged campaign data of the NO_x/CO₂ ratio from two measurement sites, up- and downwind of the test section. In addition, three different approaches were used to quantify the photocatalytic remediation, i.e. *before/after* application, *upwind/downwind* of the test section and with UV lamps *on/off*.

In contrast to first estimations based on laboratory data and the only available photocatalytic tunnel study to date, the results indicate no significant reduction of NO_x in the tunnel test section. **As an upper limit a photocatalytic NO_x reduction of ≤2% was observed for the 160 m long active section taking into account the experimental uncertainties.**

What if a cement could fight smog, soil and odours?

Discover the range of **i.active photocatalytic cements** based on the **TX Active** photocatalytic technology patented by Italcementi.

+80 

Deciduous trees*

Coating a surface area of 1,000 m² with TX Active-based products equals to planting 80 deciduous trees

-30 

Petrol-fuelled vehicles

Coating a surface area of 1,000 m² with TX Active-based products equals to eliminating the pollution caused by 30 petrol-fuelled vehicles

-50% 

Pollution

Coating 15% of the surface area of a large city with TX Active-based products ensures a 50% reduction of air pollution

* With an active leaf area of 160 m² each.

Estimated values based on the UFORE Model (Urban Forest Effect) by D.J. Nowak - USDA (United States Department of Agriculture) Forest Service (USA).



i.active is the new performance family of products based on the TX Active photocatalytic technology and featuring depolluting, self-cleaning, bacteriostatic and odour-eliminating properties.



>Depolluting >Self-cleaning >Bacteriostatic >Odour-eliminating



The **i.active** range of Italcementi products includes the following photocatalytic cements: **i.active ULTRA** - high strength Portland cement, and **i.active TECNO** - limestone Portland cement. **i.active** cements are suitable for the formulation of dry ready-mixed products, mortars and concretes, for structural and non-structural applications, cast-in-place or prefabricated elements. They endow built structures with the ability to purify the air, maintain their aesthetic



Fighting smog

i.active cements actively fight pollution. Through the combined action of light and the TX Active photocatalytic technology, **i.active** cements decompose the pollutants produced by daily activities (factories, traffic, domestic heating) resulting in better air quality. Building with **i.active** cements helps significantly to improve quality of life in urban areas, and is particularly useful in tunnels and similar structures that are difficult to ventilate.

Fighting soil

Surfaces made of **i.active** cements are brighter, cleaner, and have a lasting aesthetic quality. Recent tests performed at the University of Ghent (Belgium) demonstrated that photocatalytic surfaces built using products based on **i.active** cements are able to decompose the microorganisms that corrode the surfaces, inhibit the build-up and proliferation of algae, and prevent the consequent surface deterioration.

Fighting bacteria

Laboratory tests conducted according to standard UNI 11021:2002 have certified that the growth of microorganisms (*Aspergillus Niger Penicillium sp.*, *Paecilomyces fulvum*) is inhibited on products based on **i.active** cement. **i.active** cements help to maintain healthier, better sterilized environment, ideal for hospital settings.

Fighting bad odours

Products based on **i.active** cements foster the decomposition of inorganic compounds (NOx) and volatile organic compounds (VOCs), including aromatic hydrocarbons. For example, they can reduce tobacco and solvent smells, cooking odours and odours due to the presence of other hydrocarbons in the air. Moreover, their positive effect on bioeffluents (chemicals emitted by the human body) makes **i.active** cements especially suitable for gyms and sports centres. The final effect is an improvement in perceived air quality, particularly notable in confined spaces.

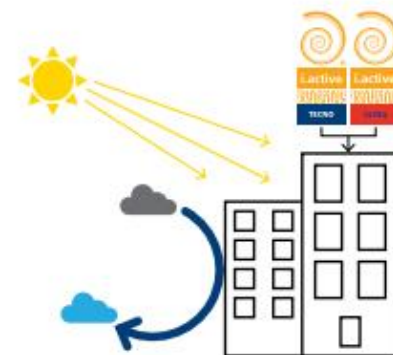
What is TX Active?



TX Active is the photocatalytic technology for cementitious materials patented by Italcementi. Mortars, paints, plasters and floors made with TX Active-based products are able to significantly reduce organic and inorganic polluting agents in urban air while preserving the aesthetic quality of buildings. With its depolluting, bacteriostatic and odour-eliminating properties, it is a quality seal for photoactive cementitious products developed to improve life in our cities.

How does it work?

Photocatalysis is a natural process in which a substance - called photocatalyst - uses natural or artificial light to activate a strong oxidizing process that results in the transformation of organic and inorganic substances into harmless compounds. Thus, TX Active acts as an accelerator of oxidizing processes that already exists in nature; it promotes faster decomposition of pollutants and prevents their build-up on surfaces.



The **i.active** family includes only a few of the many products created by Italcementi Group's continued commitment to developing innovative solutions for architecture and the construction industry. For further

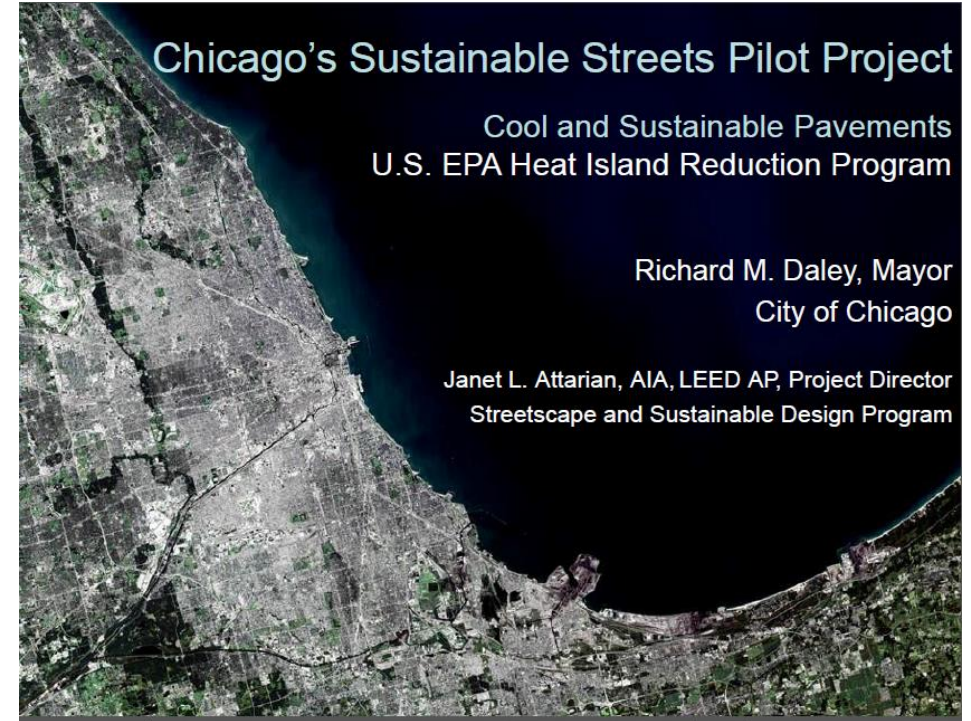
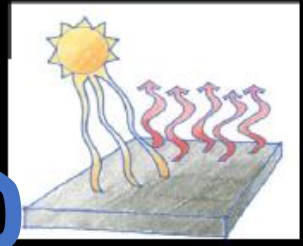
Drivers das Inovações na Construção Civil:

- Qual é o problema existe? *Manutenção frequente/envelhecimento*
- Quais as possibilidades? *Hidrofugante, hidrofílico*
- Quem é o cliente? *Não tão claro*
- O que é valor para o cliente? *desempenho*
- *Qual o desafio? Validação / convencimento*

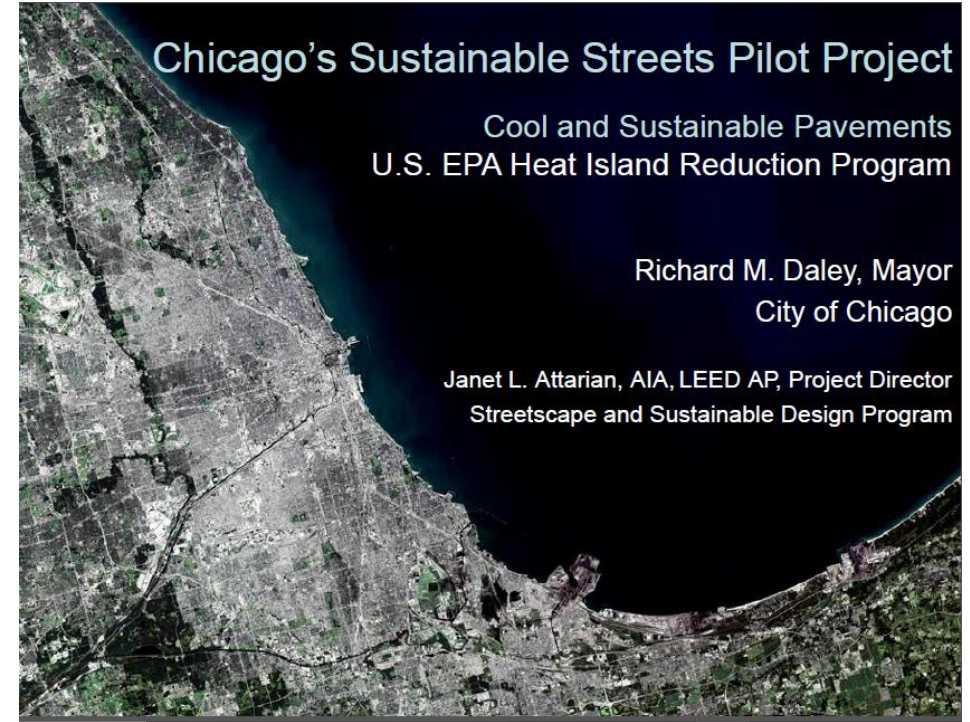
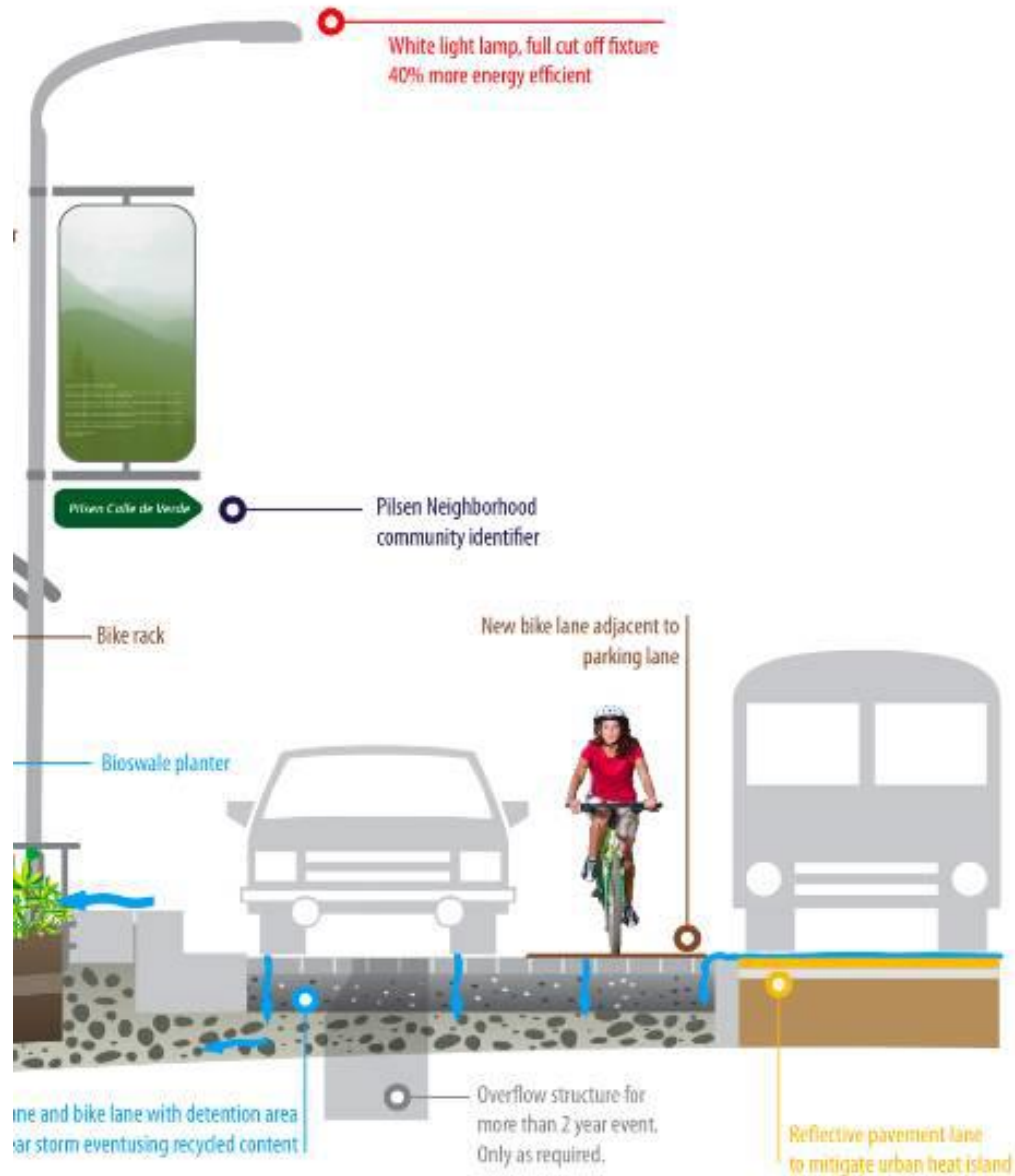
RUAS DO FUTURO

How Complete is your Street?

- Energy Efficiency
- Waste Management
- Air Quality
- Site Selection
- Beauty and Community
- Urban Heat Island
- Stormwater Management
- Water Efficiency
- Alternative Transportation
- Education



Sustainable Street



Ruas do Futuro - Integrando soluções!



Pensando as rua para às pessoas!

Cenário – ilhas de calor

vulnerabilidade das
MEGACIDADES
brasileiras às mudanças climáticas

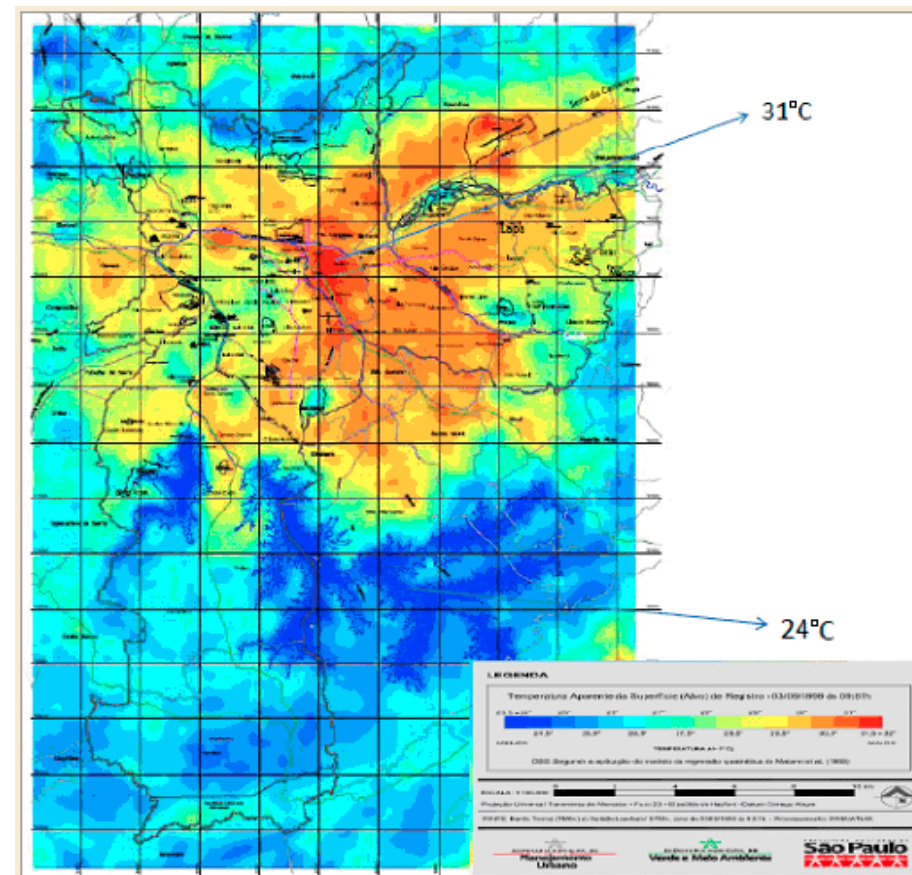
São Paulo | Rio de Janeiro | Ho

Tendências climáticas de longo prazo detectadas na Região Metropolitana de São Paulo (RMSP)

São Paulo

Vários estudos já têm detectado um aumento na intensidade e na frequência de dias com chuva intensa no sudeste da América do Sul, desde o centro da Argentina até o Centro-Oeste e Sudeste do Brasil. Tendências positivas no número de dias com chuva intensa e muito intensa, concentrada em curto período de tempo e na quantidade de eventos chuvosos que podem gerar enchentes e deslizamentos de terra em áreas de encosta, têm sido detectadas desde a década de 1990 (XAVIER et al 1994, CARVALHO et al 2002, MARENGO et al 2009c, HAYLOCK et al 2006, ALEXANDER et al 2007). Xavier et al (1994) analisaram a variabilidade da chuva na RMSP de 1933-1986, apresentando de fato um aumento na intensidade da chuva em fevereiro e maio. Estudos recentes de Haylock et al. (2006), Dufek e Ambrizzi (2007) e Marengo et al (2009 a, b, c) identificaram tendências para condições mais úmidas no sudeste do Brasil sob a forma de um aumento na intensidade e frequência de dias com chuva intensa durante os últimos 50 anos, que se estende a toda a região Sudeste e Sul do Brasil.

Existências de ilhas de calor nas zonas mais adensadas das cidades



http://megacidades.ccst.inpe.br/sao_paulo/VRMSP/capitulo4.php

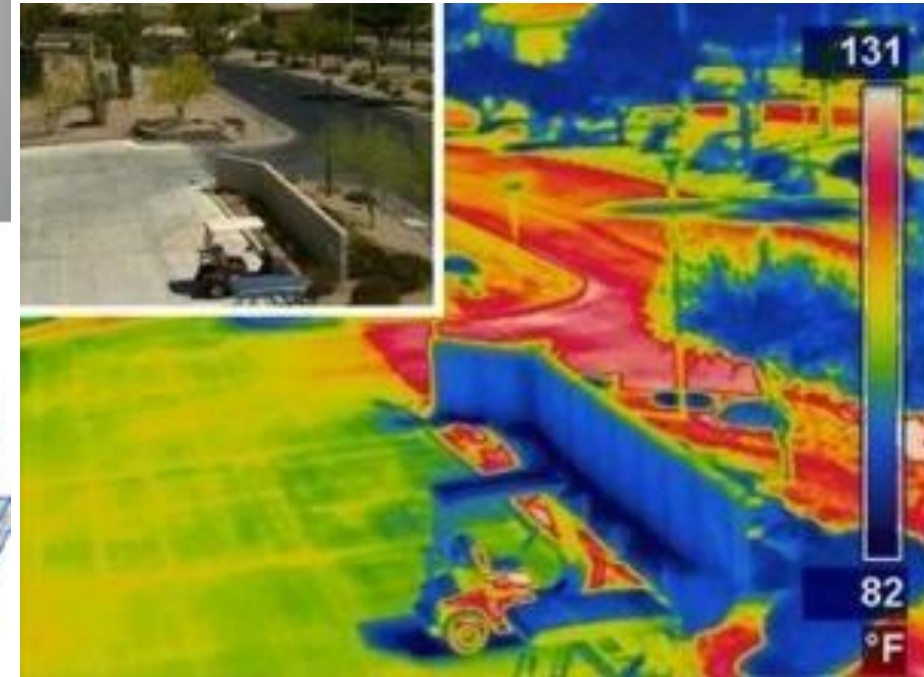
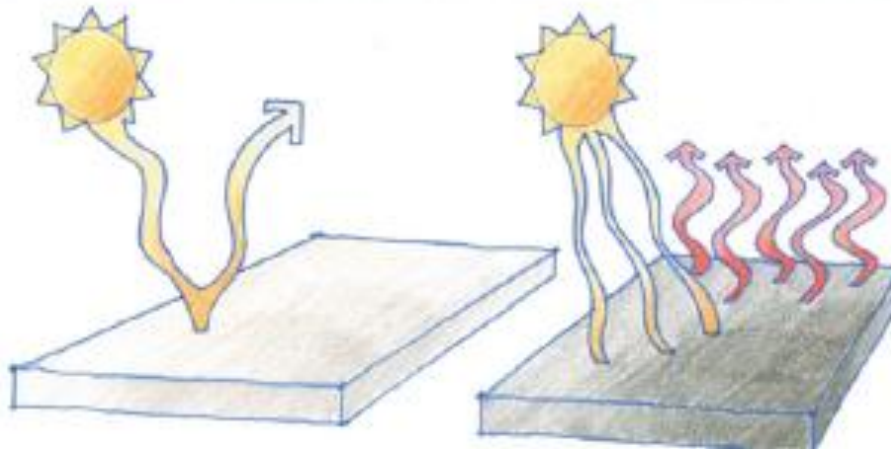
Fonte: Atlas Ambiental de São Paulo - (Prefeitura de São Paulo 2002), observações feitas no dia 03/set./1999, às 09:57.

✓ Pavimentos refletivos para diminuir ilhas de calor



Pavimento refletivos:

- Micro overlay com concreto
- Pavimento Intertravado



Cenário – ilhas de calor

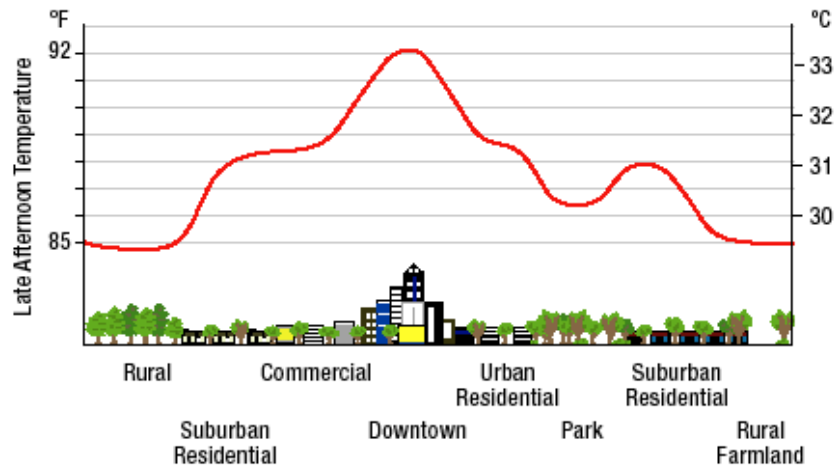
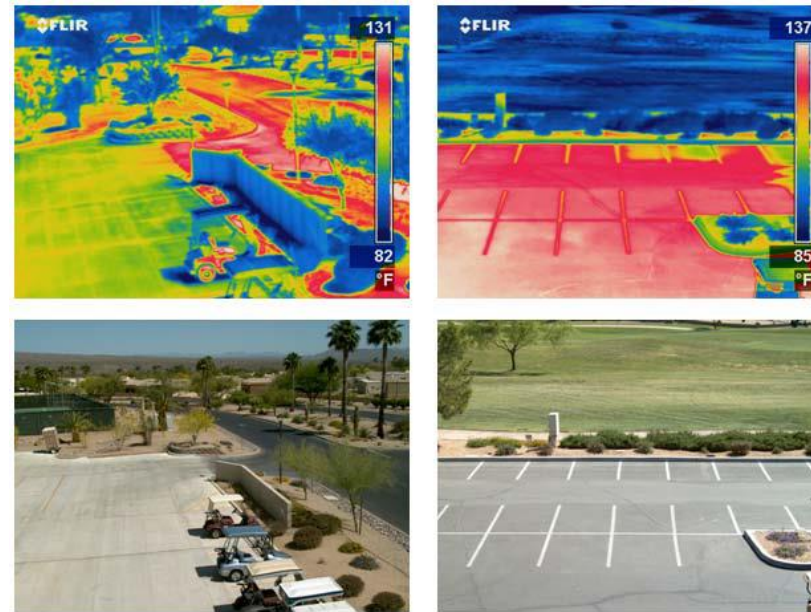
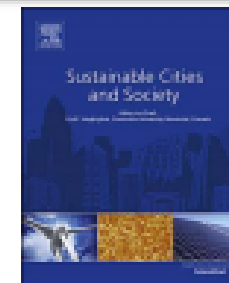


Figure 3.6: Urban heat island profile
(Source: Urban Heat Islands <http://eetd.lbl.gov/HeatIsland/>)



Tipo de pavimento	SRI – novo	SRI- envelhecido
Asfalto	0.05-0.10	0.10-0.15
Concreto simples	0.35-0.40	0.20-0.30
Concreto branco	0.70-0.80	0.46-0.60
Tinta acrílica branca	0.80-0.85	0.60-0.75



Cool roofs and cool pavements application in Acharnes, Greece

Dionysia – Denia Kolokotsa^{a,*}, Gerassimos Giannariakis^a, Kostas Gobakis^a, Giannis Giannarakis^b,
Afroditi Synnefa^c, Mat Santamouris^c



^a *Energy Management in the Built Environment Laboratory, Technical University of Crete Kounoupidiana, GR 73100 Chania, Greece*

^b *Section of Environmental Physics and Meteorology Group Building Environmental Studies Physics Department University of Athens, Athens Greece*

^c *Faculty of the Built Environment, University of NEW south Wales, Sydney, Australia*

ARTICLE INFO

Keywords:

Cool roofs

Cool pavements

Energy efficiency

Thermal comfort

ABSTRACT

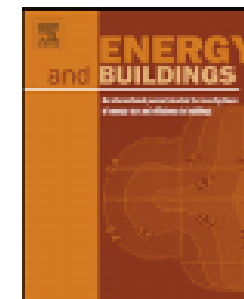
The continuously increasing urban temperature results to the well-known urban heat island phenomenon. Cool roofs and cool pavements are very promising mitigation techniques as they can be easily applied to new and existing buildings as well as urban spaces. In the present paper, the application of cool materials in the urban region of Acharnes municipality in Greece is described. Cool roofs in the form of ceiling tiles are installed on the rooftop of the municipality building while cool paving stones are used to replace conventional pavements. A series of monitoring activities are performed for the building and the urban region. Measurements of the outdoor meteorological conditions, the indoor thermal comfort of the case study building, the surface temperature of the roofs and pavements as well as thermal imaging are exploited for the analysis of the cool roofs and cool pavements' performance. Thermal models using EnergyPlus and Envi-met are developed for the analysis of the cool roofs and cool pavements respectively. The overall study showed that the application of cool roofs results to 17% reduction in the annual cooling demand for the case study building while the surface temperature of the urban pavements is reduced by almost 10 K.



Contents lists available at SciVerse ScienceDirect

Energy and Buildings

journal homepage: www.elsevier.com/locate/enbuild



Global cooling updates: Reflective roofs and pavements

Maslem Akbari*, H. Damon Matthews

at Island Group, Concordia University, Montreal, Canada

ARTICLE INFO

Keywords:
 heat island
 cool roofs
 cool pavements
 global cooling
 energy savings
 policies

ABSTRACT

With increasing the solar reflectance of urban surfaces, the outflow of short-wave solar radiation increases, less solar heat energy is absorbed leading to lower surface temperatures and reduced outflow of thermal radiation into the atmosphere. This process of “negative radiative forcing” effectively counters global warming. Cool roofs also reduce cooling-energy use in air conditioned buildings and increase comfort in unconditioned buildings; and cool roofs and cool pavements mitigate summer urban heat islands, improving outdoor air quality and comfort. Installing cool roofs and cool pavements in cities worldwide is a compelling win–win–win activity that can be undertaken immediately, outside of international negotiations to cap CO₂ emissions. We review the status of cool roof and cool pavements technologies, policies, and programs in the U.S., Europe, and Asia. We propose an international campaign to use solar reflective materials when roofs and pavements are built or resurfaced in temperate and tropical regions.

✓ Pavimentos permeáveis em calçadas, áreas de estacionamento e de tráfego leve



✓ Pavimentos permeáveis em calçadas, áreas de estacionamento e de tráfego leve



Produto com maior potencial para dar certo

Drivers das Inovações na Construção Civil:

- Aumento de Produtividade
- Melhora de desempenho/durabilidade
- Incorporação de outras funções
- Redução de impactos e aumento da sustentabilidade

Execução de estruturas de concreto armado



Fôrmas



Armadura



concretagem

Fibras de aço para concretos

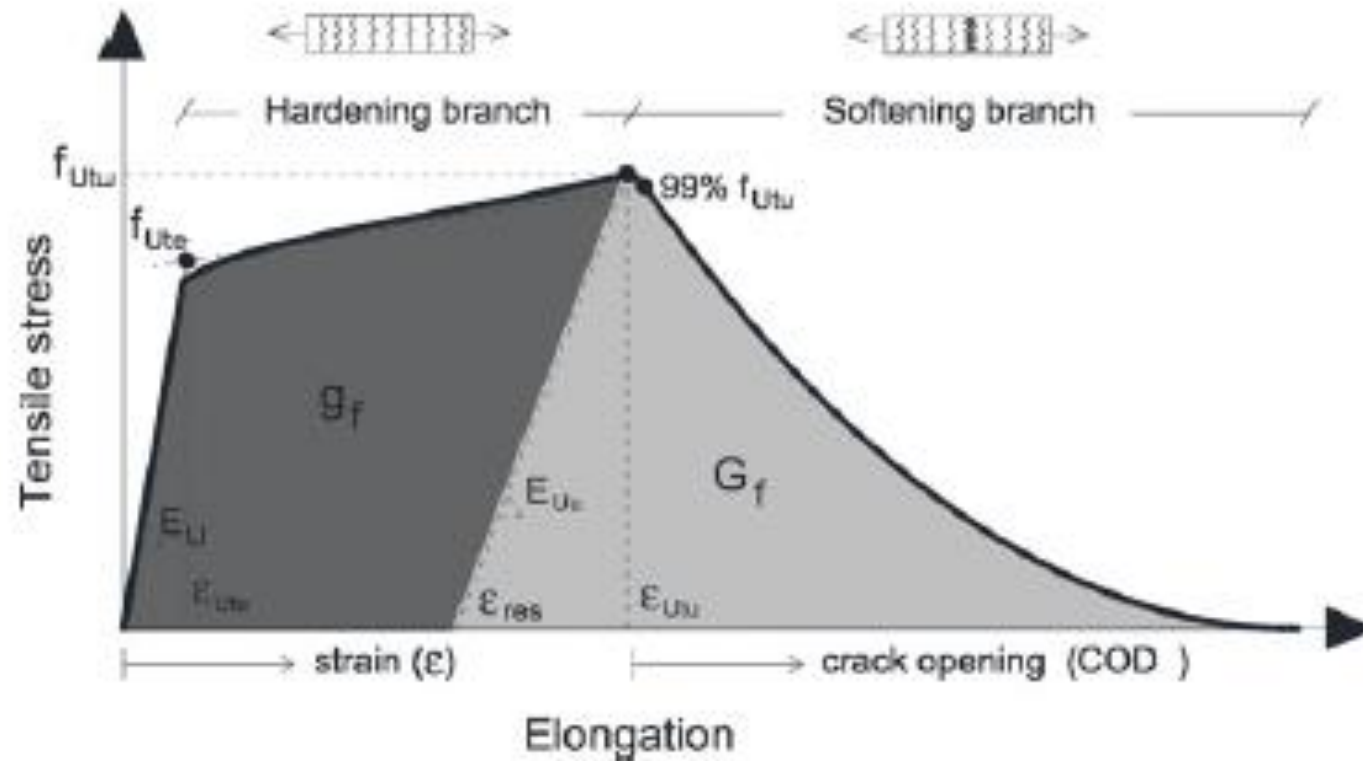


Fig. 1. Schematic representation of the tensile behaviour of UHPFRC exhibiting strain hardening in tension.

Fibras de aço para concretos

Cement and Concrete Composites 80 (2017) 342–355



Contents lists available at ScienceDirect

Cement and Concrete Composites

journal homepage: www.elsevier.com/locate/cemconcomp



Magnetic orientation of steel fibres in self-compacting concrete beams: Effect on failure behaviour



M.J.H. Wijffels, R.J.M. Wolfs, A.S.J. Suiker*, T.A.M. Salet

Eindhoven University of Technology, Department of the Built Environment, P.O. Box 513, NL-5600 MB, Eindhoven, The Netherlands

ARTICLE INFO

Article history:

Received 10 June 2016

Received in revised form

3 April 2017

Accepted 10 April 2017

Available online 13 April 2017

Keywords:

Fibre orientation

Steel fibre reinforced concrete

Fibre bridging

Energy absorption capacity

Electromagnetic coil

3D printing of concrete

ABSTRACT

The magnetic orientation of steel fibres in transparent silicone oil and in fresh, self-compacting concrete (SCC) beams is studied experimentally. The effect of the generated fibre locations and orientations on the failure response of the SCC beams is determined by means of three-point bend tests. A relatively small coil was designed for the magnetic orientation of single and multiple fibres in the transparent silicone oil. The time required for orienting a single fibre was measured for a range of magnetic fluxes, which showed to strongly decrease with increasing magnetic field strength. The presence of gravel on the fibre orientation behaviour was considered in order to mimic the influence by a concrete aggregate, indicating that the gravel does not prevent rotations and chain formations of fibres. A larger coil was developed for the magnetic orientation of fibres in freshly casted SCC beams. The energy absorption capacity of SCC beams subjected to three-point bending scales approximately proportionally with the number of “well-oriented fibres” bridging the catastrophic failure crack, which emphasizes the importance of adequately orienting steel fibres with the magnetic orientation technique.

© 2017 Elsevier Ltd. All rights reserved.

Cement and Concrete Research 97 (2017) 28–40



Contents lists available at ScienceDirect

Cement and Concrete Research

journal homepage: www.elsevier.com/locate/cemconres



Influence of fibre orientation on the tensile behaviour of ultra-high performance fibre reinforced cementitious composites



Amin Abrishambaf, Mário Pimentel*, Sandra Nunes

CONSTRUCT-LABEST, Faculty of Engineering (FEUP), University of Porto, Portugal

ARTICLE INFO

Article history:

Received 4 January 2017

Received in revised form 21 March 2017

Accepted 23 March 2017

Available online 1 April 2017

Keywords:

Ultra high performance fibre reinforced cementitious composites (UHPRFC)

Fibre orientation

Tensile behaviour

Hardening

Uniaxial tensile test

ABSTRACT

The main objective of this study is to quantify the effect of fibre orientation on the tensile behaviour of Ultra-High Performance Fibre-Reinforced Cementitious Composites (UHPRFC). A strategy to align the steel fibres within the matrix based on the activation of an external magnetic field while casting is adopted to achieve a wide range of fibre orientation profiles. The uniaxial tensile test is used for determining the tensile stress-elongation curves of 22 specimens and the quantitative evaluation of the fibre density and orientation characteristics is performed resorting to an image analysis technique. Based on the obtained results it was possible to validate an analytical formulation for determining the tensile strength of UHPRFC and to quantify the involved parameters. It is also shown that length of the hardening branch of the tensile stress-elongation curve is also very well correlated with the same parameters used in the determination of the tensile strength.

© 2017 Elsevier Ltd. All rights reserved.

Fibras de aço para concretos

A. Abrishambaf et al. / Cement and Concrete Research 97 (2017) 28–40

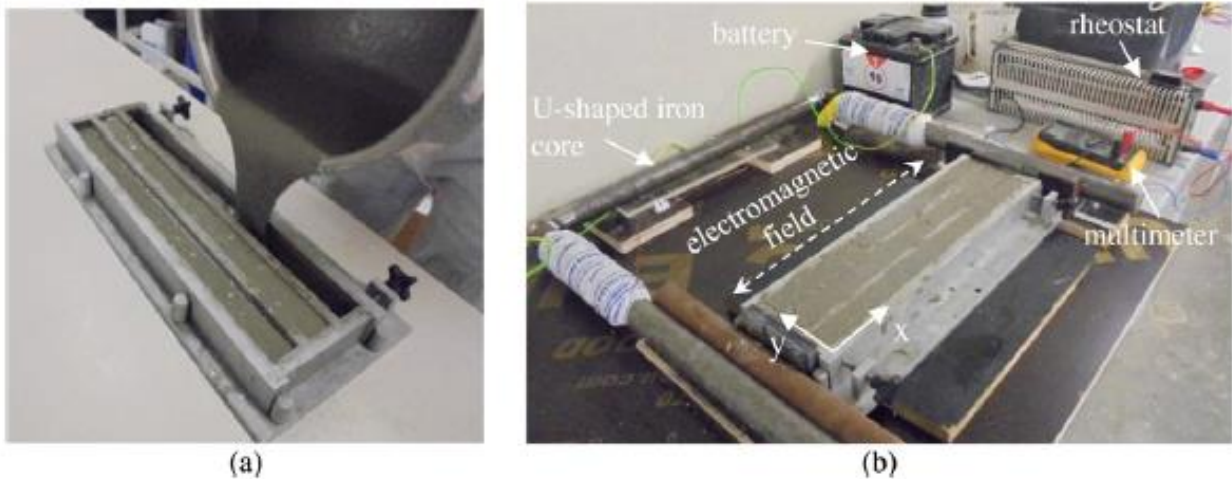
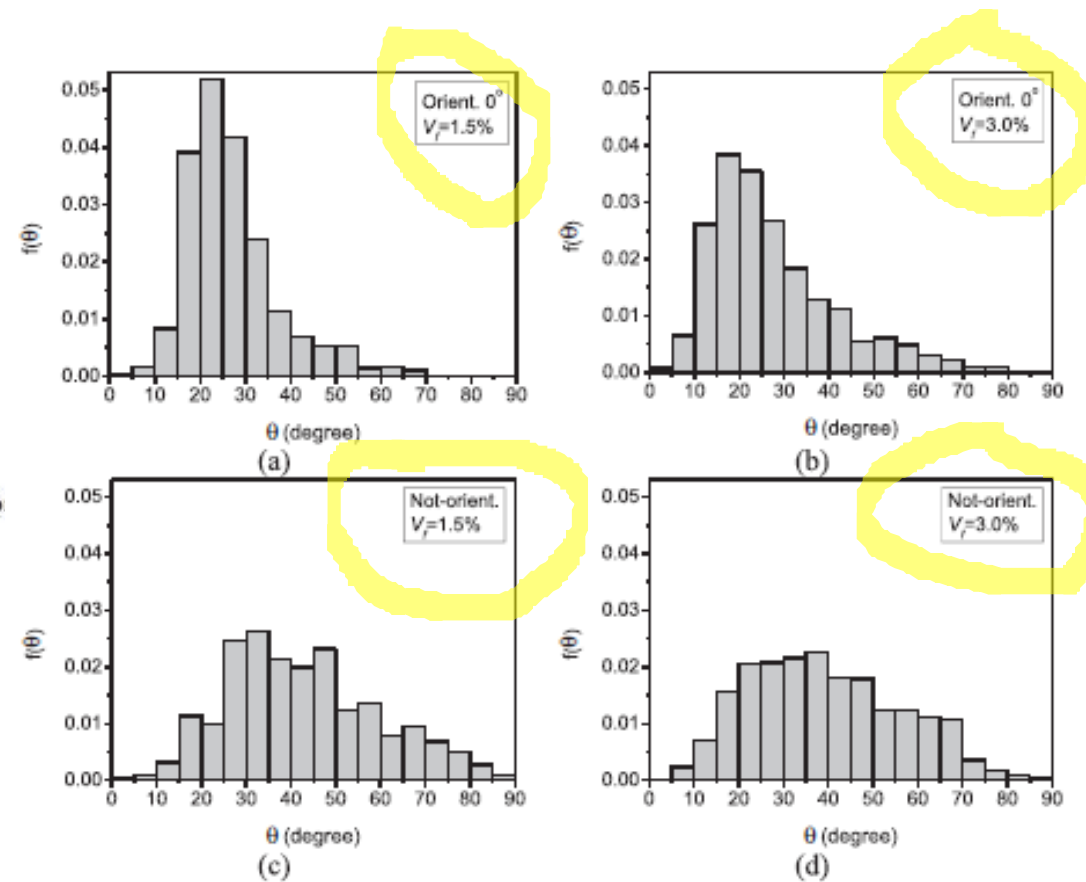


Fig. 1. (a) casting method of specimens without preferential fibre orientation ("non-oriented"); (b) production of specimens with preferential fibre orientation.

Esses teores de fibra são suficientes serem utilizadas como 100% da armadura necessária

31



Fonte: A. Abrishambaf et al. / Cement and Concrete Research 97 (2017) 28–40

Fibras de aço para concretos

M.J.H. Wijffels et al. / Cement and Concrete Composites 80 (2017) 342–355

345

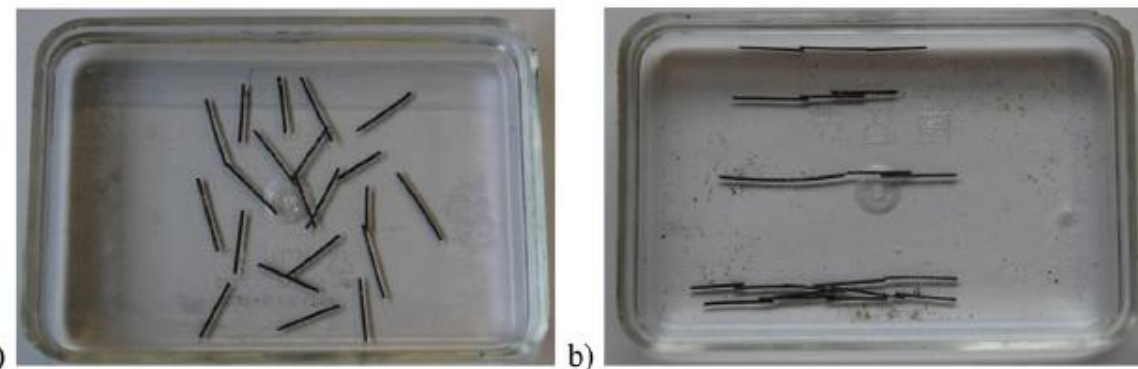
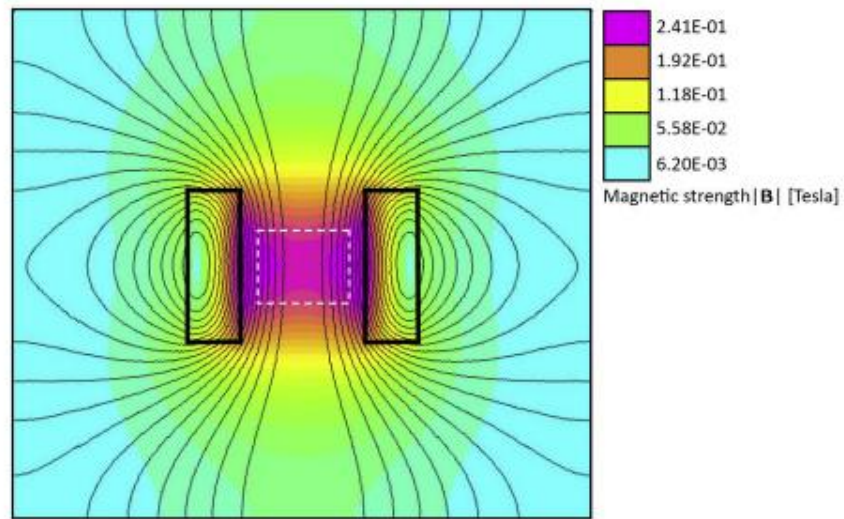
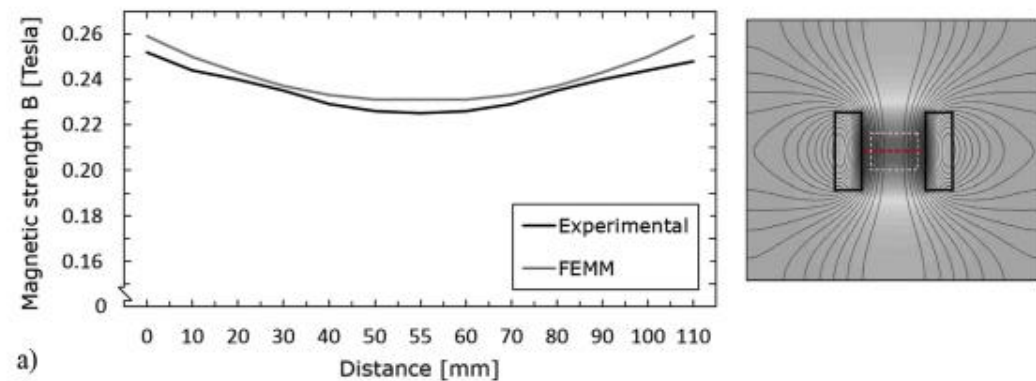
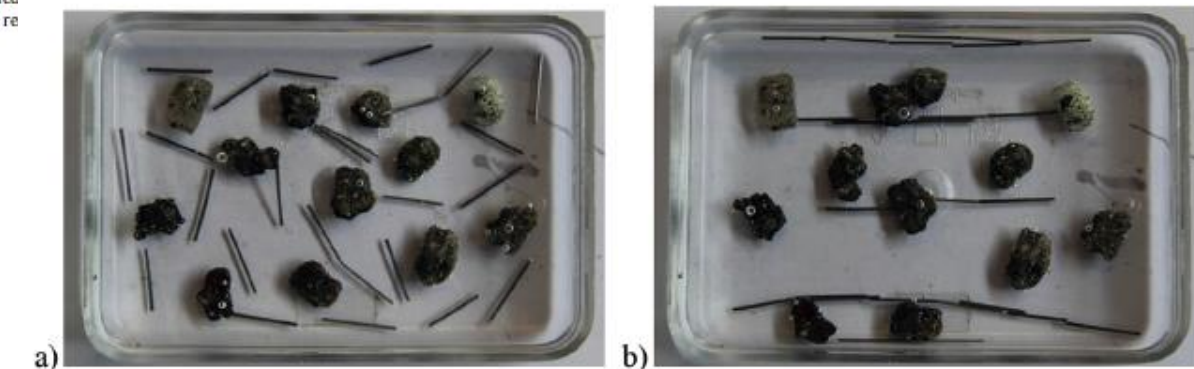


Fig. 1. Field lines (curved black lines) and strength (color) of the magnetic flux density B generated by a coil with a length of 129 mm and an inner diameter of 110 mm, as con with an axisymmetric FEMM model. The symmetrical cross-section of the coil is indicated by the two identical squares (thick black lines), with the square in between (dashed lines) denoting an area of $90 \times 70 \text{ mm}^2$ in which the strength of B is approximately homogeneous. (For interpretation of the references to colour in this figure legend, the re referred to the web version of this article.)



Fibras de aço para concretos



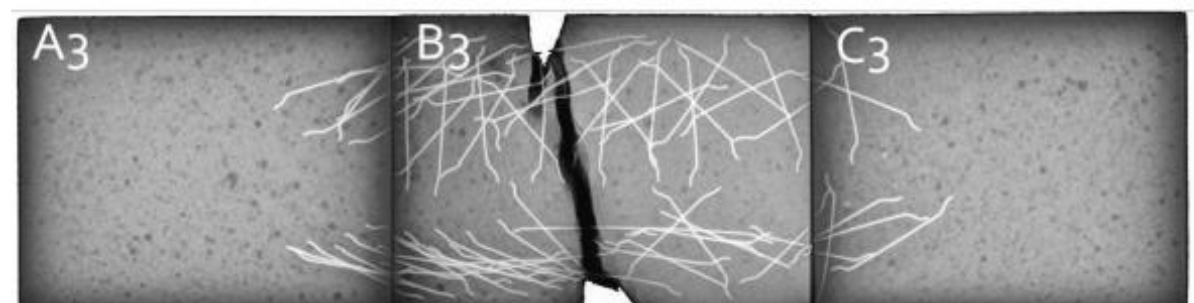
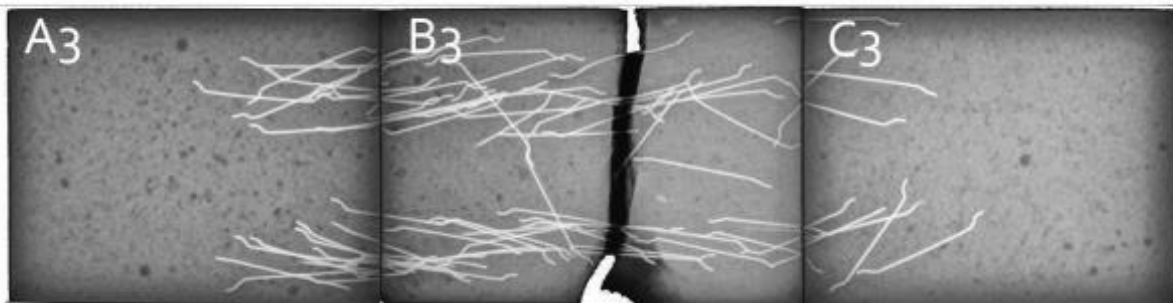
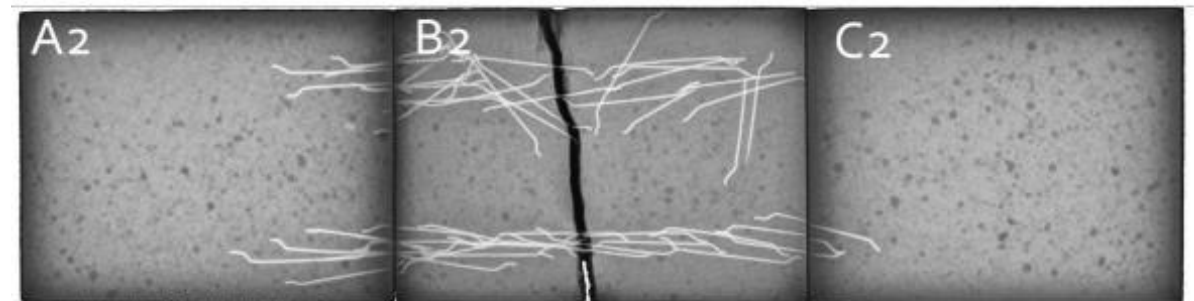
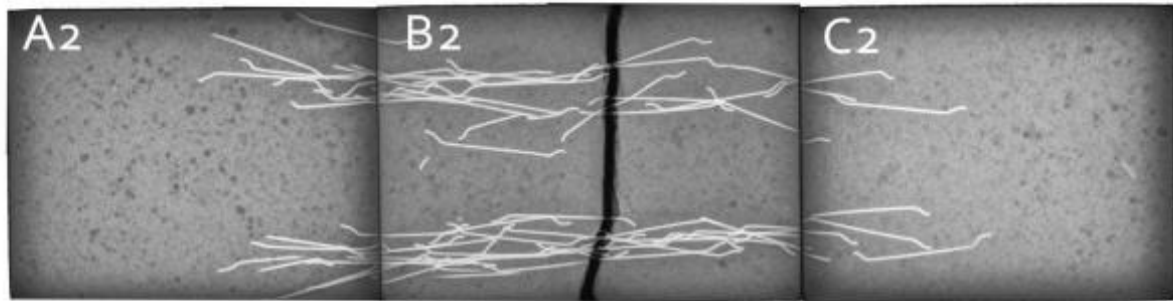
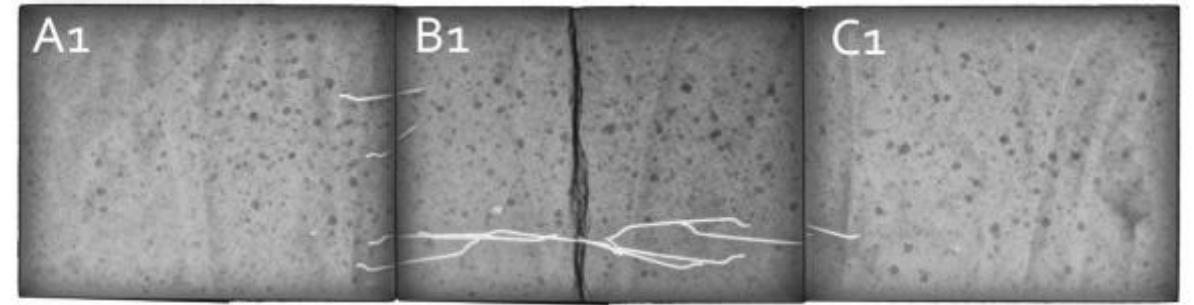
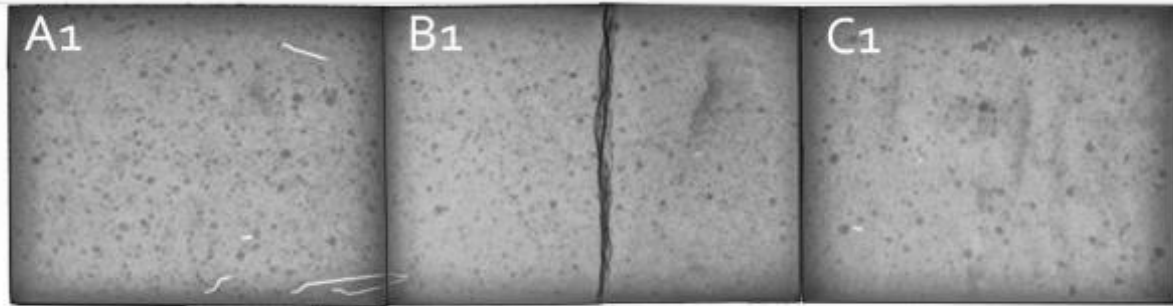
(a)



(b)

Figura 3.5: Fibras (a) desalinhas e (b) alinhadas devido ao campo magnético.

Fibras de aço para concretos



Fibras de aço para concretos

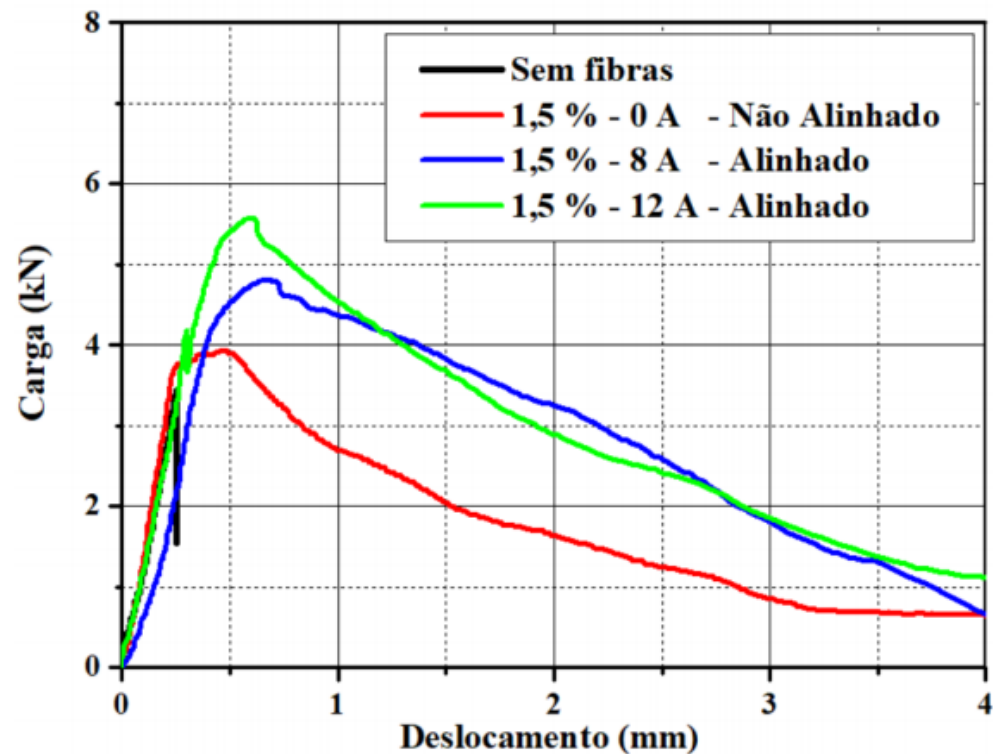


Figura 4.5: Desempenho amostras de pasta para a relação de substituição de fibras de 1,5% e relação w/c = 0,35.

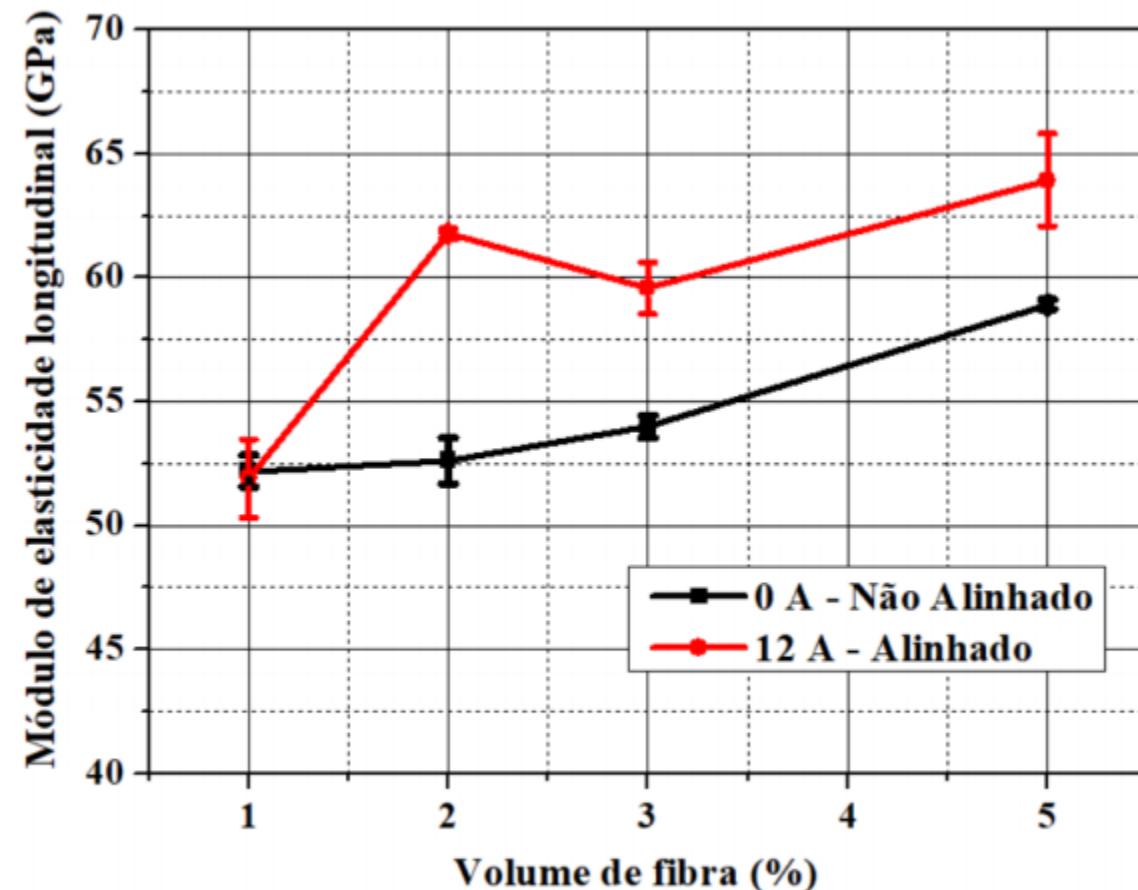
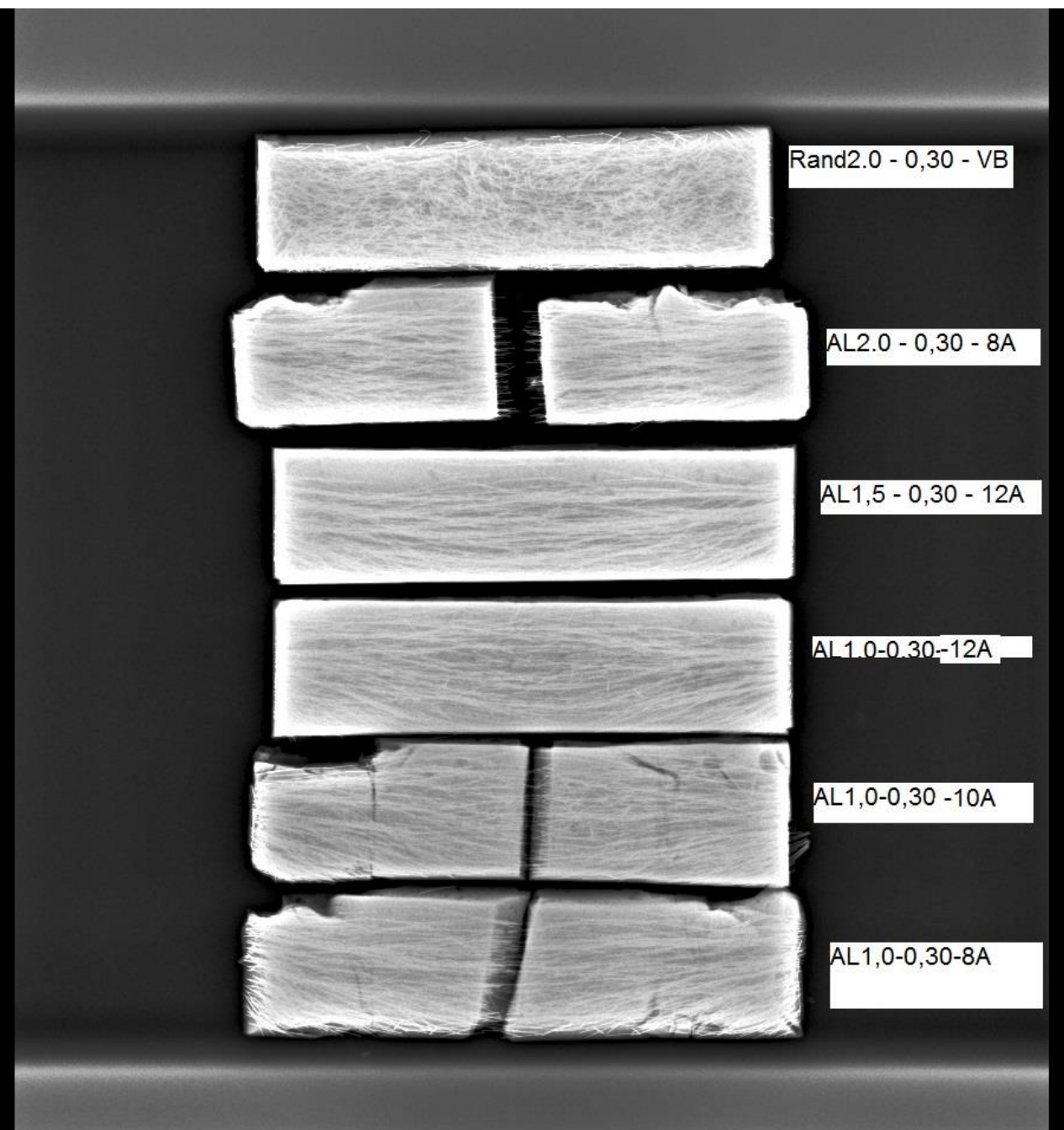


Figura 4.8: Módulo de elasticidade dinâmico longitudinal.

Fibras de aço para concretos



Fibras de aço para concretos

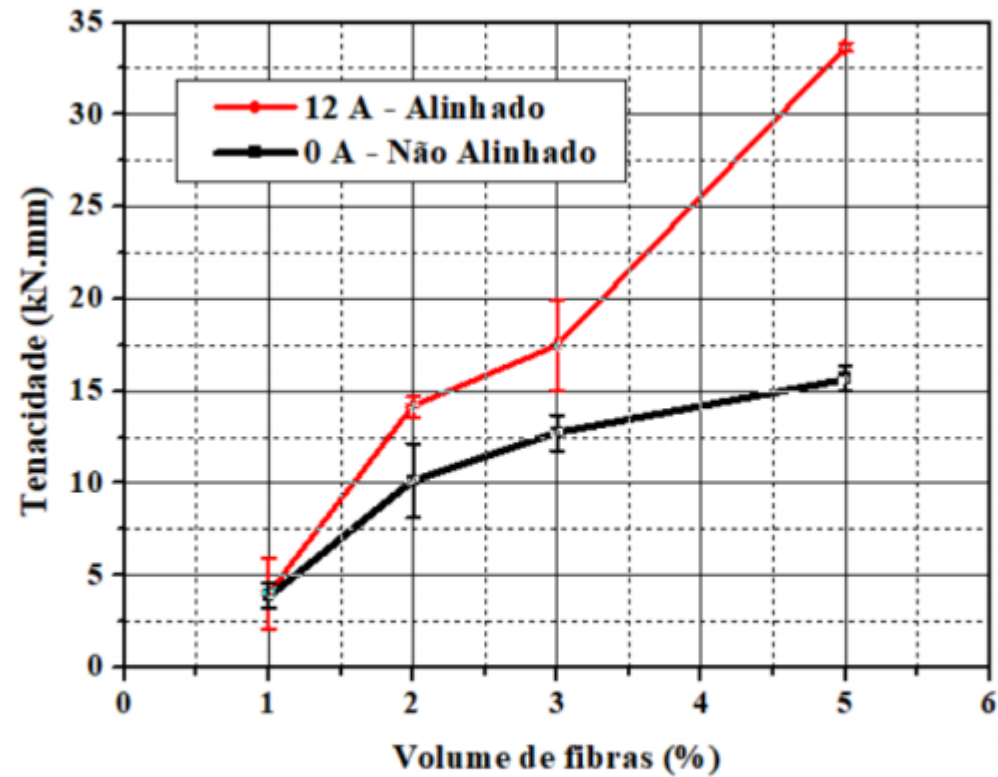


Figura 4.14: Valores médios da tenacidade em função do volume de fibras para os casos alinhado e não alinhados.

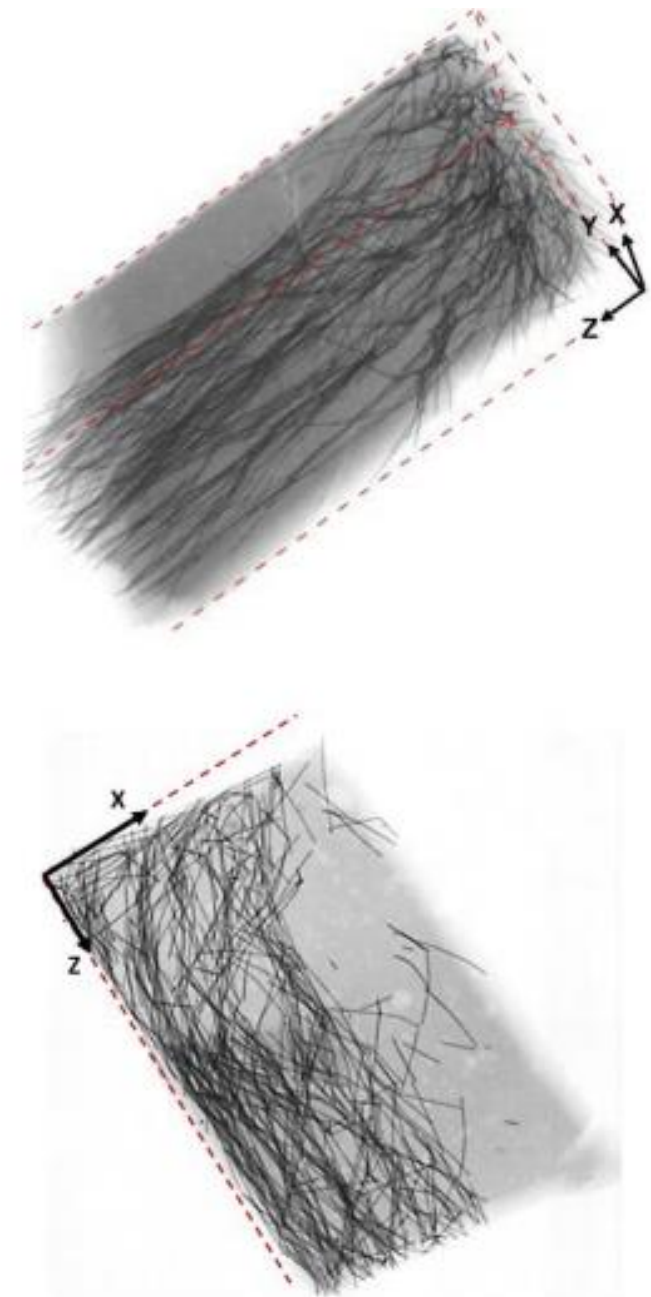


Figura 4.20: Tomografias de um corpo de prova do composto com 5% de fibras.

Execução de estruturas de concreto armado



Fôrmas

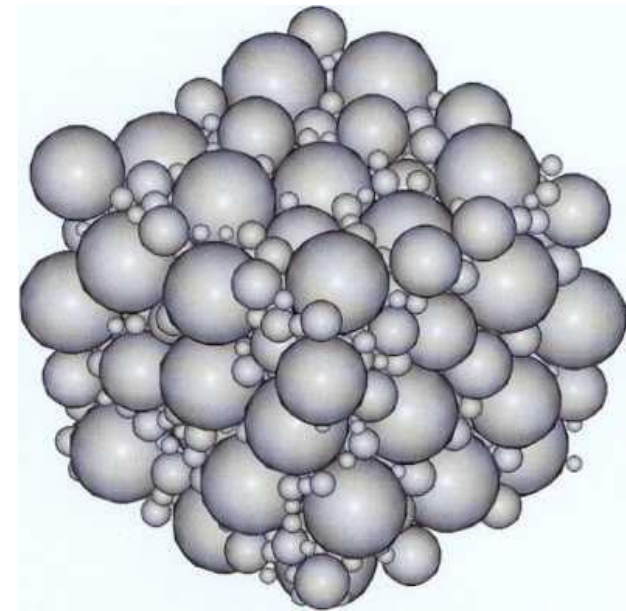
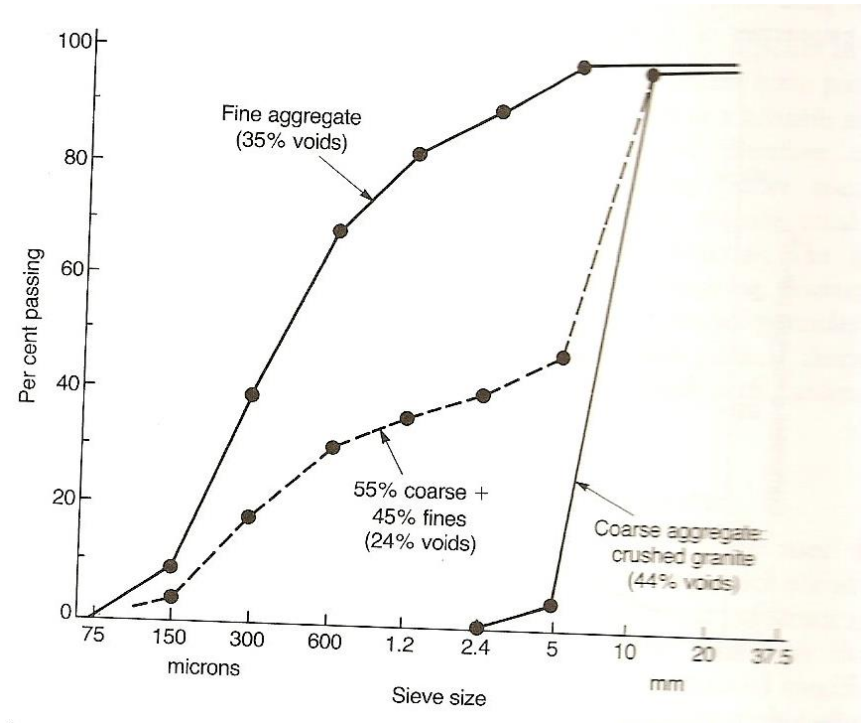
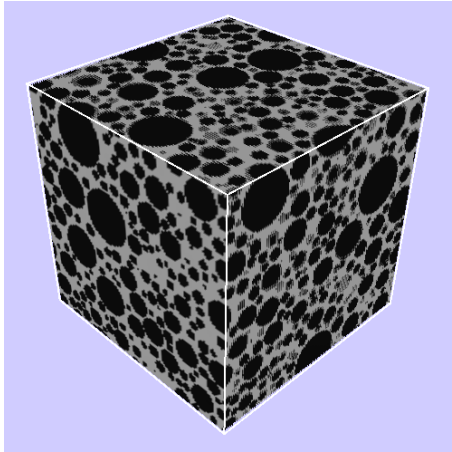


Armadura



concretagem

Novas Necessidades do Concreto



Novas Necessidades do Concreto

- Redução da Pegada de cimento sem perda de desempenho

558

B.L. Daminieli et al. / *Cement & Concrete Composites* 32 (2010) 555–562

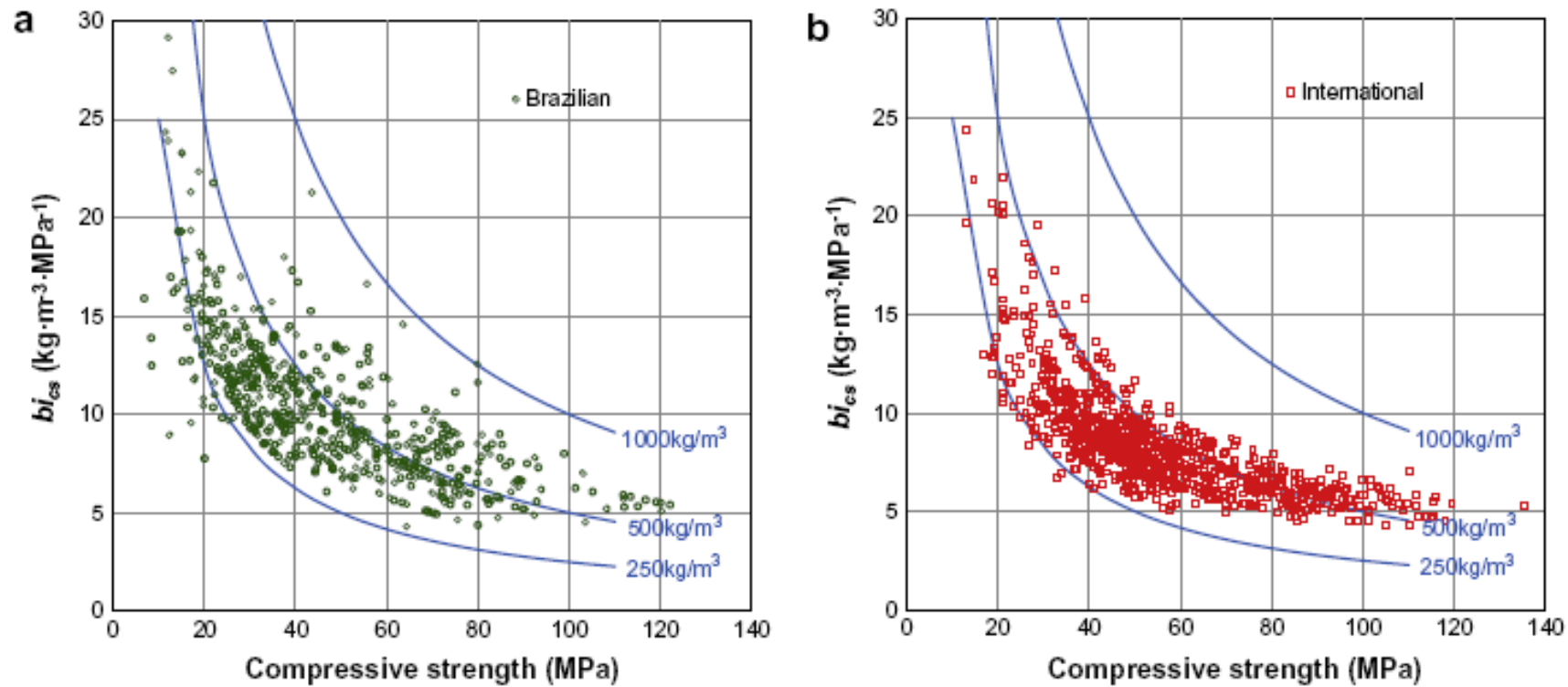


Fig. 2. Binder intensity (bi_{cs}) versus 28 day compressive strength for: (a) Brazilian data; (b) international data. The lines represent concretes with the same amount of total binder. Few data points are not shown because bi is above 25 kg/m^3 MPa.

Utilização de um indicador de eficiência para a produção de concretos

Empacotamento de partículas - Modelo de Alfred

Modelo de Alfred: é um aperfeiçoamento dos modelos de Furnas e Andreasen que mostra que na realidade esses modelos podem ser visualizados como duas formas distintas de se expressar uma mesma coisa.

$$CPFT = \left(\frac{D_p^q - D_S^q}{D_L^q - D_S^q} \right) \times 100$$

OBS: Estudos apontam que, pela comparação entre densidades obtidas experimentalmente, a eficiência de empacotamento resultantes das diversas distribuições de máxima densidade estudadas é expressa em:

ALFRED > ANDREASEN > FURNAS

Alterar o Cimento

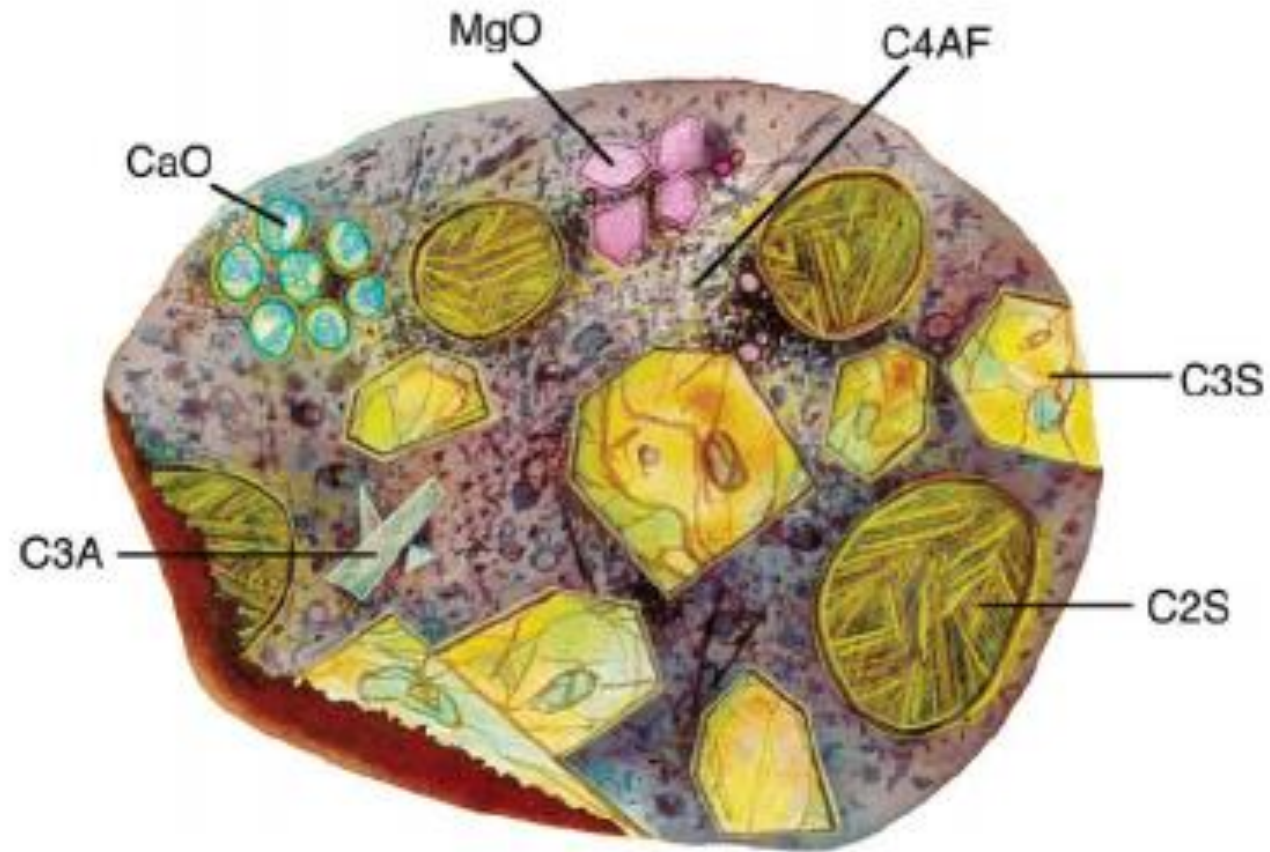


Figura 2 – Representação do grão de cimento seccionado (BISHOP et al., 2003).

Objetivos das inovações na indústria das construções:

- i. Produtos que desempenham mais de uma função
- ii. Redução de impactos

Tradicional:

carbon footprint per tonne of 0.4 tonnes.

NOVACEM

Novacem's cement, which has a patent pending on it, uses magnesium silicates which emit no CO₂ when heated. Its production process also runs at much lower temperatures - around 650C. This leads to total CO₂ emissions of up to 0.5 tonnes of CO₂ per tonne of cement produced. But the Novacem cement formula absorb far more CO₂ as it hardens - about 1.1 tonnes. So the overall carbon footprint is negative - ie the cement removes 0.6 tonnes of CO₂ per tonne used.



Contact

News & Events

Careers



Calera corporation

is dedicated

to reversing global

warming by

capturing and

storing greenhouse

gases in the built

environment.

Alteração na Hidratação

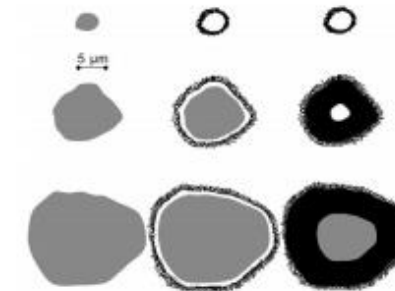
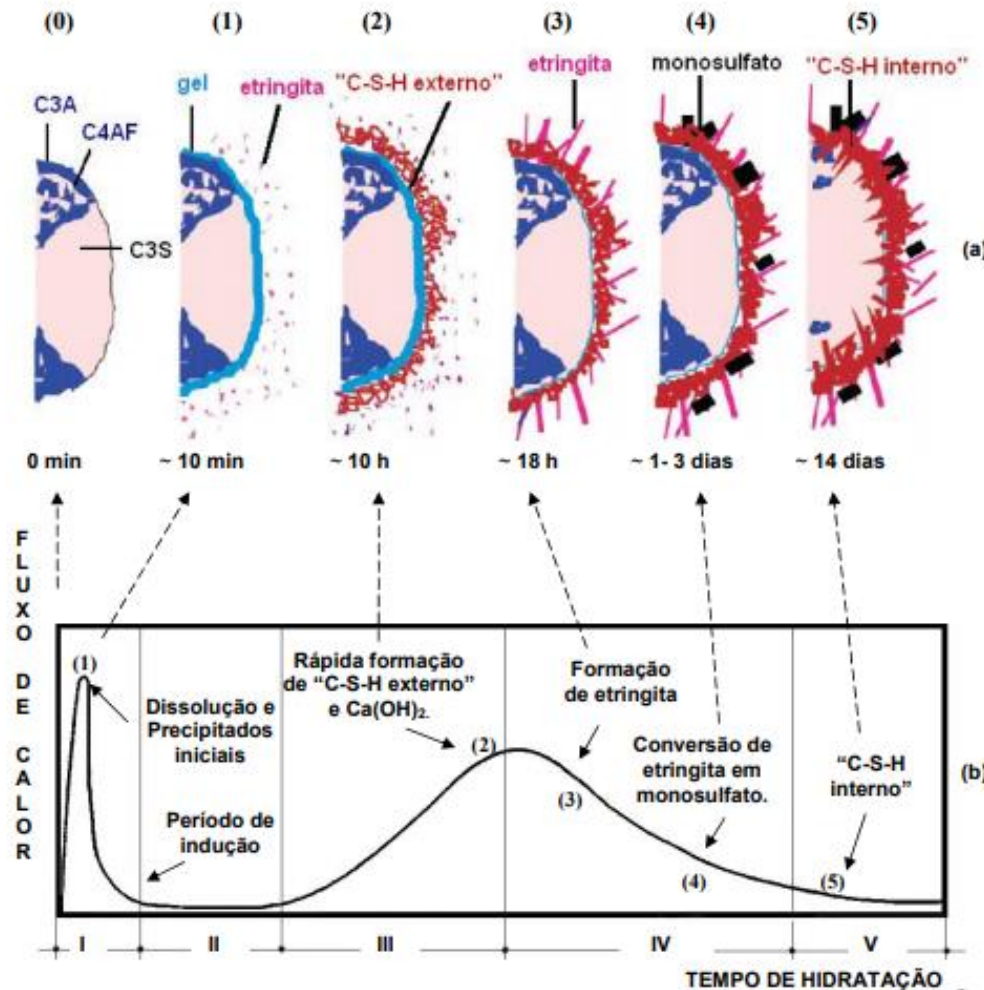
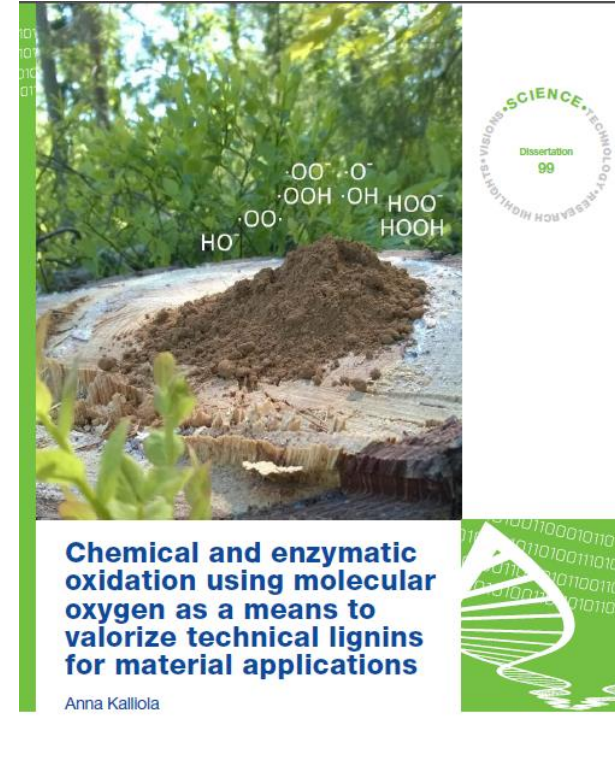
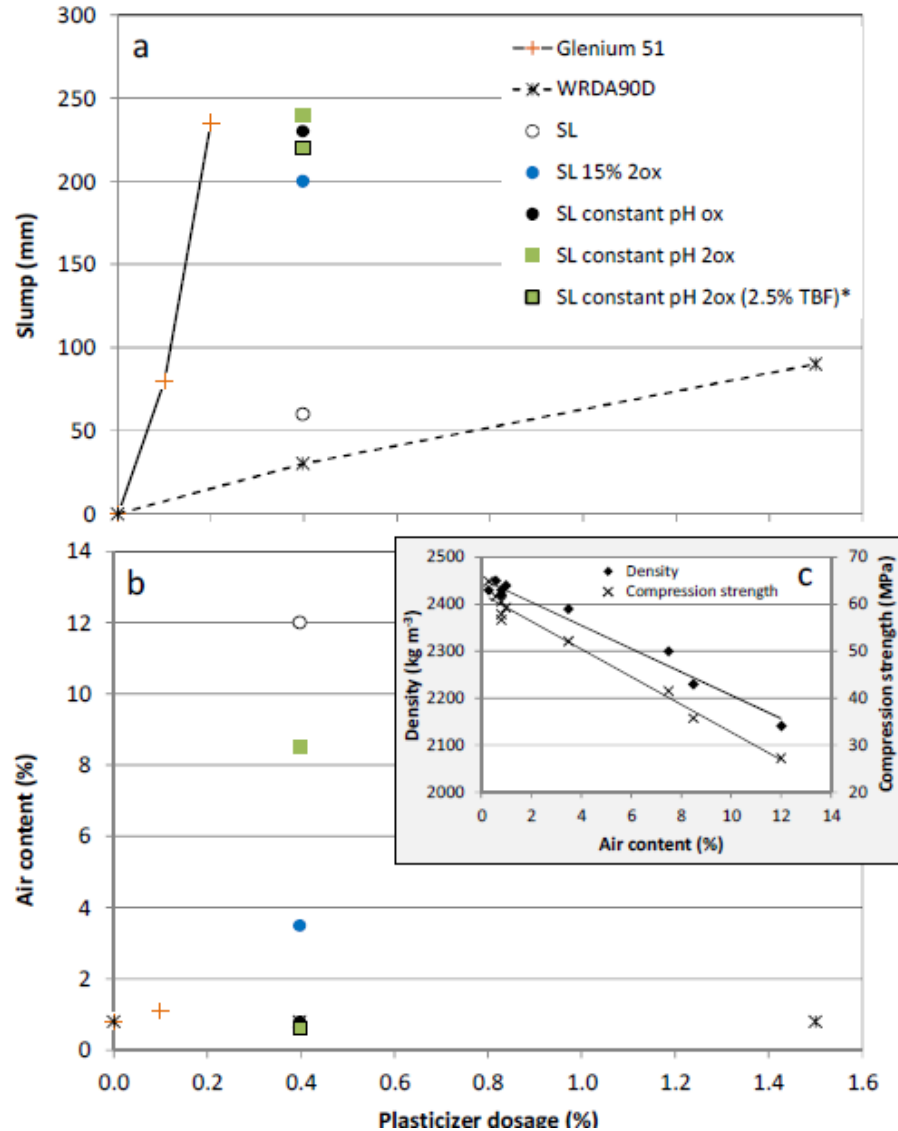


Figura 4 – Representação das camadas de hidratação em função do tempo, para os diferentes tamanhos de grãos (SCRIVENER, 2004).

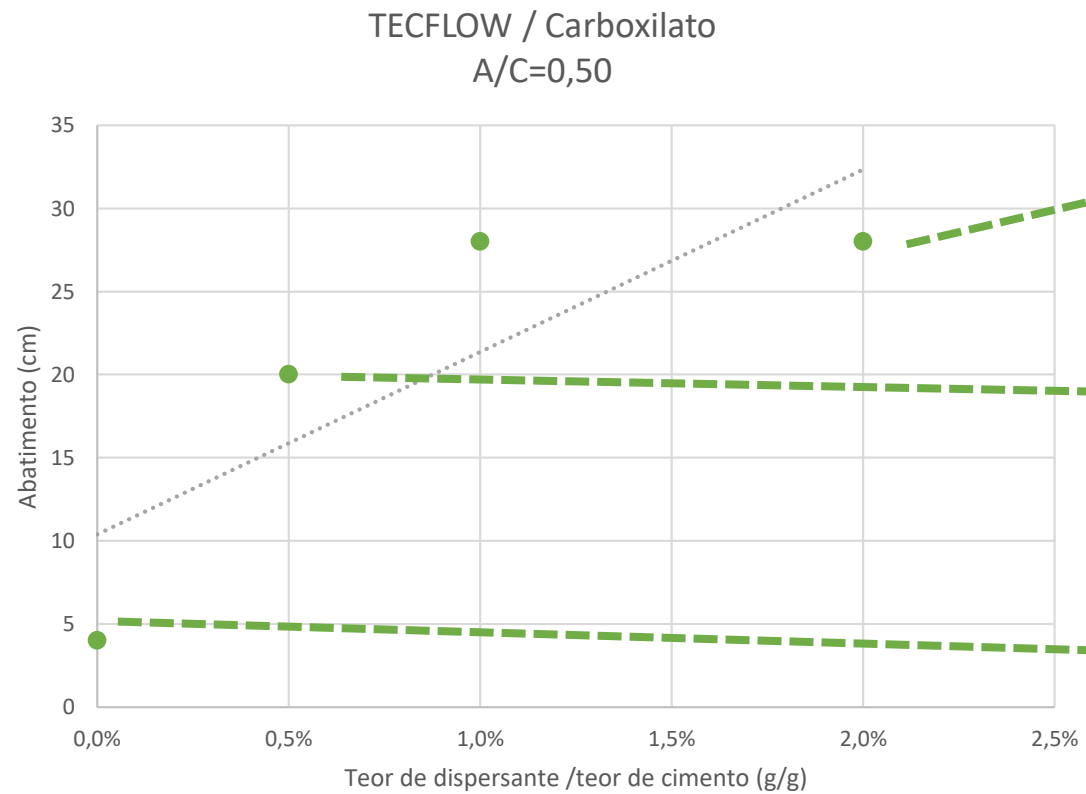
Figura 3 – (a) Desenvolvimento da microestrutura do cimento Portland, adaptado por SCRIVENER (BISHOP et al., 2003). (b) Representação da curva da taxa de liberação de calor do cimento Portland, dividida em 5 etapas (adaptado de ZAMPIERI, 1989).

- Redução da Pegada de cimento sem perda de desempenho

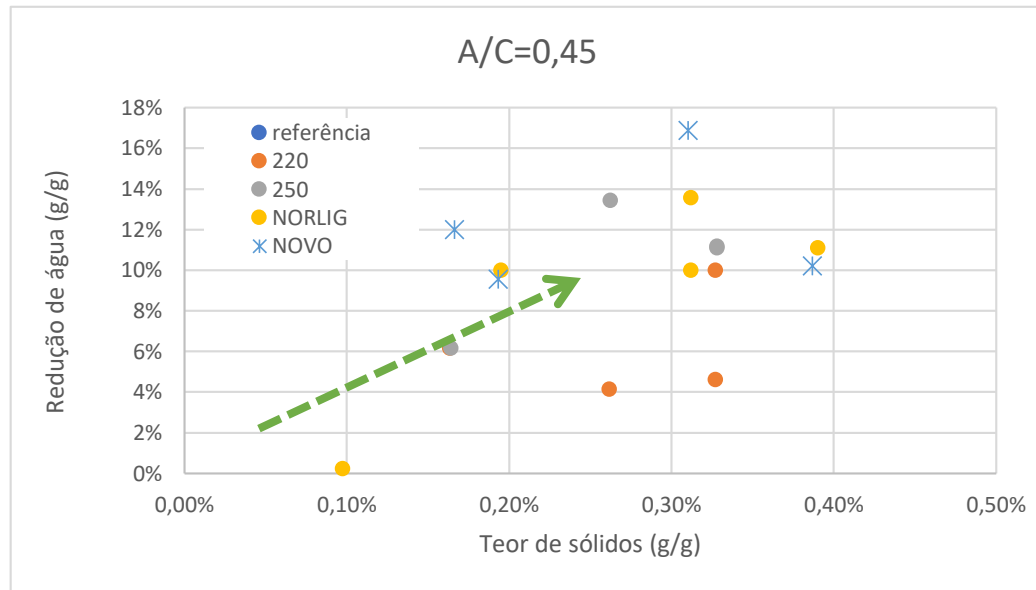


Esses aditivos inovadores já tem comprovado desempenho igual ao superior aos disponíveis no mercado com menor incorporação de ar e sensibilidade as variabilidade de produção

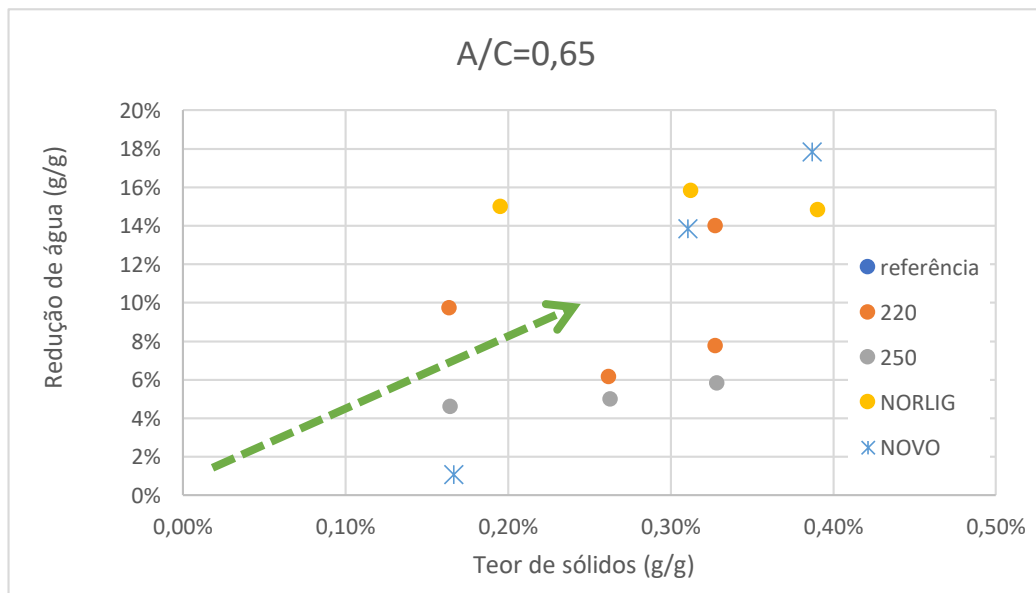
Concretos - Estado Fresco



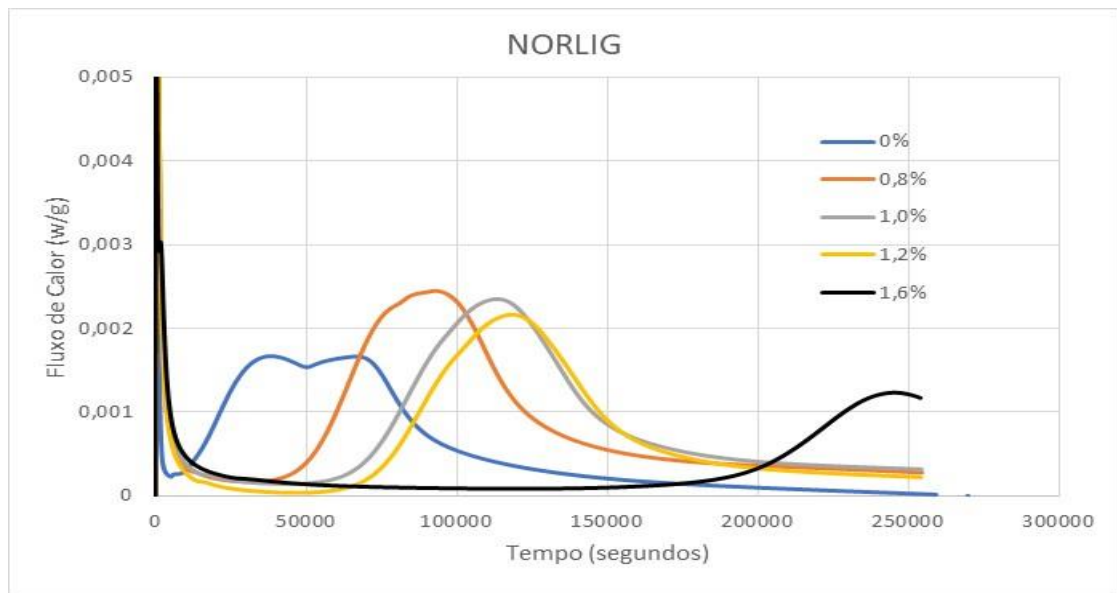
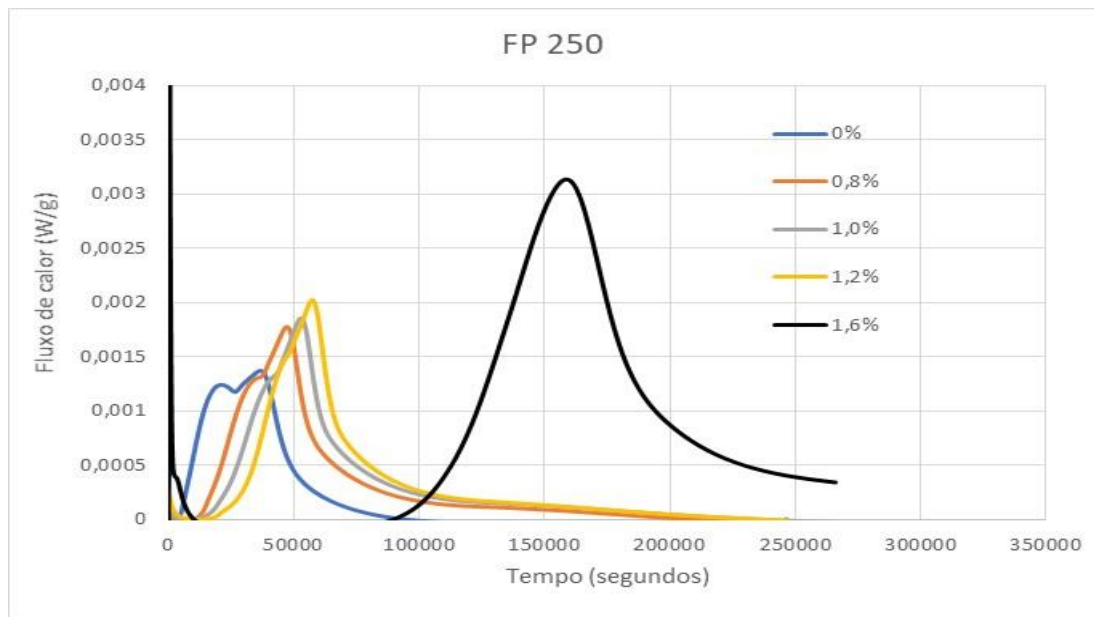
FASE 2 - RESULTADOS



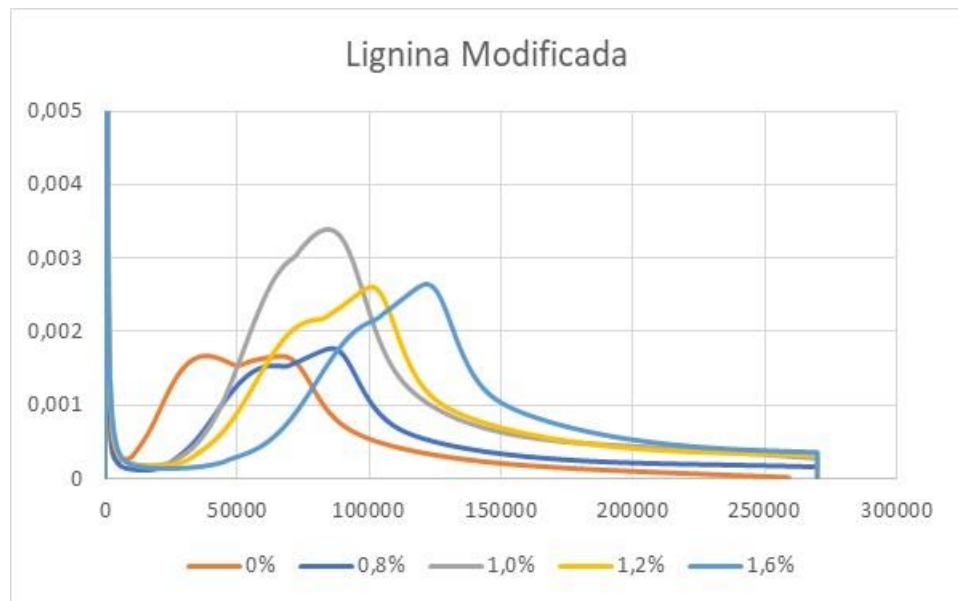
- Esse tipo de aditivo consegue reduzir cerca de 10% da quantidade de água. Tem melhor desempenho para baixas A/C e 250 para altas A/C.
- O aditivo NOVO apresentou um desempenho igual ou superior aos demais avaliados
- Seu comportamento foi satisfatório tanto para baixas A/C quanto para altas A/C



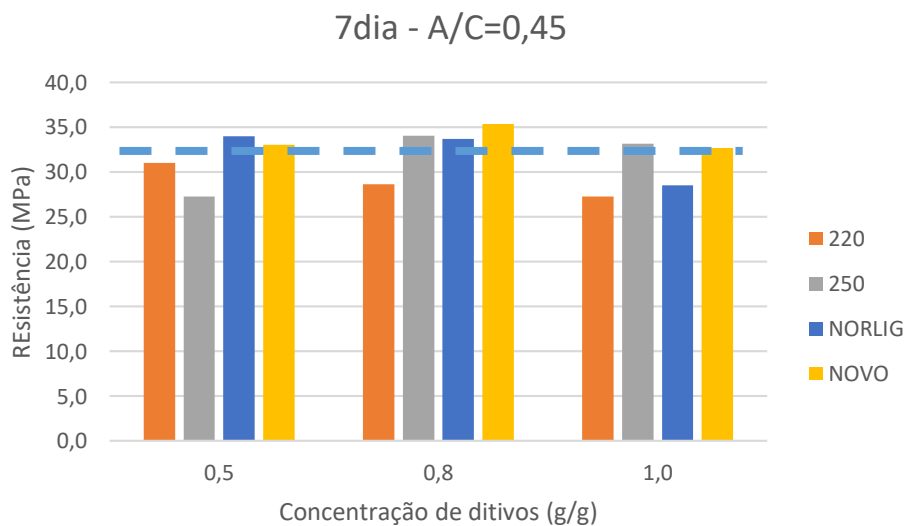
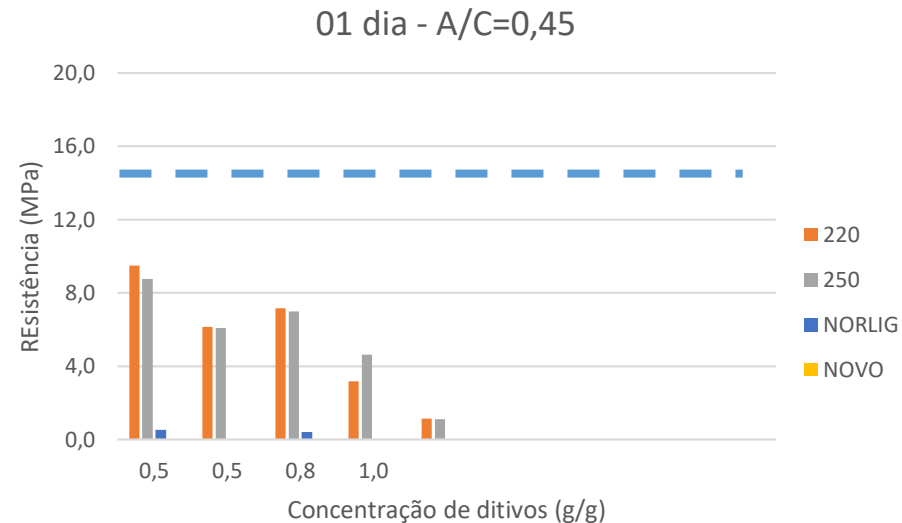
FASE 2 - RESULTADOS



- Todos os aditivos avaliados apresentaram o comportamento semelhante, sendo que apresenta os menores impactos nos retardos
- A lignina modificada e o FP250 foram os que parece ser o que exerce menor influência na hidratação do cimento



FASE 2 - RESULTADOS



- Todos os aditivos apresentaram perda de resistência no primeiro dia (15MPa de referência)
- Os aditivos 220 e 250 foram os que apresentavam os melhores desempenhos no primeiro dia
- O aditivo novo apresentou importantes retardos nessa propriedade
- Com 07 dias o 220 apresentou um perda de resistência com o aumento da concentração de aditivos (possivelmente pela maior formação de cloroaluminato que possuem baixa resistência)
- A referência também apresentou comportamento semelhante
- Os aditivos 250 e NOVO mostraram-se mais estáveis

União com outras áreas de conhecimento

- Eletrônica
- Computação
- Elétrica



MAIN SKILL - VISTUALIDADE

X

- Engenheiro civil
- Arquiteto



MAIN SKILL - REALIDADE

União com outras áreas de conhecimento

Table 2
Applications of smartphone based systems exploiting the embedded camera.

Working principle	Target(s)	Range of detection	Ref.
colorimetric	pH test strips	0 – 14	[36]
colorimetric	25-hydroxyvitamin D concentration	15 – 110 nM	[37]
colorimetric	alcohol concentration in saliva	0 – 0.3%	[38]
colorimetric	pH, protein and glucose in urine	5 – 9, 0 – 100 mg/dL, 0 – 300 mg/dL	[39]
colorimetric	blood hematocrit level	10–65%	[41]
colorimetric	streptomycin concentration in food	50 – 267 nM	[42]
colorimetric	BSA, catalase enzyme and carbohydrate	0 – 1 mg/mL, 0 – 1 mg/mL, 0 – 140 µg/mL	[43]
colorimetric	cloud coverage	4 – 98%	[48]
colorimetric	surface corrosion of iron	N/A	[50]
irradiance measurement	UVA solar irradiance	0 – 10 mW/m ²	[60]
irradiance measurement	UVA aerosol optical depth	0.05 – 0.20	[61]
irradiance measurement	UVB solar irradiance	1 – 9 mW/m ²	[63]
irradiance measurement	atmospheric total ozone column	260 – 320 DU	[65]
irradiance measurement	SO ₂ volcanic emission	0 – 3.5 kg/s	[66]
fluorescence	ochratoxin A concentration in beer	2 – 20 µg/L	[44]
fluorescence	degradation level of olive oil	N/A	[45]
fluorescence	discrimination of different edible oils	N/A	[46]
fluorescence	bisphenol A concentration in water	4.4 – 200 µM	[47]
electrochemiluminescence	2-(dibutylamino)ethanol and L-proline	0 – 5 mM, 0 – 10 mM	[52]
Mie scattering	Escherichia coli in water	10 – 10 ⁷ CFU/mL	[53]
Mie scattering	bacterial concentration in meat	10 – 10 ⁸ CFU/mL	[54]
spectrophotometric	pH for river quality water	6 – 8	[69]
spectrophotometric	BSA protein and trypsin enzyme concentration	0 – 0.30 mg/mL, 0 – 0.30 mg/mL	[70]
spectrophotometric	optical spectrum (color dyes and milk samples)	N/A	[73]
spectrophotometric	Fe ²⁺ in medicine and Na ⁺ in saline solutions	2.93 – 4.76 mg/L, 0.78 – 2.01 mg/L	[74]
spectrophotometric	porcine immunoglobulin concentration	4.25 nM – 3.4 µM	[76]
computer vision	bacterial colony counter	0 – 96 CFU	[79]
computer vision	bacterial colony counter	N/A	[80]
computer vision	bacterial colony counter	0 – 250 CFU	[81]
computer vision	bacterial colony counter	N/A	[82]
computer vision	bacterial colony counter	0 – 500 CFU	[83]
computer vision	surveillance of fruit flies	N/A	[84]
computer vision	food recognition tool	N/A	[85]
computer vision	food recognition and nutritional value	N/A	[86]
computer vision	heart rate measurement	N/A	[87]
mobile microscopy	cell imaging (brightfield and fluorescent)	N/A	[88]
mobile microscopy	image analysis of green algae in freshwater	N/A	[89]

Measurement 135 (2019) 572–592

Contents lists available at ScienceDirect

Measurement

journal homepage: www.elsevier.com/locate/measurement



União com outras áreas de conhecimento

Table 4

Applications of smartphone based systems exploiting the embedded accelerometer, gyroscope, magnetometer and GPS.

Sensor(s)	Application type	Detection rate	Ref.
GPS	crowd dynamics monitoring	N/A	[103]
GPS	crowd dynamics monitoring	N/A	[104]
GPS	bicycle tracking	N/A	[105]
GPS	driving speed monitoring	N/A	[106]
accelerometer	activity recognition	88%	[107]
accelerometer	activity recognition	70%	[108]
accelerometer	activity recognition	91%	[109]
accelerometer, gyroscope	activity recognition	90%	[110]
accelerometer, gyroscope, magnetometer, linear accelerometer	activity recognition	N/A	[111]
accelerometer, gyroscope, microphone	activity recognition	86%	[112]
accelerometer	fall detection	97%	[114]
accelerometer	fall detection	98.4%	[115]
accelerometer	fall detection	N/A	[116]
accelerometer, gyroscope	fall portent detection	88.5%	[117]
accelerometer	seismic events monitoring	N/A	[118]
accelerometer, magnetometer, GPS	seismic events monitoring	N/A	[119]
accelerometer	structural health monitoring	N/A	[120]
accelerometer	structural health monitoring	N/A	[121]
accelerometer, gyroscope	vibration and cable force tests	N/A	[122]
accelerometer	driver behavior and road conditions	N/A	[123]
accelerometer, gyroscope	driver behavior monitoring	90%	[124]
accelerometer, gyroscope, magnetometer	driver behavior monitoring	96%	[125]
accelerometer, gyroscope, magnetometer	driver behavior monitoring	91%	[126]
accelerometer, gyroscope, GPS, camera	driver behavior monitoring	77 – 91%	[127]
accelerometer, magnetometer, GPS	road conditions monitoring	78%	[128]
accelerometer, gyroscope	road conditions monitoring	98%	[129]
accelerometer, gyroscope, GPS	road conditions monitoring	90%	[130]

Measurement 135 (2019) 572–592

Contents lists available at ScienceDirect

Measurement

journal homepage: www.elsevier.com/locate/measurement



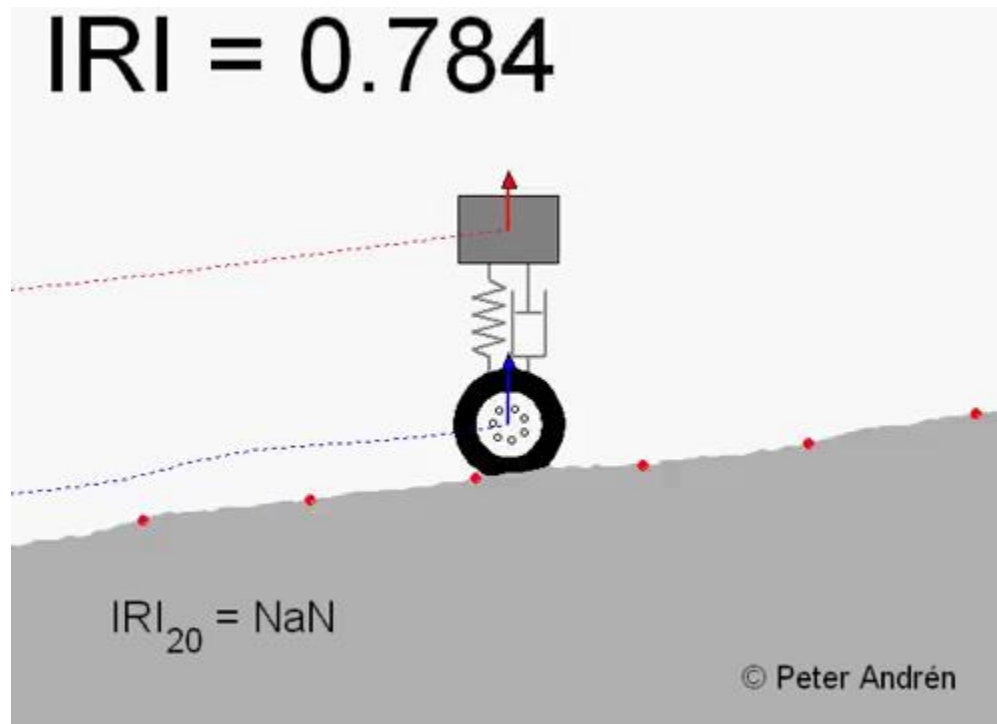
A sensor-centric survey on the development of smartphone measurement and sensing systems

Marco Grossi

Department of Electrical Energy and Information Engineering "Guglielmo Marconi" (DEI), University of Bologna, Bologna, Italy

Parâmetros de qualidade: DEFINIÇÕES

International Roughness Index – **IRI** é o somatório por quilômetro das irregularidades do pavimento em relação a um plano de referência (m/km) e medido entre pontos

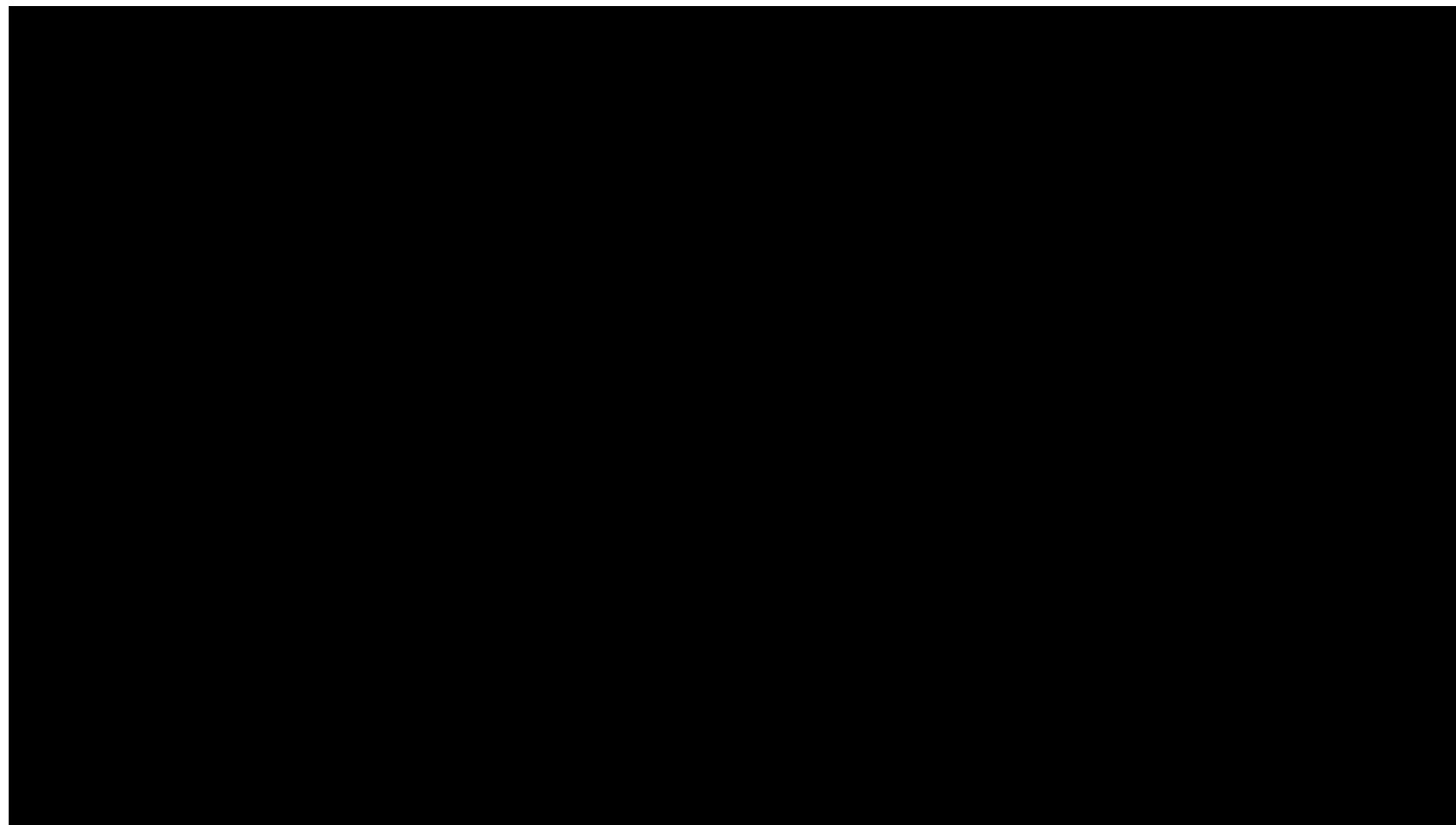


Classificação IRI

0 a 2,4	ótimo
2,4 a 4,8	bom
4,8 a 7,2	regular
7,2 a 10	ruim
> 10	péssimo

MÉTODO MAIS USUAL DE MEDIÇÃO DO IRI

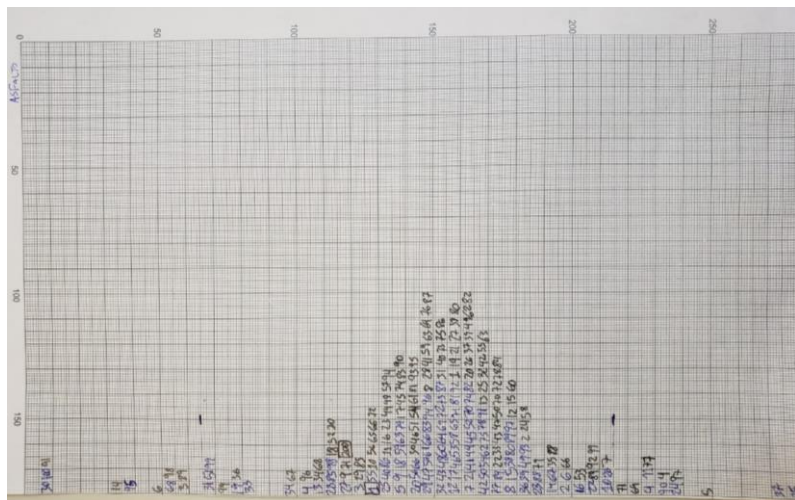
- **MERLIN** – **M**achine for **E**valuation **R**oughness using **L**ow-cost **I**Nstrumentation)



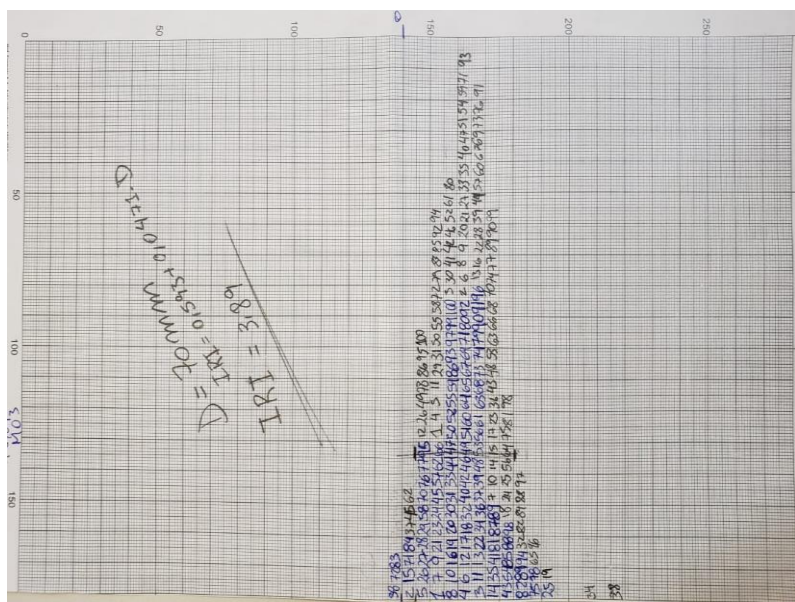
Além disso, o método exige cerca de 2h para cada ciclo completo de ensaio (total de 200 leituras).

MÉTODO MAIS USUAL

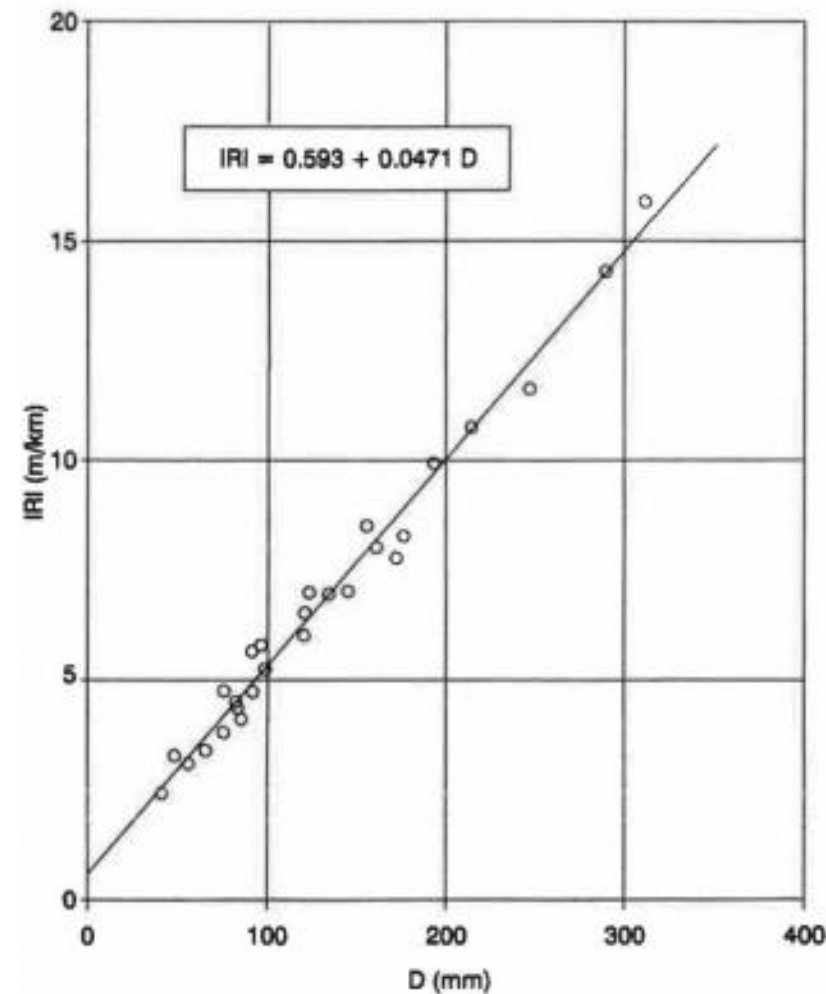
- Típico resultado do MERLIN ----- $IRI = 0,593 + 0,0471 * D$



RUIM



BOM



FONTE: CUNDILL, M.A. (sd.)

OUTRAS POSSIBILIDADES MAIS MODERNAS

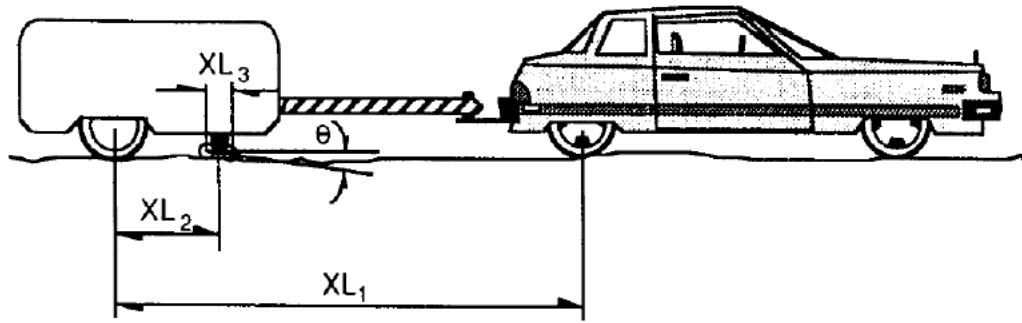


Figura 6 – Desenho esquemático do perfilômetro CHLOE (HAAS *et al.*, 1994)

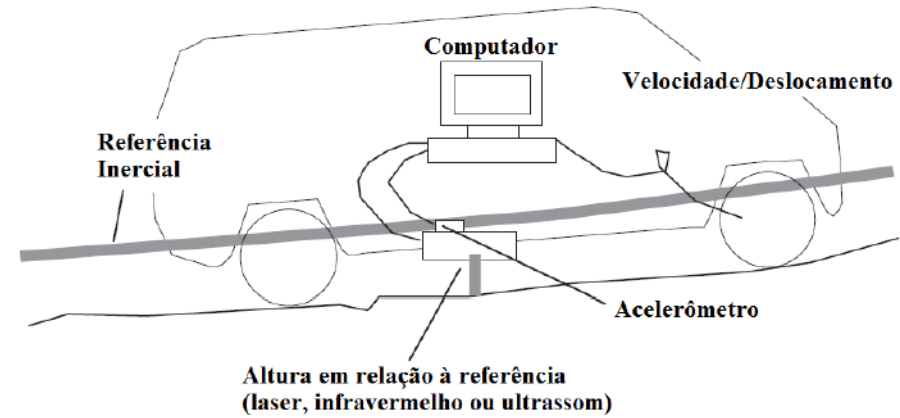


Figura 10 - Esquema do funcionamento de um perfilômetro inercial (Adaptada de SAYERS e KARAMIHAS, 1998)

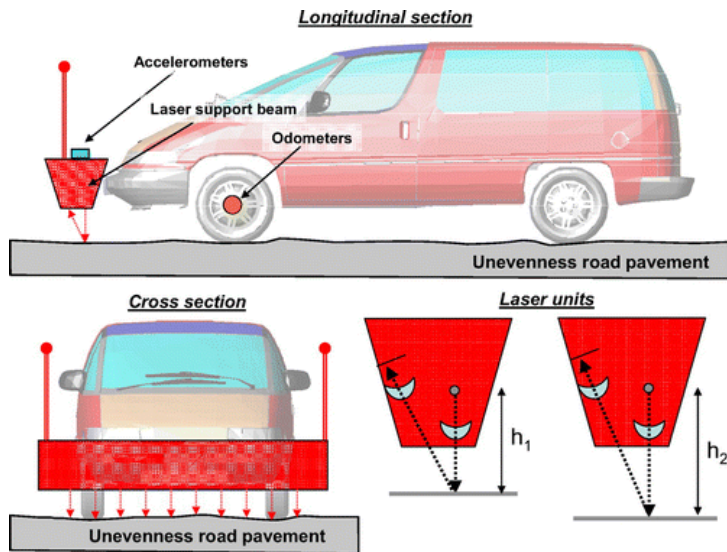


Figure 3. Dipstick 2000.

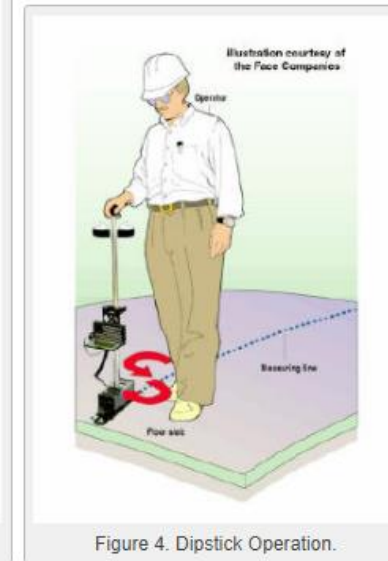


Figure 4. Dipstick Operation.

A MOBILE PROFILOMETER FOR ROAD SURFACE MONITORING BY USE OF ACCELEROMETERS

K. TOMIYAMA & A. KAWAMURA
Kitami Institute of Technology, Japan

tomiya@kitami-it.ac.jp, kawamu@kitami-it.ac.jp

S. NAKAJIMA

WAcorn Hokkaido Co., Ltd, Japan

shigenori_nakajima@notes.isuzu.co.jp

T. ISHIDA

Hokkaido Regional Development Bureau, Japan,





ishida-t22ae@hkd.mlit.go.jp

M. JOMOTO

Taisei Rotec Corporation, Japan

masakazu_jomoto@taiseirotec.co.jp

Measurement of Pavement Roughness Using Android-Based Smartphone Application

Shahidul Islam , William Buttlar , Roberto Aldunate , William Vavrik 

<https://doi.org/10.3141/2457-04>

Abstract

References

Cited by

PDF

Abstract

Pavement roughness is an expression of the irregularities in a pavement surface that adversely affect the ride quality of a vehicle. Roughness also affects vehicle delay costs, fuel consumption, tires, and maintenance costs. Roughness is predominantly characterized by the international roughness index (IRI), which is often measured with inertial profilers. Inertial profilers are equipped with sensitive accelerometers, a height-measuring laser, and a distance-measuring instrument for measuring vehicle vertical acceleration data and the pavement profile. Modern smartphones are equipped with several sensors including a three-axis accelerometer, which was used in this project to collect vehicle acceleration data with an Android-based application. In the study, acceleration data were double integrated numerically to obtain a pavement profile, which was input into the software program ProVAL. The pavement roughness was then calculated. For the initial validation, pavement profile and acceleration data were collected with both an inertial profiler and the newly developed smartphone application from three test sites. The initial validation results suggest that the newly developed smartphone application can measure IRI with good correspondence to the inertial profiler and with good repeatability between measurement replications. However, calibration is needed for rougher pavement sections because the current analysis techniques do not directly account for acceleration damping resulting from vehicle suspension systems. With improvements in analysis that consider the vehicle suspension effects and additional validation, the approach could be used to reduce the cost of acquiring pavement roughness data for agencies and to reduce user costs for the traveling public by providing more robust feedback about route choice and its effect on estimated vehicle maintenance cost and fuel efficiency.

Journal of Civil Engineering and Architecture 9 (2015) 485-496
doi: 10.17265/1934-7359/2015.04.012



Roadroid: Continuous Road Condition Monitoring with Smart Phones

Lars Forslöf¹ and Hans Jones^{1,2}

1. Roadroid AB, Ljusdal 82735, Sweden

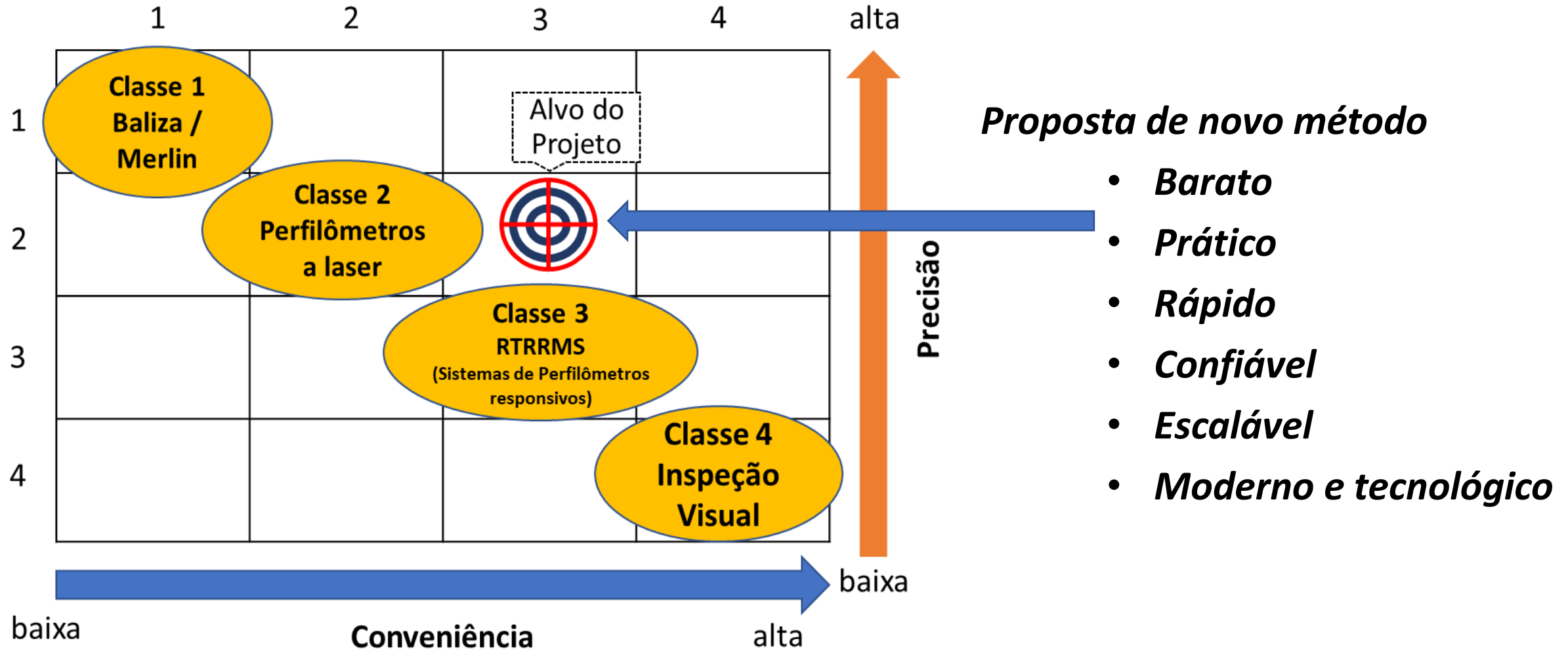
2. Department of Computer Engineering, Dalarna University, Borlänge 78450, Sweden

Abstract: Road condition is an important variable to measure in order to decrease road and vehicle operating/maintenance costs, but also to increase ride comfort and traffic safety. By using the built-in vibration sensor in smart phones, it is possible to collect road roughness data which can be an indicator of road condition up to a level of Class 2 or 3 in a simple and cost efficient way. Since data collection therefore is possible to be done more frequently, one can better monitor roughness changes over time. The continuous data collection can also give early warnings of changes and damage, enable new ways to work in the operational road maintenance management, and can serve as a guide for more accurate surveys for strategic asset management and pavement planning. Collected measurement data are wirelessly transferred by the operator when needed via a web service to an internet mapping server with spatial filtering functions. The measured data can be aggregated in preferred sections, as well as exported to other GIS (geographical information systems) or road management systems. Our conclusion is that measuring roads with smart phones can provide an efficient, scalable, and cost-effective way for road organizations to deliver road condition data.

Key words: Road condition, asset management, mobility, smart phone, intelligent transportation systems.

Há iniciativas em todos o mundo para desenvolver soluções que mais simples, práticas e econômicas para avaliação da qualidade superficial dos pavimentos

AVALIAÇÃO



SISTEMA DE AQUISIÇÃO DE DADOS

- Desenvolvimento de um aplicativo (playstore)
- Arquitetura de um banco de dados (tecnologia **BIGDATA**) robusto e na nuvem (upload de milhões de dados diariamente) (tecnologia **DATA ANALYTICS**)

OPÇÃO DEFINITIVA: DISPOSITIVO ABAIXO DA SUSPENSÃO DO VEÍCULO



Data e Hora	LONG	Latitude	Longitude	Vibração
1538774733139	-46,84014687	-46,84014687	-23,57876187	6,129
1538774733243	-46,84014687	-46,84013792	-23,57877206	6,052
1538774733353	-46,84014687	-46,84012912	-23,57878225	6,091
1538774733456	-46,84014687	-46,84012042	-23,57879292	6,933
1538774733554	-46,84011167	-46,84011167	-23,57880333	7,202
1538774733653	-46,84011167	-46,84010796	-23,57880741	6,167
1538774733773	-46,84011167	-46,84010426	-23,57881148	7,01
1538774733875	-46,84011167	-46,84010056	-23,57881556	7,623
1538774733984	-46,84011167	-46,84009685	-23,57881963	7,623
1538774734095	-46,84011167	-46,84009315	-23,5788237	8,542
1538774734206	-46,84011167	-46,84008944	-23,57882778	7,776
1538774734315	-46,84011167	-46,84008574	-23,57883185	7,738
1538774734426	-46,84011167	-46,84008204	-23,57883593	8,312
1538774734533	-46,84007833	-46,84007833	-23,57884	8,619
1538774734634	-46,84007833	-46,84007574	-23,57884278	8,121

DESENVOLVIMENTO DE HARDWARE E INSTALAÇÃO NA FROTA

- UBER, TAXI, 99....
- Instalados antes da suspensão



Desenvolvimento de um dispositivo dedicado e instalação em uma frota de carros



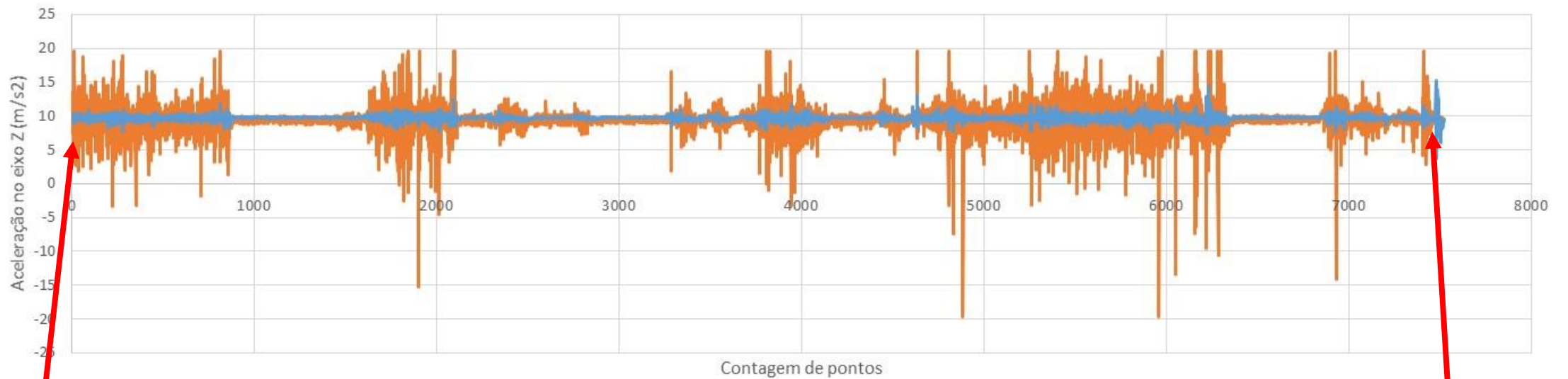
SISTEMA DE AQUISIÇÃO DE DADOS

- Aquisição de 10 pontos a cada segundo (10Hz)
- Captura dos dados internos (conforto dos passageiros)
- Captura dos dados externos (exclusivo da rugosidade do pavimento)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	AB	AC	AD	AE	AF	AG	AH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
1	ID	Evento	EventoC	Arq	DataTime	DataStar	HourStar	GPSLong	GPSLat	GPSAlt	Vel	AcelX	AcelY	AcelZ	Frequenc	NumeroS	NumeroE	ErroGPS	AcelRan	AcelRes	ExernalA	ExernalB	ExernalC	ExernalD	ExernalE	ExernalF	ExernalG	ExernalH	ExernalI	ExernalJ	ExernalK	ExernalL	ExernalM	ExernalN	ExernalO	ExernalP	ExernalQ	ExernalR	ExernalS	ExernalT	ExernalU	ExernalV	ExernalW	ExernalX	ExernalY	ExernalZ	ExernalAA	ExernalAB	ExernalAC	ExernalAD	ExernalAE	ExernalAF	ExernalAG	ExernalAH	ExernalAI	ExernalAJ	ExernalAK	ExernalAL	ExernalAM	ExernalAN	ExernalAO	ExernalAP	ExernalAQ	ExernalAR	ExernalAS	ExernalAT	ExernalAU	ExernalAV	ExernalAW	ExernalAX	ExernalAY	ExernalAZ	ExernalBA	ExernalBB	ExernalBC	ExernalBD	ExernalBE	ExernalBF	ExernalBG	ExernalBH	ExernalBI	ExernalBJ	ExernalBK	ExernalBL	ExernalBM	ExernalBN	ExernalBO	ExernalBP	ExernalBQ	ExernalBR	ExernalBS	ExernalBT	ExernalBU	ExernalBV	ExernalBW	ExernalBX	ExernalBY	ExernalBZ	ExernalCA	ExernalCB	ExernalCC	ExernalCD	ExernalCE	ExernalCF	ExernalCG	ExernalCH	ExernalCI	ExernalCJ	ExernalCK	ExernalCL	ExernalCM	ExernalCN	ExernalCO	ExernalCP	ExernalCQ	ExernalCR	ExernalCS	ExernalCT	ExernalCU	ExernalCV	ExernalCW	ExernalCX	ExernalCY	ExernalCZ	ExernalDA	ExernalDB	ExernalDC	ExernalDD	ExernalDE	ExernalDF	ExernalDG	ExernalDH	ExernalDI	ExernalDJ	ExernalDK	ExernalDL	ExernalDM	ExernalDN	ExernalDO	ExernalDP	ExernalDQ	ExernalDR	ExernalDS	ExernalDT	ExernalDU	ExernalDV	ExernalDW	ExernalDX	ExernalDY	ExernalDZ	ExernalEA	ExernalEB	ExernalEC	ExernalED	ExernalEE	ExernalEF	ExernalEG	ExernalEH	ExernalEI	ExernalEJ	ExernalEK	ExernalEL	ExernalEM	ExernalEN	ExernalEO	ExernalEP	ExernalEQ	ExernalER	ExernalES	ExernalET	ExernalEU	ExernalEV	ExernalEW	ExernalEX	ExernalEY	ExernalEZ	ExernalFA	ExernalFB	ExernalFC	ExernalFD	ExernalFE	ExernalFF	ExernalFG	ExernalFH	ExernalFI	ExernalFJ	ExernalFK	ExernalFL	ExernalFM	ExernalFN	ExernalFO	ExernalFP	ExernalFQ	ExernalFR	ExernalFS	ExernalFT	ExernalFU	ExernalFV	ExernalFW	ExernalFX	ExernalFY	ExernalFZ	ExernalGA	ExernalGB	ExernalGC	ExernalGD	ExernalGE	ExernalGF	ExernalGG	ExernalGH	ExernalGI	ExernalGJ	ExernalGK	ExernalGL	ExernalGM	ExernalGN	ExernalGO	ExernalGP	ExernalGQ	ExernalGR	ExernalGS	ExernalGT	ExernalGU	ExernalGV	ExernalGW	ExernalGX	ExernalGY	ExernalGZ	ExernalHA	ExernalHB	ExernalHC	ExernalHD	ExernalHE	ExernalHF	ExernalHG	ExernalHH	ExernalHI	ExernalHJ	ExernalHK	ExernalHL	ExernalHM	ExernalHN	ExernalHO	ExernalHP	ExernalHQ	ExernalHR	ExernalHS	ExernalHT	ExernalHU	ExernalHV	ExernalHW	ExernalHX	ExernalHY	ExernalHZ	ExernalIA	ExernalIB	ExernalIC	ExernalID	ExernalIE	ExernalIF	ExernalIG	ExernalIH	ExernalII	ExernalIJ	ExernalIK	ExernalIL	ExernalIM	ExernalIN	ExernalIO	ExernalIP	ExernalIQ	ExernalIR	ExernalIS	ExernalIT	ExernalIU	ExernalIV	ExernalIW	ExernalIX	ExernalIY	ExernalIZ	ExernalJA	ExernalJB	ExernalJC	ExernalJD	ExernalJE	ExernalJF	ExernalJG	ExernalJH	ExernalJI	ExernalJJ	ExernalJK	ExernalJL	ExernalJM	ExernalJN	ExernalJO	ExernalJP	ExernalJQ	ExernalJR	ExernalJS	ExernalJT	ExernalJU	ExernalJV	ExernalJW	ExernalJX	ExernalJY	ExernalJZ	ExernalKA	ExernalKB	ExernalKC	ExernalKD	ExernalKE	ExernalKF	ExernalKG	ExernalKH	ExernalKI	ExernalKJ	ExernalKK	ExernalKL	ExernalKM	ExernalKN	ExernalKO	ExernalKP	ExernalKQ	ExernalKR	ExernalKS	ExernalKT	ExernalKU	ExernalKV	ExernalKW	ExernalKX	ExernalKY	ExernalKZ	ExernalLA	ExernalLB	ExernalLC	ExernalLD	ExernalLE	ExernalLF	ExernalLG	ExernalLH	ExernalLI	ExernalLJ	ExernalLK	ExernalLL	ExernalLM	ExernalLN	ExernalLO	ExernalLP	ExernalLQ	ExernalLR	ExernalLS	ExernalLT	ExernalLU	ExernalLV	ExernalLW	ExernalLX	ExernalLY	ExernalLZ	ExernalMA	ExernalMB	ExernalMC	ExernalMD	ExernalME	ExernalMF	ExernalMG	ExernalMH	ExernalMI	ExernalMJ	ExernalMK	ExernalML	ExernalMM	ExernalMN	ExernalMO	ExernalMP	ExernalMQ	ExernalMR	ExernalMS	ExernalMT	ExernalMU	ExernalMV	ExernalMW	ExernalMX	ExernalMY	ExernalMZ	ExernalNA	ExernalNB	ExernalNC	ExernalND	ExernalNE	ExernalNF	ExernalNG	ExernalNH	ExernalNI	ExernalNJ	ExernalNK	ExernalNL	ExernalNM	ExernalNN	ExernalNO	ExernalNP	ExernalNQ	ExernalNR	ExernalNS	ExernalNT	ExernalNU	ExernalNV	ExernalNW	ExernalNX	ExernalNY	ExernalNZ	ExernalOA	ExernalOB	ExernalOC	ExernalOD	ExernalOE	ExernalOF	ExernalOG	ExernalOH	ExernalOI	ExernalOJ	ExernalOK	ExernalOL	ExernalOM	ExernalON	ExernalOO	ExernalOP	ExernalOQ	ExernalOR	ExernalOS	ExernalOT	ExernalOU	ExernalOV	ExernalOW	ExernalOX	ExernalOY	ExernalOZ	ExernalPA	ExernalPB	ExernalPC	ExernalPD	ExernalPE	ExernalPF	ExernalPG	ExernalPH	ExernalPI	ExernalPJ	ExernalPK	ExernalPL	ExernalPM	ExernalPN	ExernalPO	ExernalPP	ExernalPQ	ExernalPR	ExernalPS	ExernalPT	ExernalPU	ExernalPV	ExernalPW	ExernalPX	ExernalPY	ExernalPZ	ExernalQA	ExernalQB	ExernalQC	ExernalQD	ExernalQE	ExernalQF	ExernalQG	ExernalQH	ExernalQI	ExernalQJ	ExernalQK	ExernalQL	ExernalQM	ExernalQN	ExernalQO	ExernalQP	ExernalQQ	ExernalQR	ExernalQS	ExernalQT	ExernalQU	ExernalQV	ExernalQW	ExernalQX	ExernalQY	ExernalQZ	ExernalRA	ExernalRB	ExernalRC	ExernalRD	ExernalRE	ExernalRF	ExernalRG	ExernalRH	ExernalRI	ExernalRJ	ExernalRK	ExernalRL	ExernalRM	ExernalRN	ExernalRO	ExernalRP	ExernalRQ	ExernalRR	ExernalRS	ExernalRT	ExernalRU	ExernalRV	ExernalRW	ExernalRX	ExernalRY	ExernalRZ	ExernalSA	ExernalSB	ExernalSC	ExernalSD	ExernalSE	ExernalSF	ExernalSG	ExernalSH	ExernalSI	ExernalSJ	ExernalSK	ExernalSL	ExernalSM	ExernalSN	ExernalSO	ExernalSP	ExernalSQ	ExernalSR	ExernalSS	ExernalST	ExernalSU	ExernalSV	ExernalSW	ExernalSX	ExernalSY	ExernalSZ	ExernalTA	ExernalTB	ExernalTC	ExernalTD	ExernalTE	ExernalTF	ExernalTG	ExernalTH	ExernalTI	ExernalTJ	ExernalTK	ExernalTL	ExernalTM	ExernalTN	ExernalTO	ExernalTP	ExernalTQ	ExernalTR	ExernalTS	ExernalTT	ExernalTU	ExernalTV	ExernalTW	ExernalTX	ExernalTY	ExernalTZ	ExernalUA	ExernalUB	ExernalUC	ExernalUD	ExernalUE	ExernalUF	ExernalUG	ExernalUH	ExernalUI	ExernalUJ	ExernalUK	ExernalUL	ExernalUM	ExernalUN	ExernalUO	ExernalUP	ExernalUQ	ExernalUR	ExernalUS	ExernalUT	ExernalUU	ExernalUV	ExernalUW	ExernalUX	ExernalUY	ExernalUZ	ExernalVA	ExernalVB	ExernalVC	ExernalVD	ExernalVE	ExernalVF	ExernalVG	ExernalVH	ExernalVI	ExernalVJ	ExernalVK	ExernalVL	ExernalVM	ExernalVN	ExernalVO	ExernalVP	ExernalVQ	ExernalVR	ExernalVS	ExernalVT	ExernalVU	ExernalVV	ExernalVW	ExernalVX	ExernalVY	ExernalVZ	ExernalWA	ExernalWB	ExernalWC	ExernalWD	ExernalWE	ExernalWF	ExernalWG	ExernalWH	ExernalWI	ExernalWJ	ExernalWK	ExernalWL	ExernalWM	ExernalWN	ExernalWO	ExernalWP	ExernalWQ	ExernalWR	ExernalWS	ExernalWT	ExernalWU	ExernalWV	ExernalWW	ExernalWX	ExernalWY	ExernalWZ	ExernalXA	ExernalXB	ExernalXC	ExernalXD	ExernalXE	ExernalXF	ExernalXG	ExernalXH	ExernalXI	ExernalXJ	ExernalXK	ExernalXL	ExernalXM	ExernalXN	ExernalXO	ExernalXP	ExernalXQ	ExernalXR	ExernalXS	ExernalXT	ExernalXU	ExernalXV	ExernalXW	ExernalXX	ExernalXY	ExernalXZ	ExernalYA	ExernalYB	ExernalYC	ExernalYD	ExernalYE	ExernalYF	ExernalYG	ExernalYH	ExernalYI	ExernalYJ	ExernalYK	ExernalYL	ExernalYM	ExernalYN	ExernalYO	ExernalYP	ExernalYQ	ExernalYR	ExernalYS	ExernalYT	ExernalYU	ExernalYV	ExernalYW	ExernalYX	ExernalYY	ExernalYZ	ExernalZA	ExernalZB	ExernalZC	ExernalZD	ExernalZE	ExernalZF	ExernalZG	ExernalZH	ExernalZI	ExernalZJ	ExernalZK	ExernalZL	ExernalZM	ExernalZN	ExernalZO	ExernalZP	ExernalZQ	ExernalZR	ExernalZS	ExernalZT	ExernalZU	ExernalZV	ExernalZW	ExernalZX	ExernalZY	ExernalZZ
570	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	0,073	-1,192	9,8557	10	12	23	9	39,227	0,038	-2,287	0,1186	11,063	0,07	-0,026	0,0765																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
571	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	0,1437	-1,177	9,9982	10	12	23	9	39,227	0,038	-2,249	0,012	10,625	0,1138	-0,055	0,1126																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
572	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	0,164	-1,187	9,6367	10	12	23	9	39,227	0,038	-2,057	-0,016	11,646	-0,132	0,0672	0,0062																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
573	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	0,1018	-1,197	9,8414	10	12	23	9	39,227	0,038	-1,024	-0,005	9,4334	0,069	-0,293	-0,84																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
574	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	0,0766	-1,144	9,9301	10	12	23	9	39,227	0,038	0,0431	-1,149	4,8399	0,004	-0,153	-0,182																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
575	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	0,1772	-1,165	9,7456	10	12	23	9	39,227	0,038	-0,842	0,0837	13,855	0,1723	0,143	0,158																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
576	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	-0,078	-0,145	10,111	10	12	23	9	39,227	0,038	-3,242	1,0634	8,6869	0,3165	-0,139	-0,386																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
577	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	-0,123	-0,251	9,9322	10	12	23	9	39,227	0,038	-9,043	2,0431	7,5577	-0,239	0,0871	0,8725																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
578	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,713339	-23,6304868	702	39,6	0,1197	-1,133	9,9527	10	12	23	9	39,227	0,038	-3,787	1,512	9,6726	-0,109	-0,021	0,25																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
579	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	-0,101	-0,177	9,9946	10	12	23	10	39,227	0,038	-2,534	0,3565	10,491	0,2121	0,0808	0,2724																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
580	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	0,1879	-0,164	10,244	10	12	23	10	39,227	0,038	-1,395	0,2464	8,5697	-0,013	0,0466	0,0746																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
581	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	-0,123	-0,102	10,051	10	12	23	10	39,227	0,038	1,0814	-0,144	11,125	0,3856	#####	0,0529																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
582	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	-0,049	-0,155	10,226	10	12	23	10	39,227	0,038	1,1986	-0,378	11,921	2,0448	0,3943	0,2444																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
583	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	0,2729	-0,145	9,578	10	12	23	10	39,227	0,038	-1,392	0,2249	12,735	0,3808	0,0578	0,1449																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
584	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	0,0634	-0,178	10,293	10	12	23	10	39,227	0,038	-2,067	-0,063	7,2395	0,0603	0,0404	-0,092																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
585	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	-0,045	-1,126	10,43	10	12	23	10	39,227	0,038	-1,955	-0,11	8,773	0,1524	-0,005	0,199																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
586	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	-0,194	-1,173	10,331	10	12	23	10	39,227	0,038	-5,101	0,9329	11,788	0,1424	0,1001	0,3259																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
587	1E+08	0	0	1220973	#####	2E+07	15h22m2	-46,7132633	-23,6303894	683	40,57	0,0359	-0,134	9,3877	10	12	23	10	39,227	0,038	-3,914	0,9111	5,7418	-0,107	-0,144	-0,222																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
588	1E+08	0	0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															

RESULTADO - EXEMPLO

- Grande quantidade de pontos avaliados – 7500 pontos em pouco mais de 14 minutos
- Todos GEOreferenciados e com precisão de 1m (05 casas decimais)

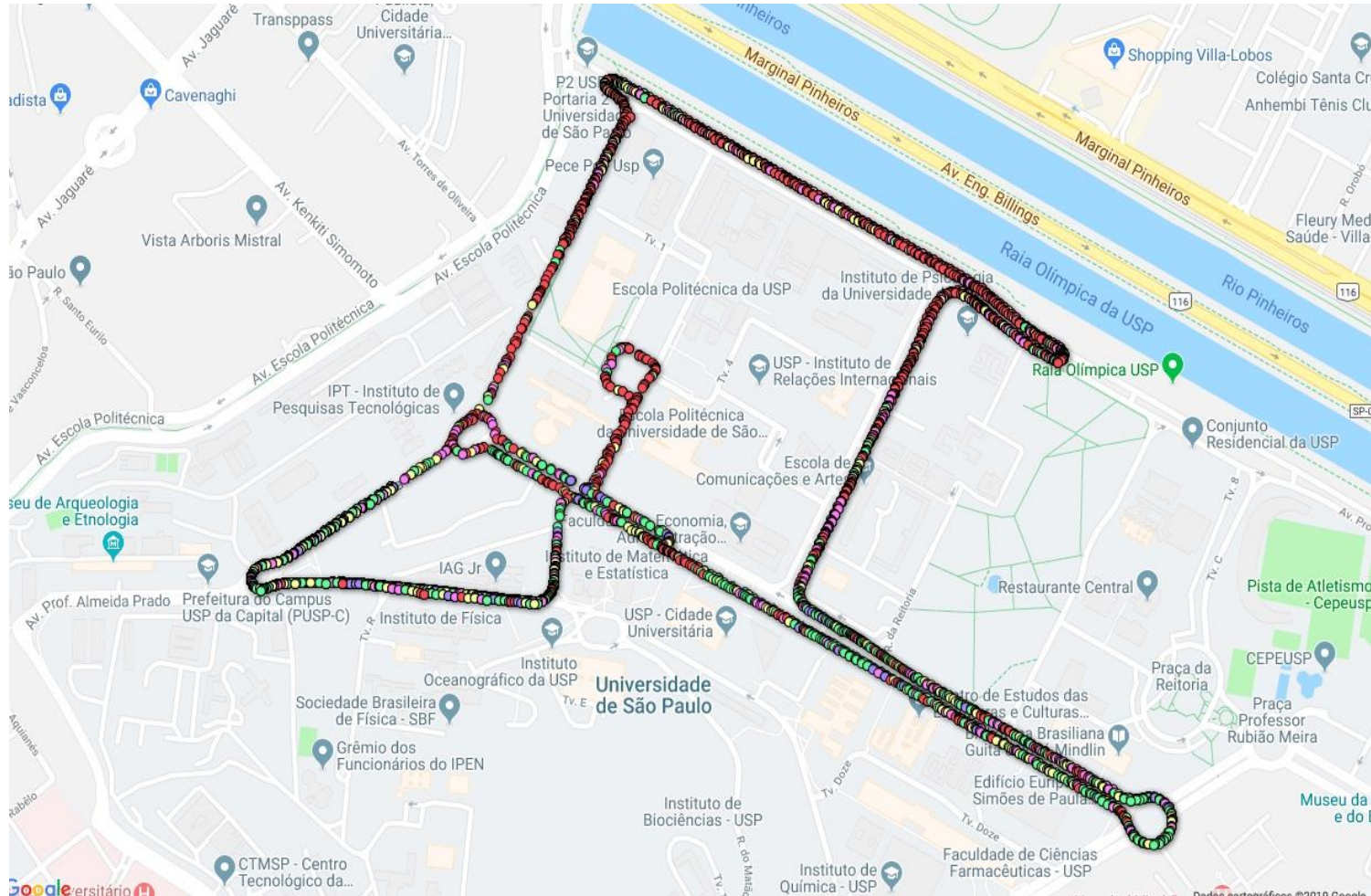


15h21m01s389

15h35m43s999

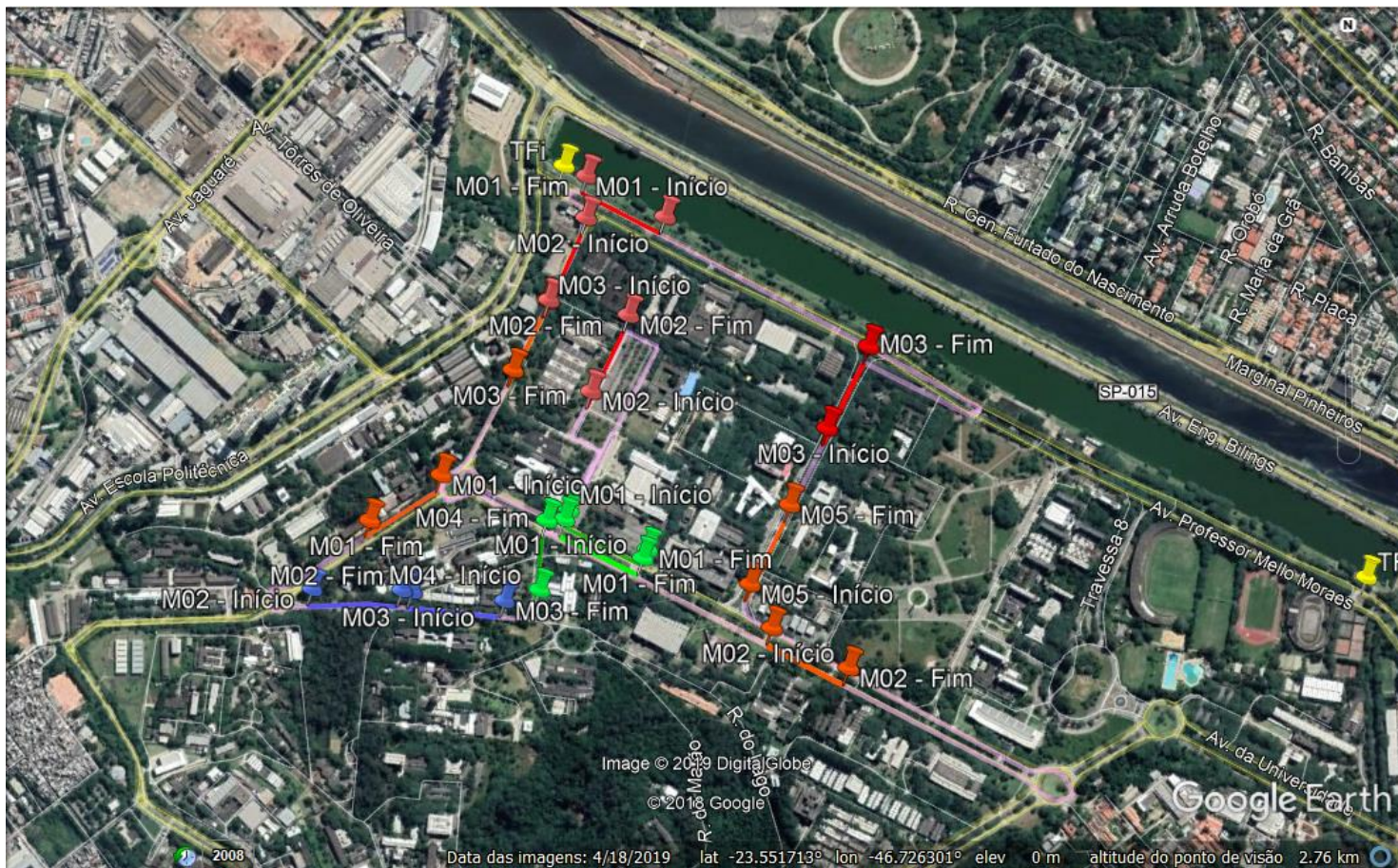
VALIDAÇÃO TÉCNICA

- Escolher trajetórias de referência para que houvesse uma calibração dos resultados



VALIDAÇÃO TÉCNICA

- Escolher trajetórias de referência para que houvesse uma calibração dos resultados

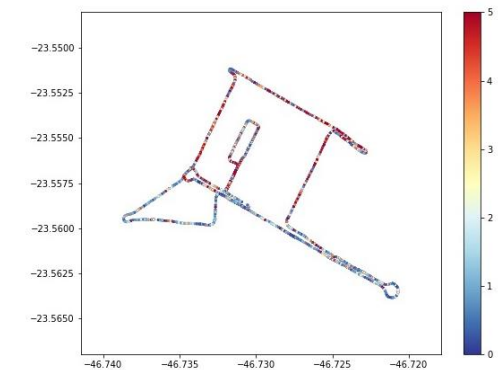


	IRI (mm/m)	classificação
1	5,7	Regular
2	10,5	Péssimo
3	14,7	Péssimo
4	13,3	Péssimo
5	10,9	Péssimo
6	8,1	Ruim
7	4,8	Regular
8	3,9	Bom
9	1,8	Regular
10	6,2	Regular
11	6,7	Regular
12	11,4	Péssimo
13	10,5	Péssimo

VALIDAÇÃO TÉCNICA

- Escolher trajetórias de referência para que houvesse uma calibração dos resultados

10	3,60	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
1	Linhas	2502	1695	2631	2267	1563	1877	2263	2141	2170	3853	1733	1772	1646
2	IRI	5,8	10,5	14,7	13,3	11,0	8,1	4,8	3,9	4,8	6,2	6,7	11,4	10,5
3	RMS 10-EAZ	2,3	4,8	6,1	6,1	5,8	3,2	2,6	2,5	3,1	3,5	2,4	9,6	4,5
4	RMS EAZ/vel	1,3	1,6	1,1	1,1	0,9	0,8	1,0	1,1	1,0	1,2	1,2	1,0	1,7
5	Media EAZ	9,5	9,6	9,3	9,6	9,2	9,5	9,4	9,4	9,4	9,3	9,4	8,6	9,3
6	Mediana EAZ	9,5	9,5	9,6	9,7	9,4	9,5	9,5	9,5	9,5	9,5	9,5	9,4	9,3
7	Media 10-EAZ	0,5	0,4	0,7	0,4	0,8	0,5	0,6	0,6	0,6	0,7	0,6	1,4	0,7
8	Mediana 10-EAZ	0,5	0,5	0,4	0,3	0,6	0,5	0,5	0,5	0,5	0,5	0,5	0,6	0,7
9	Media EAZ/Vel	1,2	1,4	0,9	0,9	0,8	0,8	0,9	1,0	0,9	1,1	1,1	0,7	1,5
10	Mediana EAZ/Vel	1,1	1,3	0,8	0,9	0,8	0,7	0,8	0,9	0,8	1,0	0,9	0,7	1,4
11	(RMS EAZ/vel) ⁻¹	0,4	0,2	0,2	0,2	0,2	0,3	0,4	0,4	0,3	0,3	0,4	0,1	0,2
12	(Media EAZ/Vel) ⁻¹	0,8	0,7	1,2	1,1	1,3	1,3	1,1	1,0	1,1	1,0	0,9	1,4	0,7
13	(Mediana EAZ/Vel) ⁻¹	0,9	0,8	1,2	1,1	1,3	1,4	1,2	1,1	1,2	1,0	1,1	1,3	0,7
14	Media vel	31,4	26,4	45,1	38,6	45,0	46,2	40,2	36,5	40,1	35,9	37,4	44,8	24,1
15	RMS EAZ abs(n-(n-1))	2,8	6,7	8,0	8,3	8,2	4,2	3,6	3,3	4,2	4,7	3,0	13,4	6,1
16	Media EAZ abs(n-(n-1))	1,8	3,9	4,9	5,5	5,8	2,7	2,4	2,1	2,2	2,4	1,6	9,0	3,8
17	Mediana EAZ abs(n-(n-1))	1,8	3,9	4,9	5,5	5,8	2,7	2,4	2,1	2,2	2,4	1,6	9,0	3,8
18	Media abs(10-EAZ)	5,0	1,8	0,4	2,7	2,2	6,1	1,4	4,8	1,9	2,6	0,1	29,6	1,9
19	Mediana abs(10-EAZ)	0,7	4,9	0,4	1,4	1,9	6,9	0,2	1,1	2,2	0,3	0,0	9,6	8,5
20	Media abs(media-EAZ)	0,2	4,5	13,6	6,1	1,9	1,7	1,6	0,9	2,8	2,4	2,7	1,1	10,2
21	Mediana abs(media-EAZ)	0,3	4,5	13,6	3,0	1,9	1,7	1,5	1,4	2,8	3,8	0,1	8,8	10,2
22	RMS (media-EAZ)	2,3	4,8	6,0	6,1	5,7	3,1	2,5	2,4	3,0	3,4	2,3	9,5	4,4
23	RMS EAZn-(n-1)	2,8	6,7	8,0	8,3	8,2	4,2	3,6	3,3	4,2	4,7	3,0	13,4	6,1
24	Sd	2,3	4,8	6,0	6,1	5,7	3,1	2,5	2,4	3,0	3,4	2,3	9,5	4,4
25	Sd/Media	0,2	0,5	0,6	0,6	0,6	0,3	0,3	0,3	0,3	0,4	0,2	1,1	0,5
26	Mediana - Sd	4,9	-0,2	-2,5	-2,5	-2,1	3,3	4,5	4,6	3,5	2,6	4,9	-9,6	0,5
27		2,27												

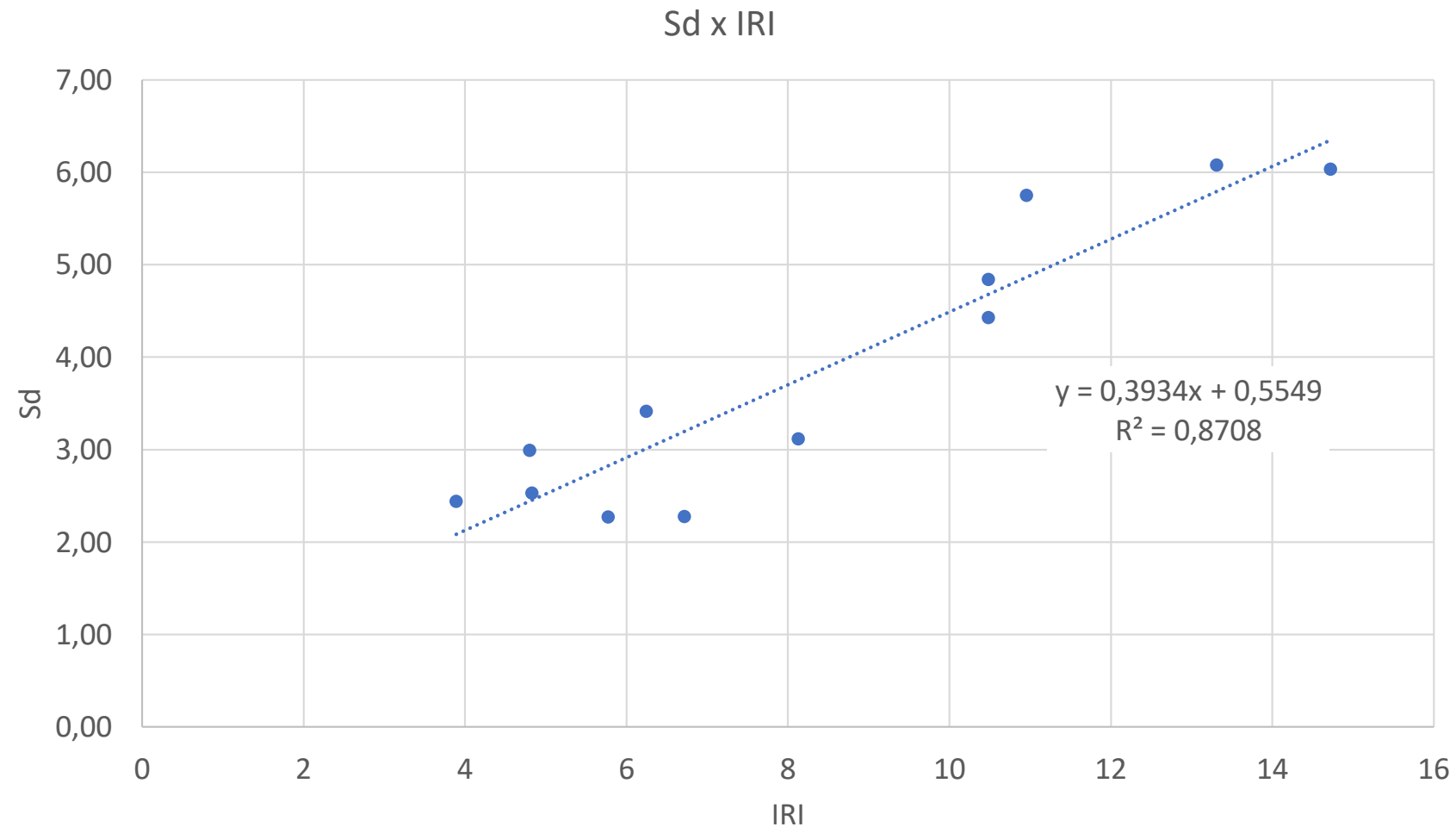


- Escolher trajetórias de referência para que houvesse uma calibração dos resultados

A photograph of a handwritten mathematical formula on a piece of paper. The formula is:
$$\text{RMS}(M_{\text{m}} - \text{EAZ}) = \sqrt{\frac{\sum (\overline{\text{EAZ}} - \text{EAZ}_m)^2}{n}}$$

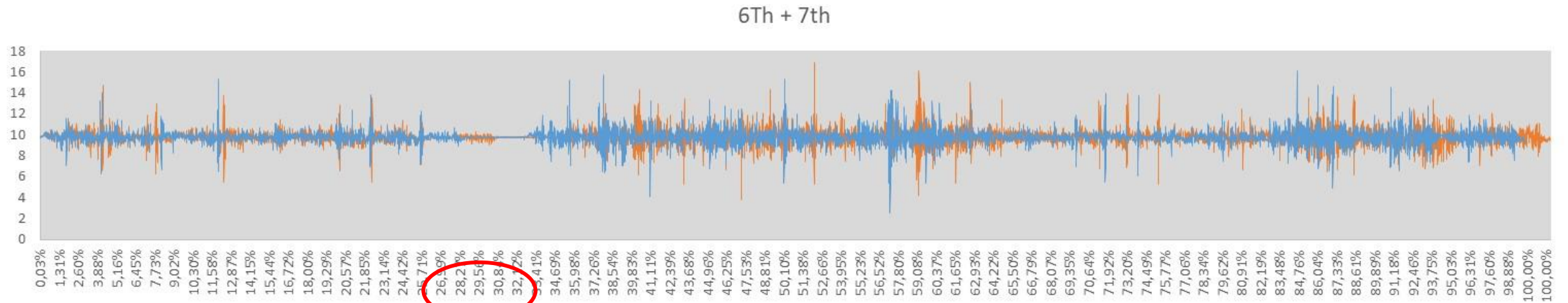
$$\text{RMS} = \text{RAIZ}(\text{SOMAQUAD}(\text{MÉDIA}(\text{ExernalAcelZ}) - \text{ExernalAcelZ}) / \text{CONT.NUM}(\text{N:N}))$$

- Escolher trajetórias de referência para que houvesse uma calibração dos resultados



RESULTADOS

- Eliminação da interferência da vibração própria do carro

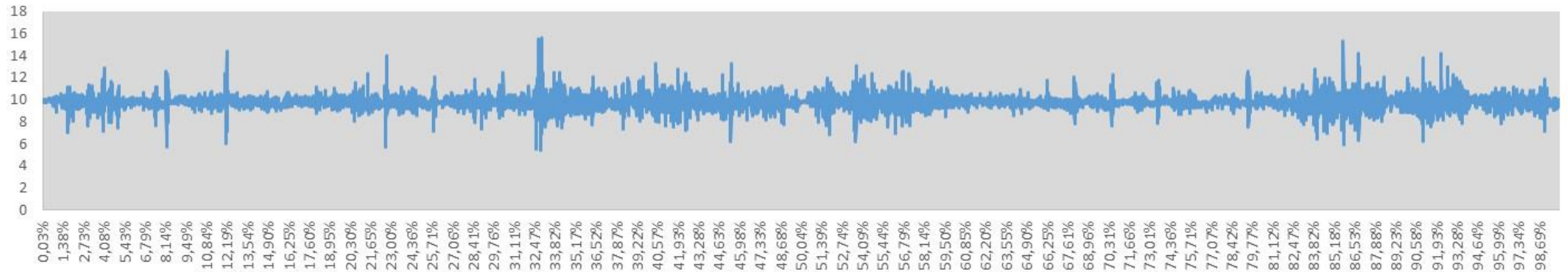


Veículo parado

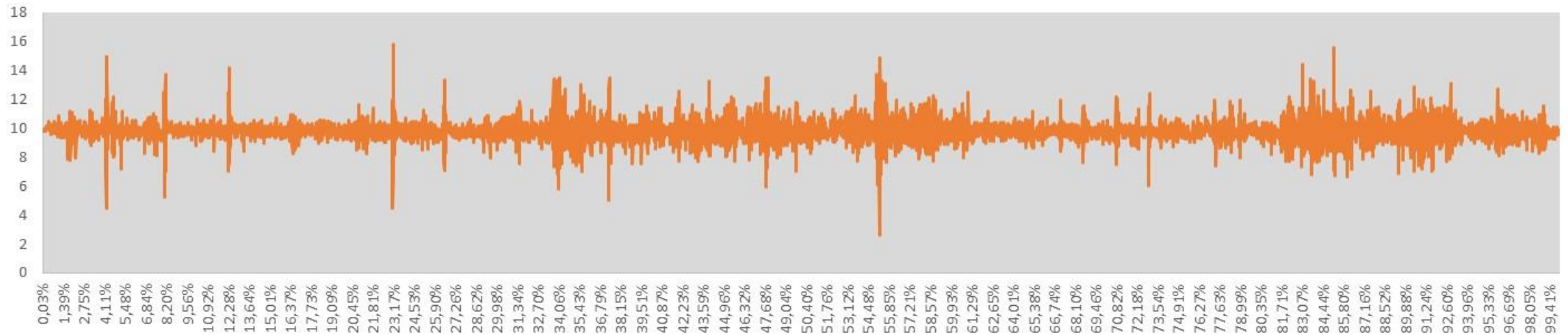
RESULTADOS

- Entender o nível dos sinais

1st - Bruto



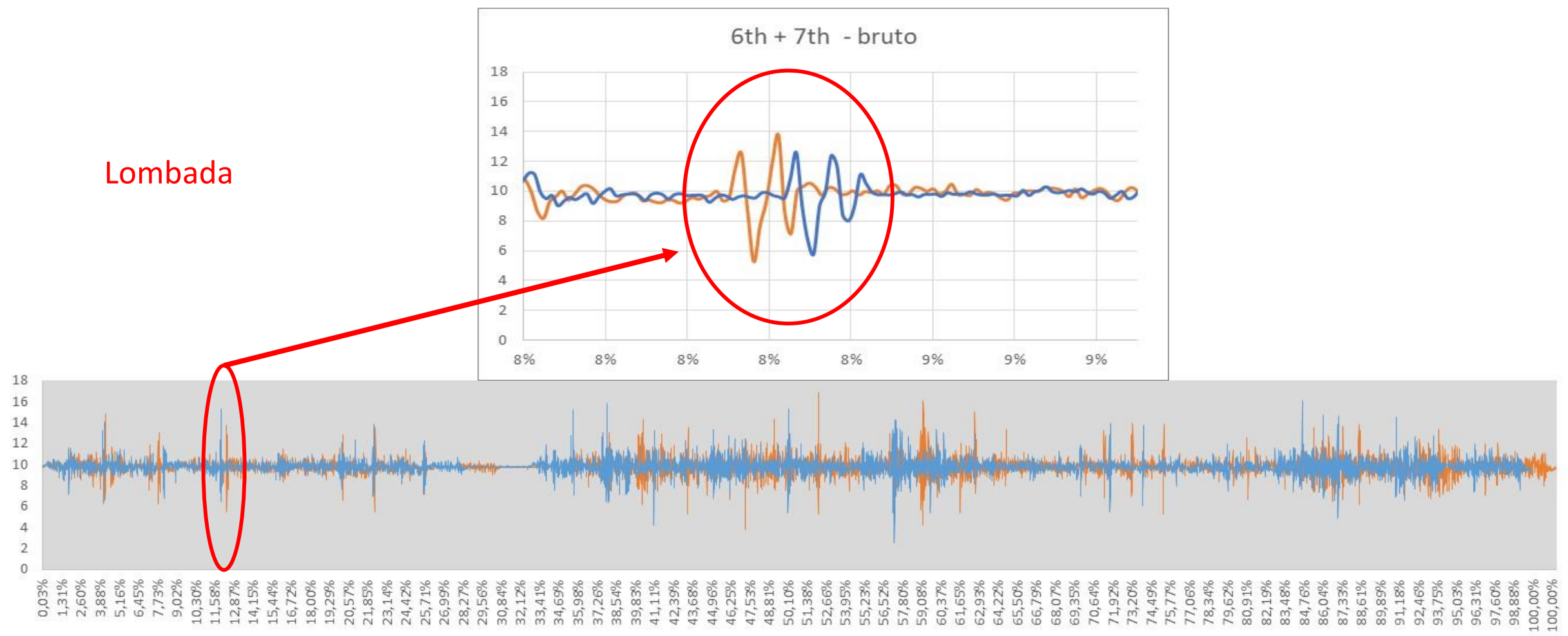
5th - Bruto



RESULTADOS

- Caracterização dos defeitos pontuais

Lombada



- Alta repetibilidade para um mesmo trajeto

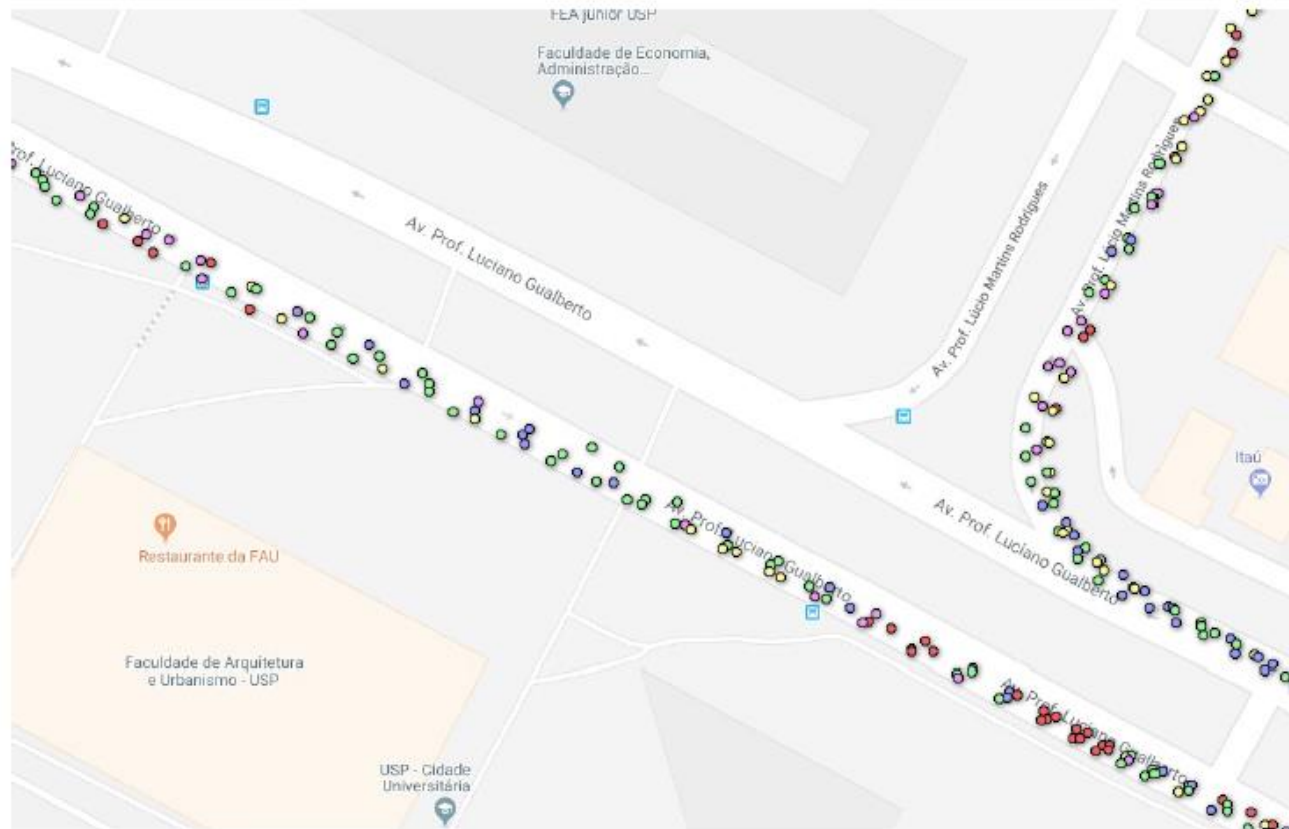
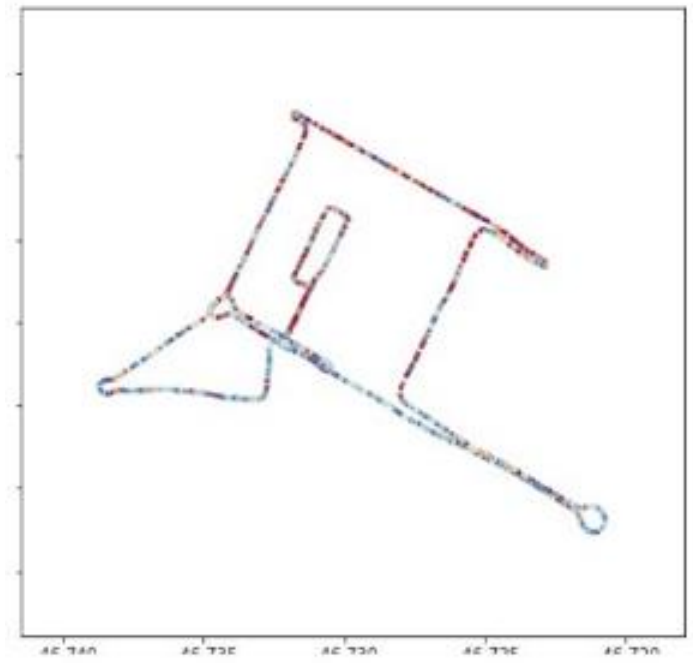
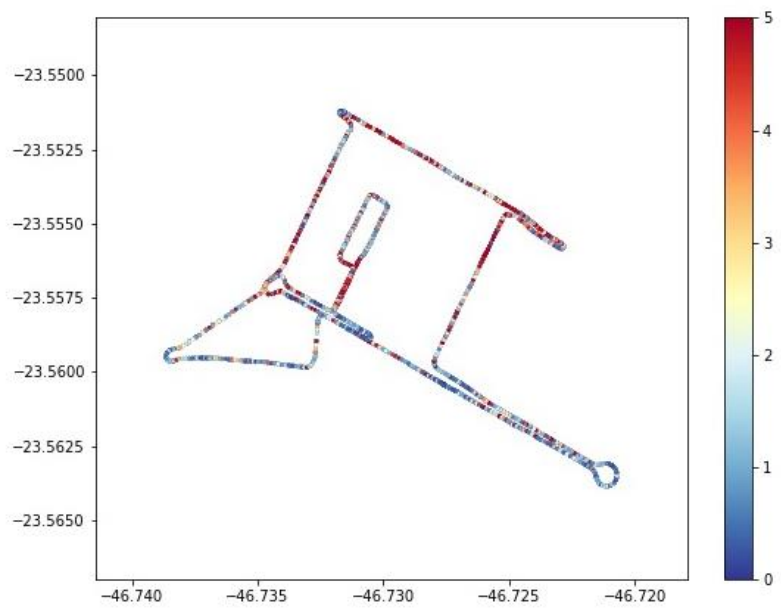
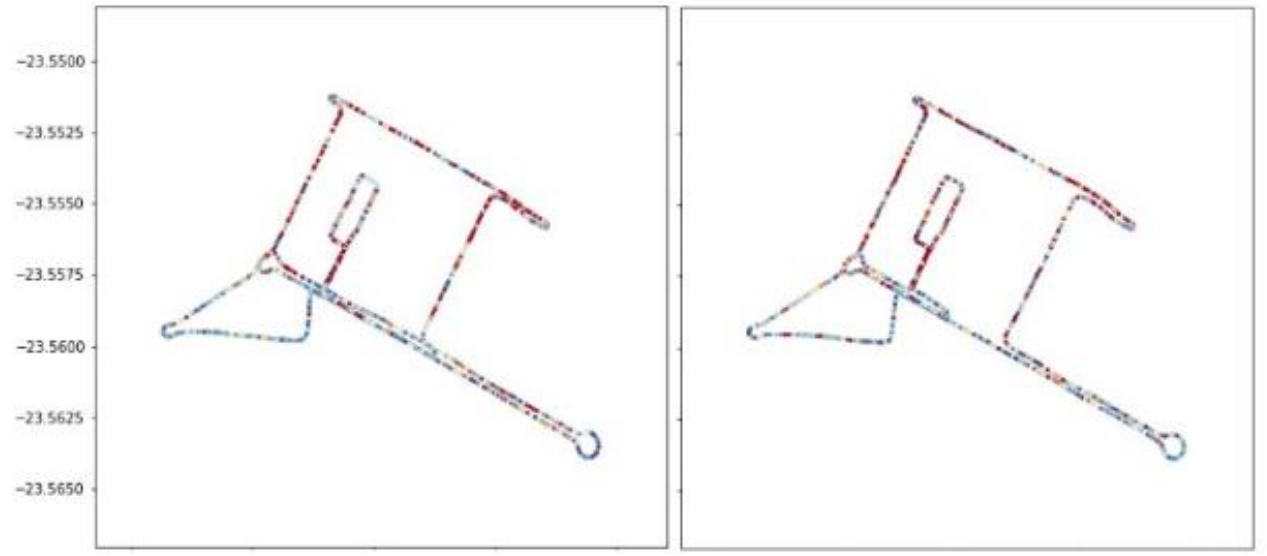
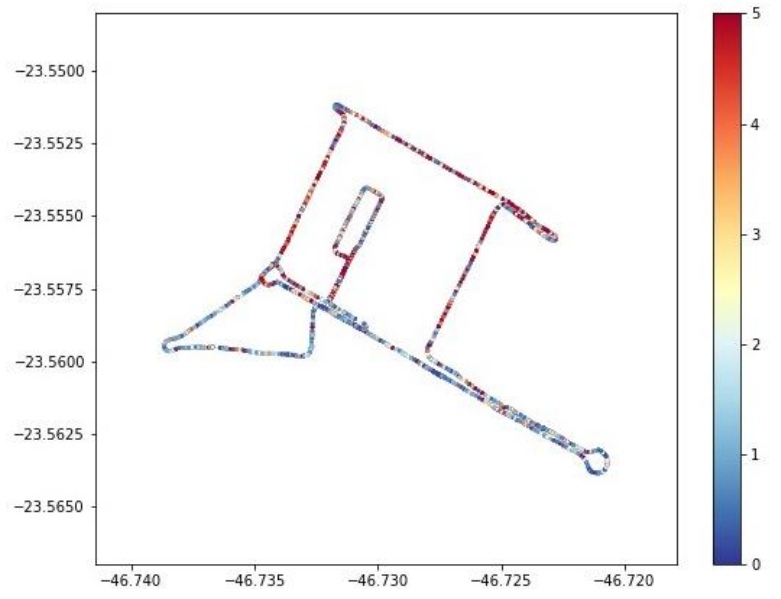


Figura: detalhe de 4 voltas coincidentes dentro da USP -SP em Jan/19

Avaliação da Amplitude ($Z_n - Z_{n-1}$)

Nível de qualidade Irregularidade do pavimento	Aceleração média (RMS) – m/s^2
Muito confortável	<0,3 (green)
Pouco desconfortável	0,3-0,6 (blue)
Regular	0,6-1,0 (yellow)
Ruim	1,0-1,5 (pink)
Extremamente desconfortável	>1,5 (red)

DESAFIOS



RESULTADOS

- Criar um sistema robusto que permita a adequada localização dos defeitos e irregularidades
- Escolher trajetórias de referência para que houvesse uma calibração dos resultados

Avaliação da Amplitude ($Z_n - Z_{n-1}$)

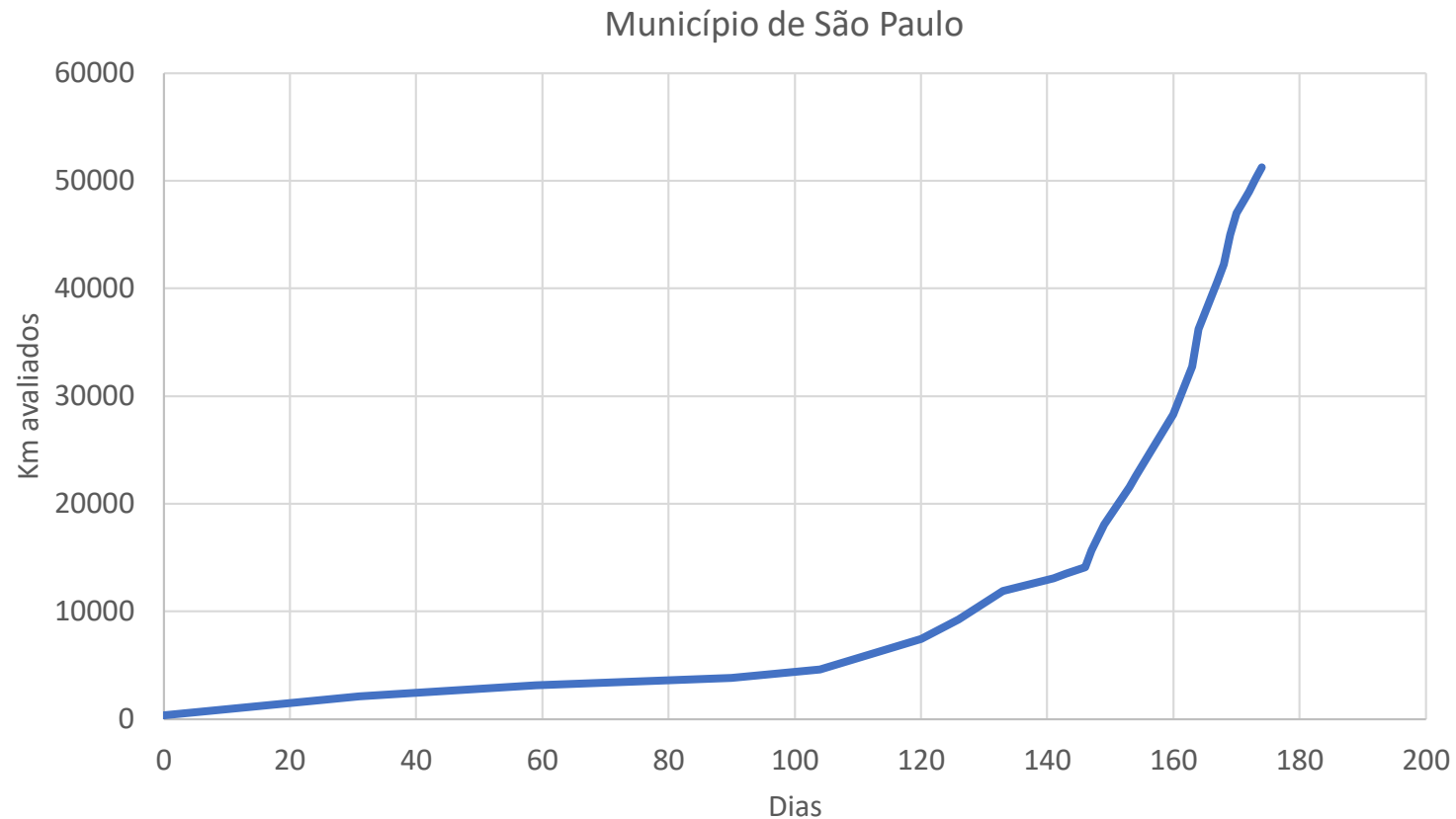
Nível de qualidade Irregularidade do pavimento	Aceleração média (RMS) – m/s ²
Muito confortável	<0,3
Pouco desconfortável	0,3-0,6
Regular	0,6-1,0
Ruim	1,0-1,5
Extremamente desconfortável	>1,5

normalização ISO 2631:1 de 1997

Nível de conforto humano	Aceleração média (RMS) – m/s ²
Muito confortável	<0,315
Pouco desconfortável	0,315-0,63
Medianamente desconfortável	0,50-1,00
Desconfortável	0,80-1,60
Muito desconfortável	1,25-2,50
Extremamente desconfortável	>2,0

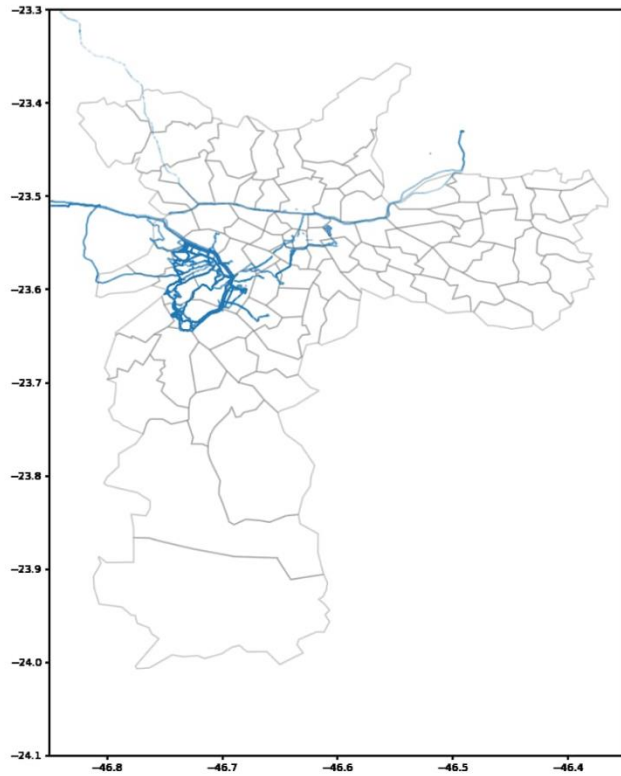
RESULTADOS

- ~1500KM/DIA
- Eliminação de baixas velocidades ($v > 10\text{km/h}$)
- Acréscimo diário superior a 1.500.000 de linhas (**BIG DATA & Analytics**)
- **Já foram transitadas em torno de 60% das ruas do município**

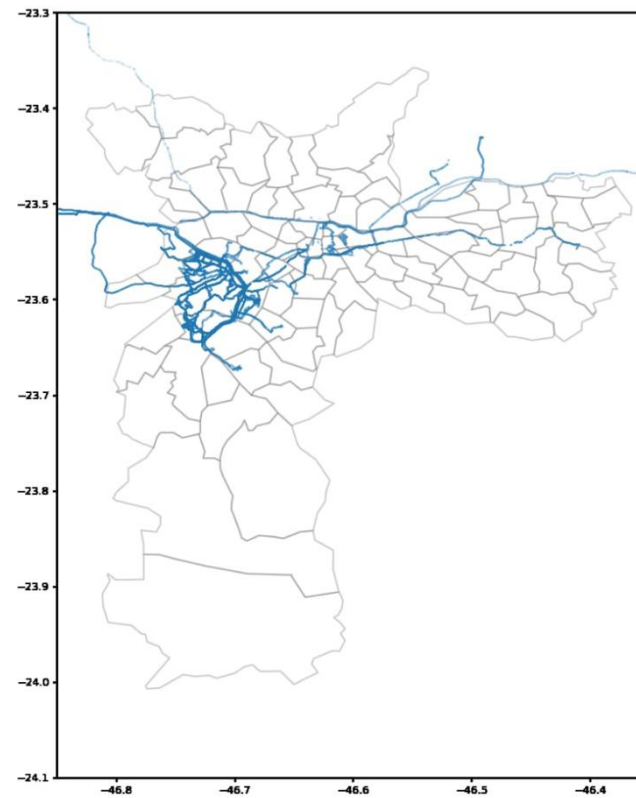


RESULTADOS

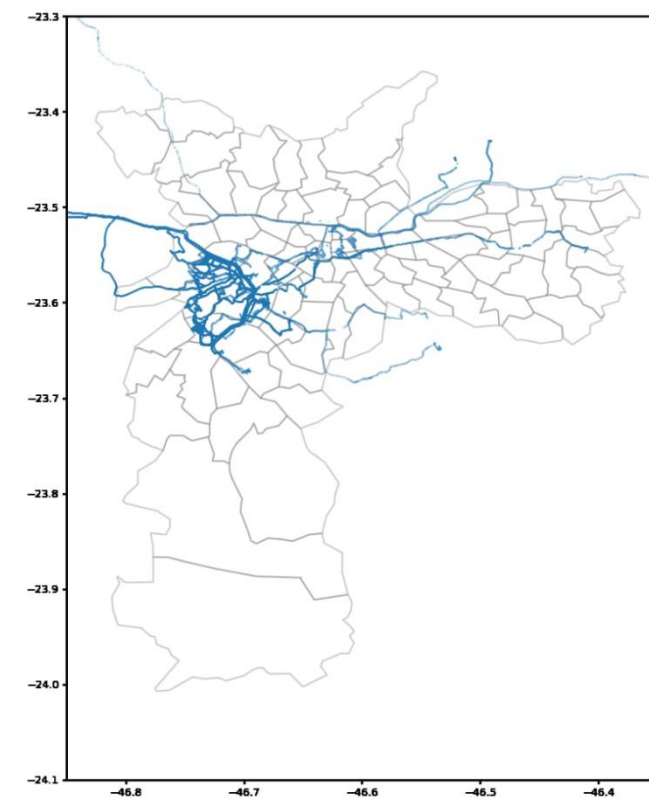
- Mapas ilustrativos da evolução



2018



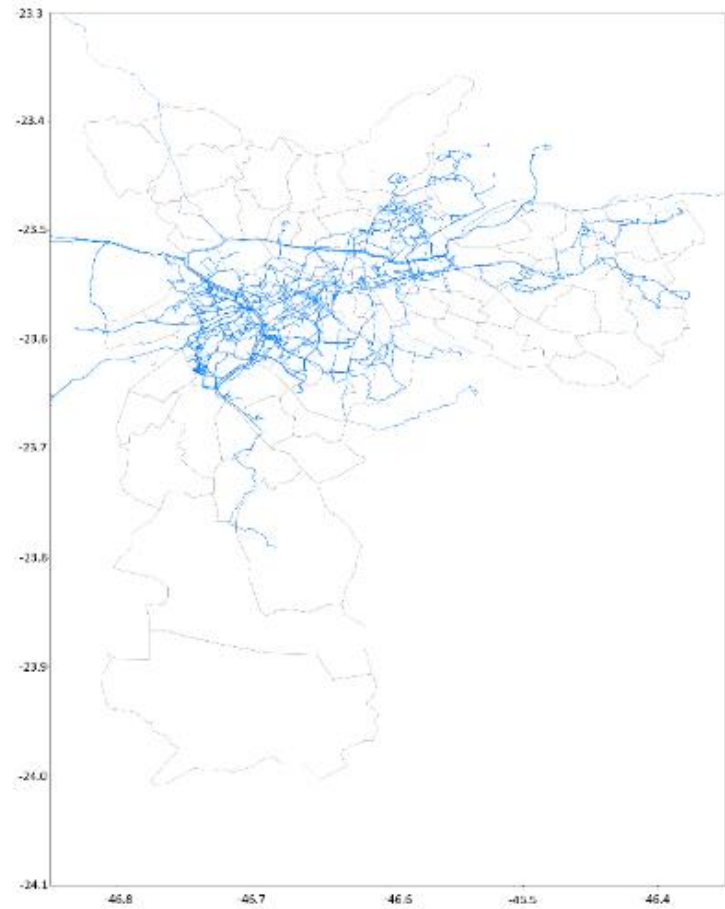
Janeiro



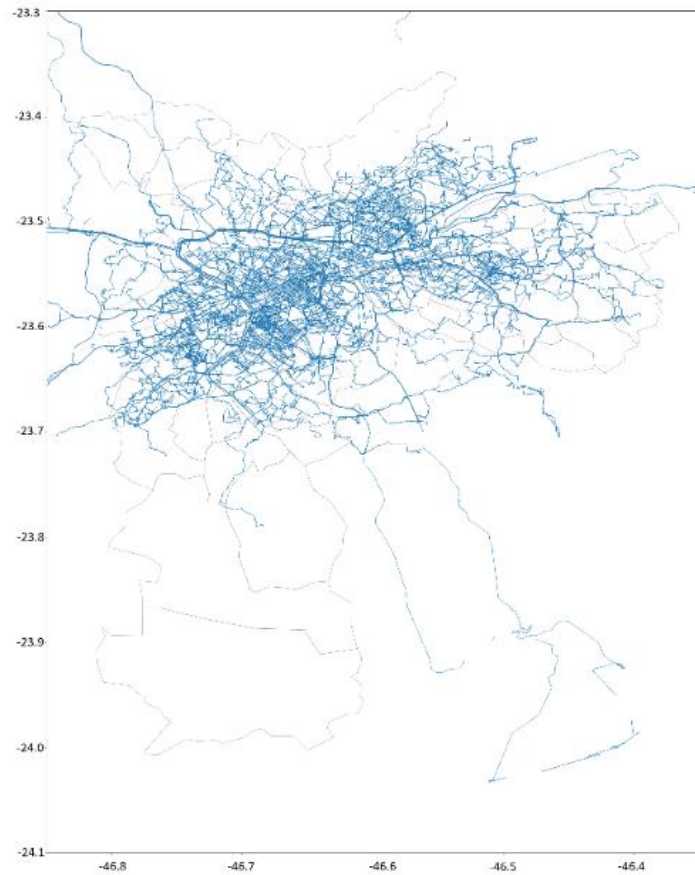
Fevereiro

RESULTADOS

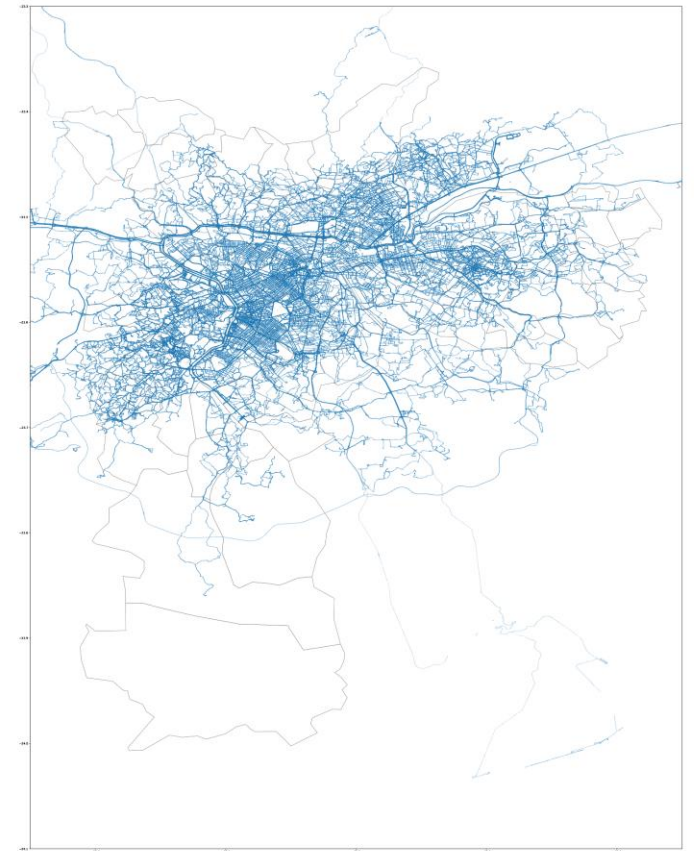
- Mapas ilustrativos da evolução



abril

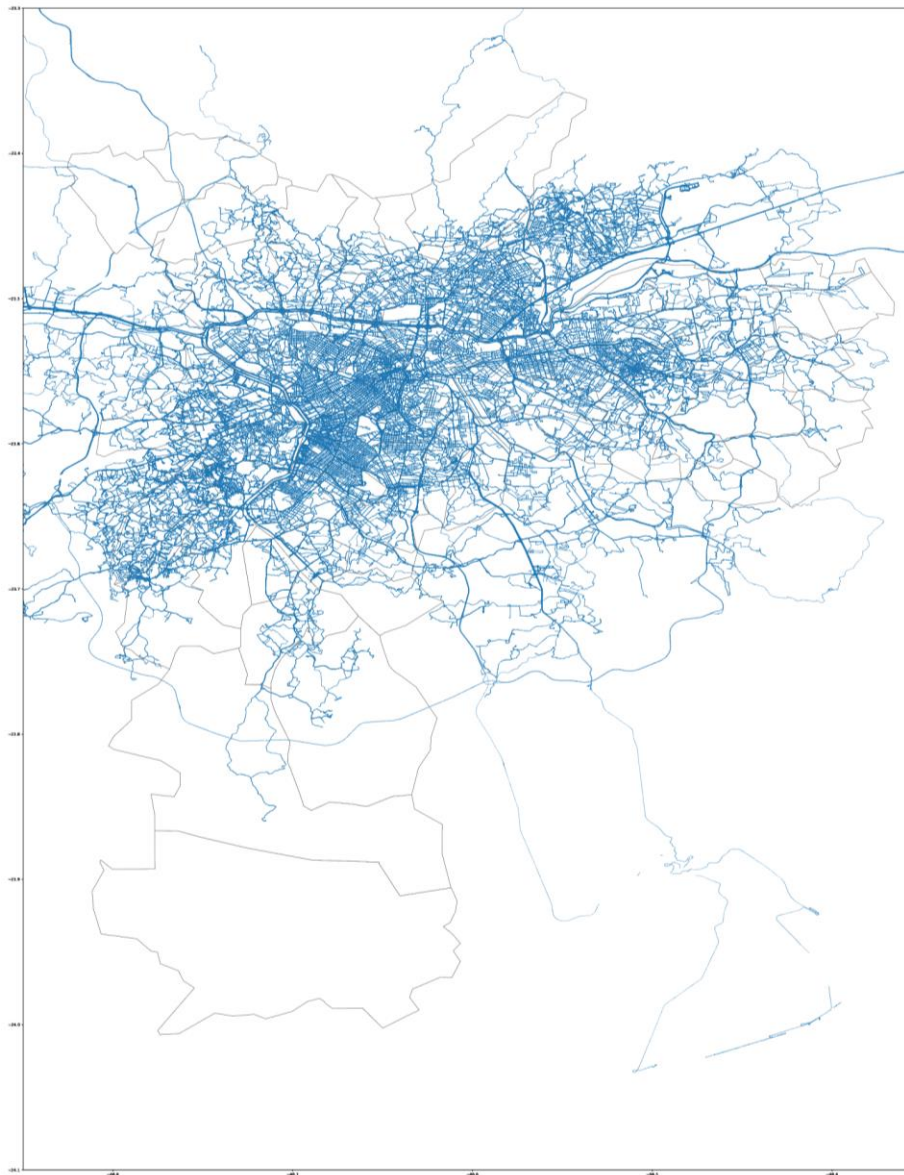


Maio



Junho

- Mapas ilustrativos da evolução



Julho/2019

RESULTADOS

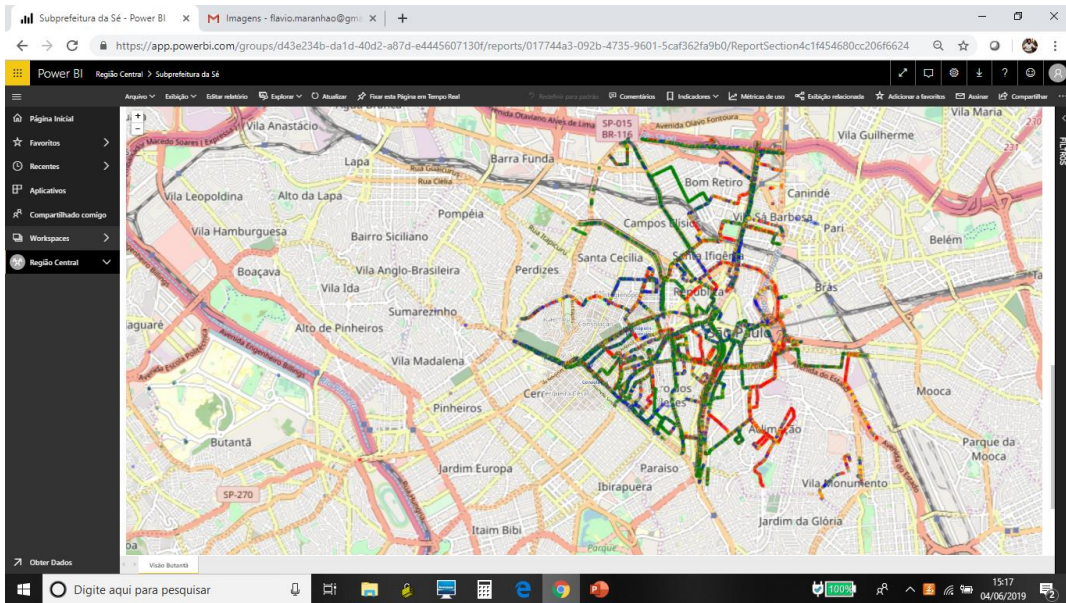
- Acompanhamento das vias que sofreram grande intervenções



Comprovação das melhorias realizadas na intervenção



RESULTADOS – prefeitura regional da Sé

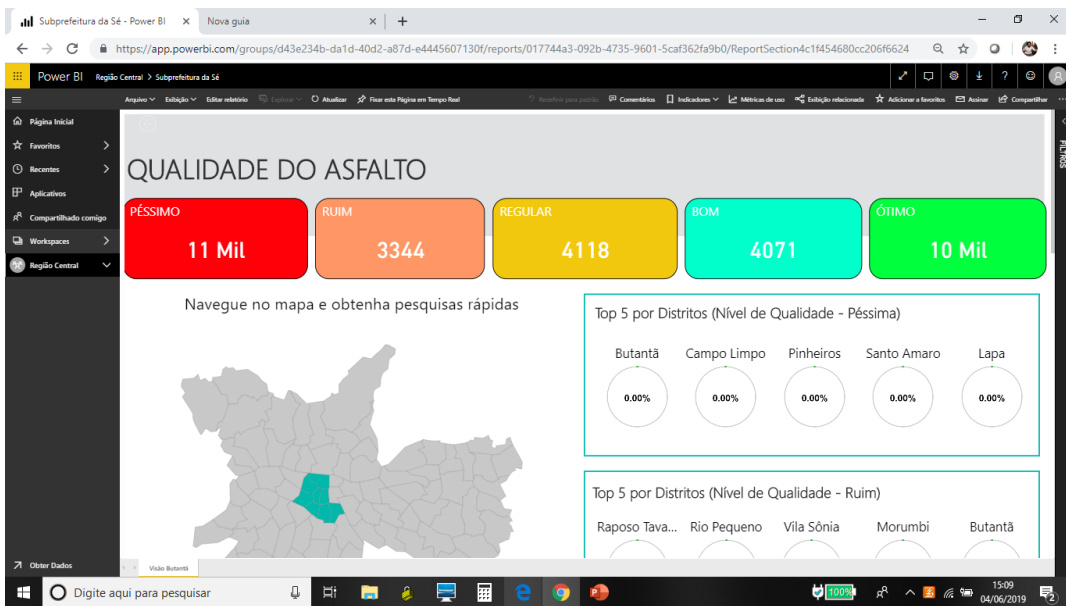


Rebouças

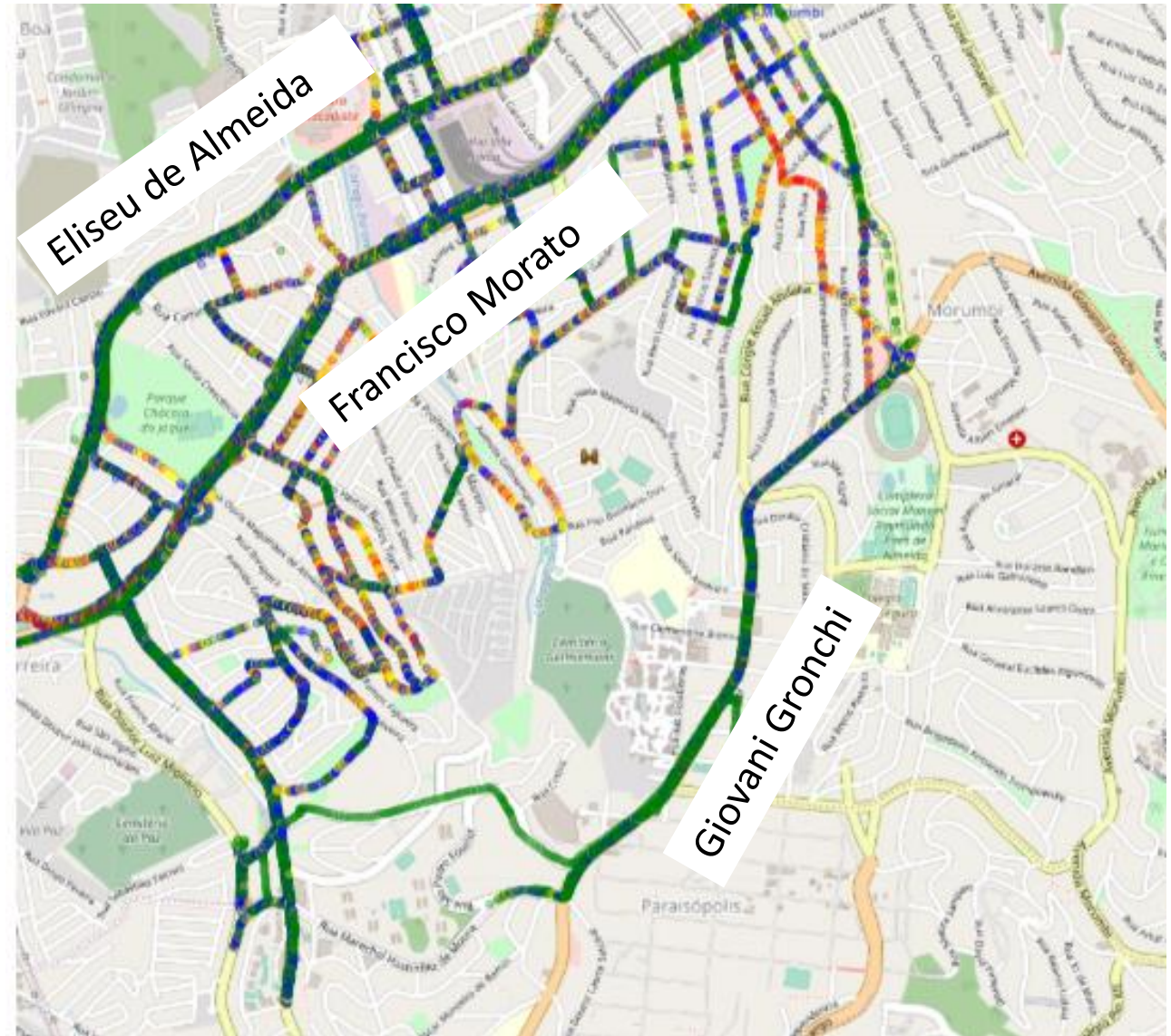
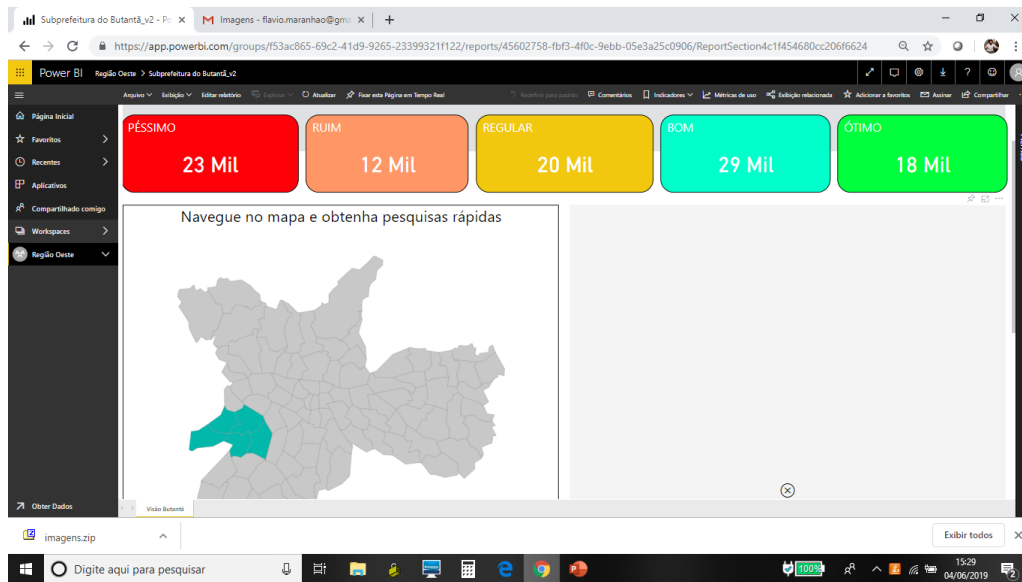
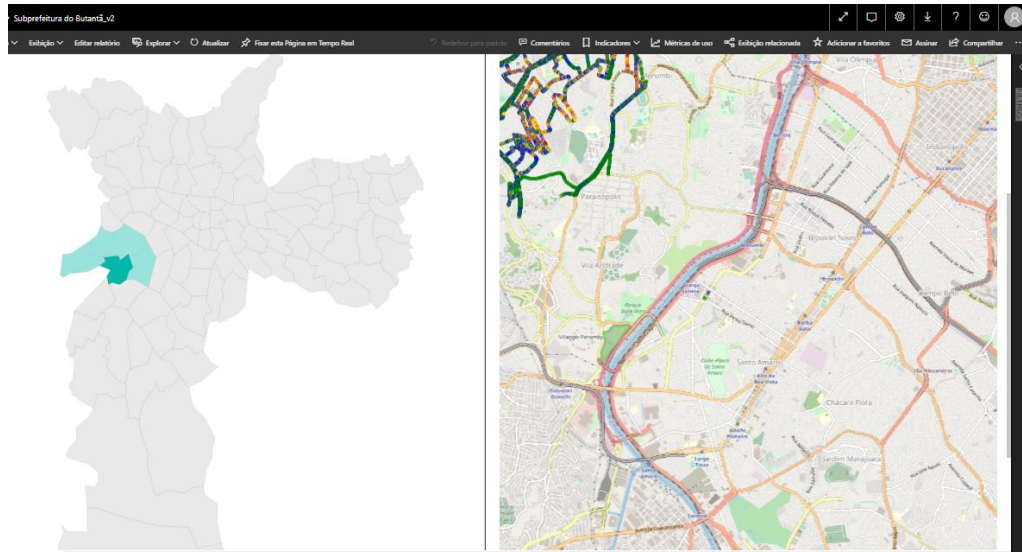
9 de Julho



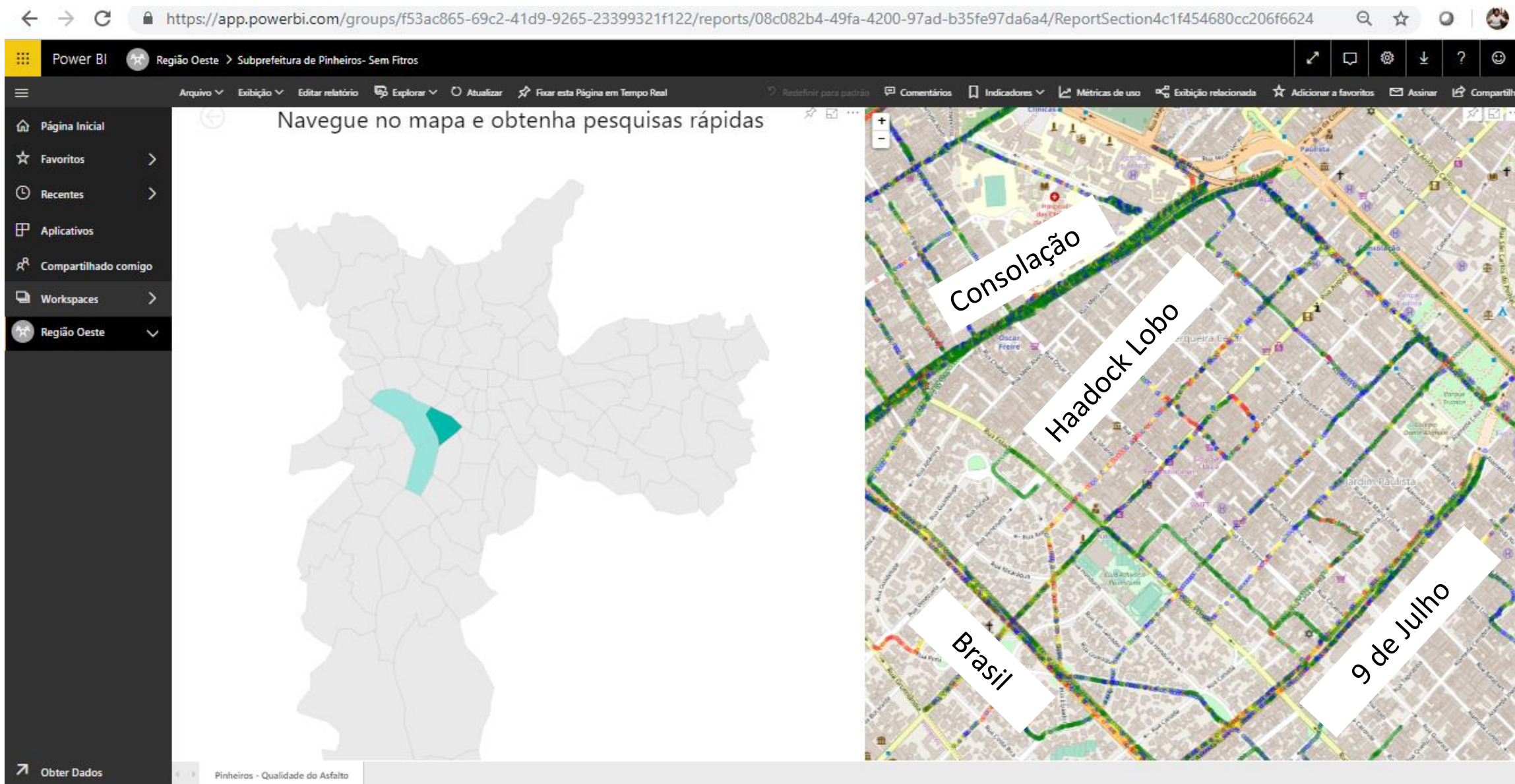
23 de Maio



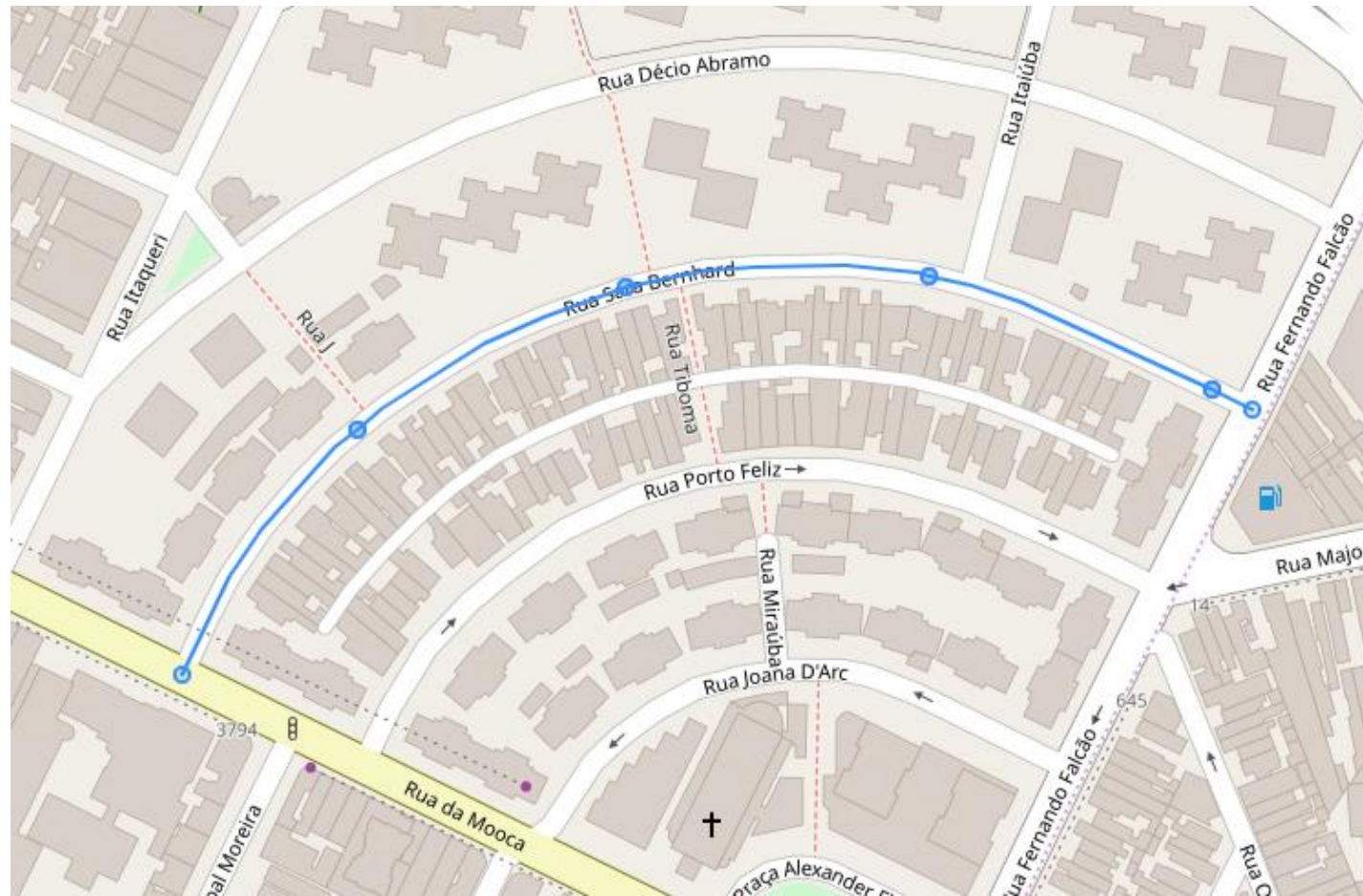
RESULTADOS – Butantã – distrito Vila Sônia



RESULTADOS – Pinheiros –

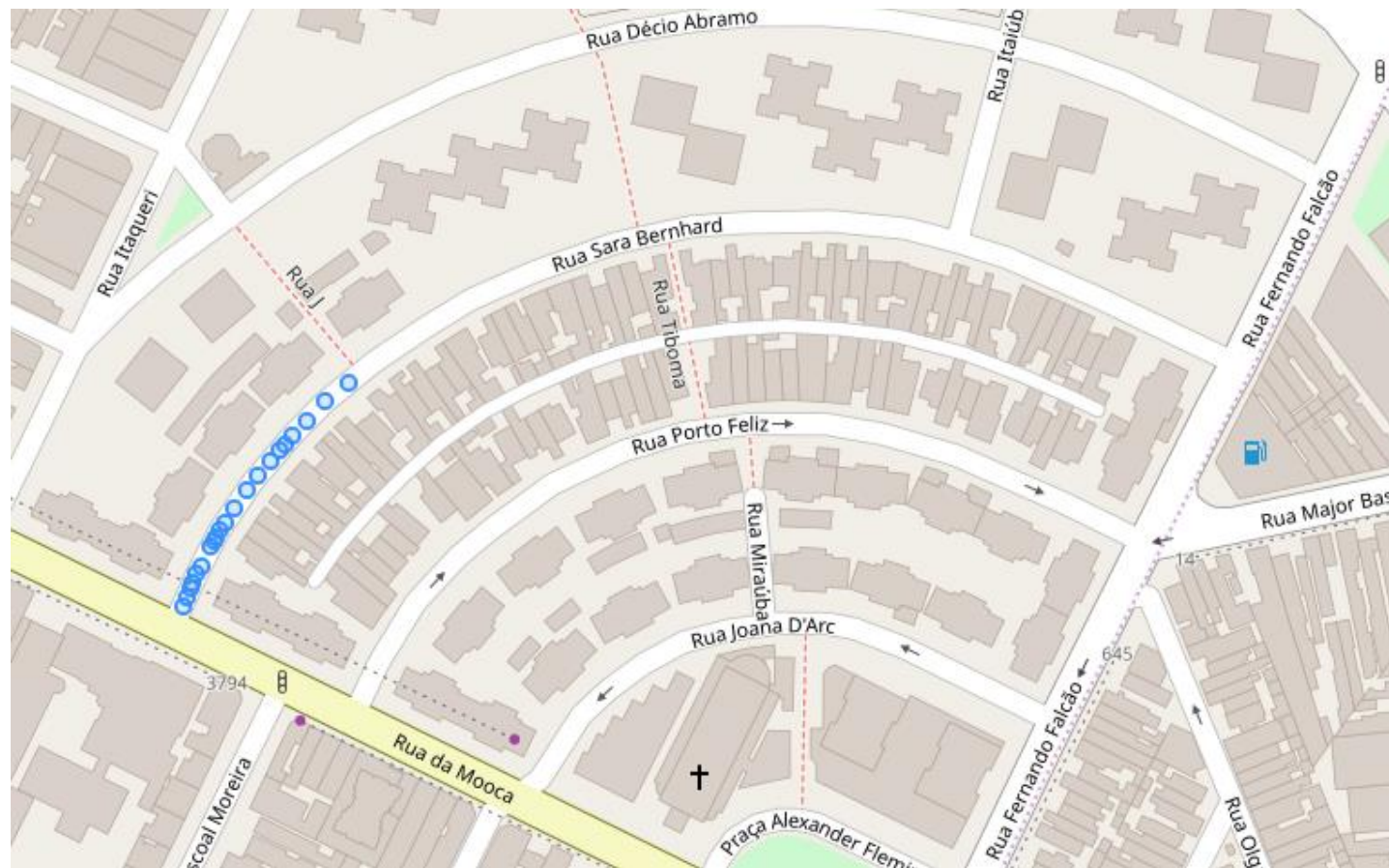


Transformar Pontos em trechos



- Divisão em segmentos de rua de no máximo 100 metros

Transformar Pontos em trechos



- Agrupando os dados dos pontos em segmentos

- 706.043 relações
21 min 48 seg

Power BI Região Noroeste

← → ↻ https://app.powerbi.com/groups/fc592c58-1429-4882-9d7b-40be4a4a00c2/list/dashboards

Meu Workspace

Pesquisar

WORKSPACES DO APLICATIVO

- Região Central
- Região Leste 1
- Região Leste 2
- Região Nordeste
- Região Noroeste
- Região Oeste
- Região Sudeste
- Região Sul

trabalho Conjuntos de dados Fluxos de dados

Mostrando 0 itens

AÇÕES PROPRIETÁRIO INCLUIDO NO APLICATIVO

Você não tem painéis

Todos os dashboards, neste workspace, estarão aqui.

+ Criar Configurações Access Publicar aplicativo

Obter Dados Criar workspace do aplicativo

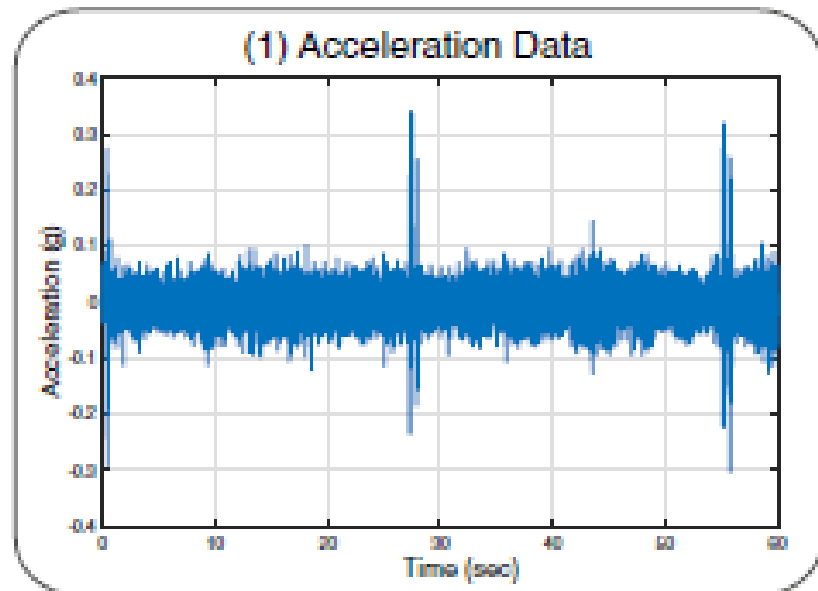
Digite aqui para pesquisar

15:54 04/06/2019

Crowdsensing Framework for Monitoring Bridge Vibrations Using Moving Smartphones

This paper discusses new services that can be delivered to urban environments through big data generated by the public's smartphones, enhancing the relationship between a city and its infrastructure.

By THOMAS J. MATARAZZO¹, PAOLO SANTI, SHAMIM N. PAKZAD, KRISTOPHER CARTER, CARLO RATTI, BABAK MOAVENI, CHRIS OSGOOD, AND NIGEL JACOB



significant indicators of the first three modal frequencies of the bridge. This result confirmed that bridge modal frequencies can be detected from this class of mobile smartphone data. In particular, when aggregated, the smartphone results improved in precision and, in one case, rivaled those of the reference sensor. The outcome is an opportunity for local governments to collaborate with entities having complementing strengths, to encourage mass collection of data containing bridge vibrations, which can contribute to more effective management and informed decision making. Over a longer period of time, continued programs can keep these urban assets in circulation throughout their design lives, reduce their maintenance costs, and potentially increase their service by extending their lifespans. ■

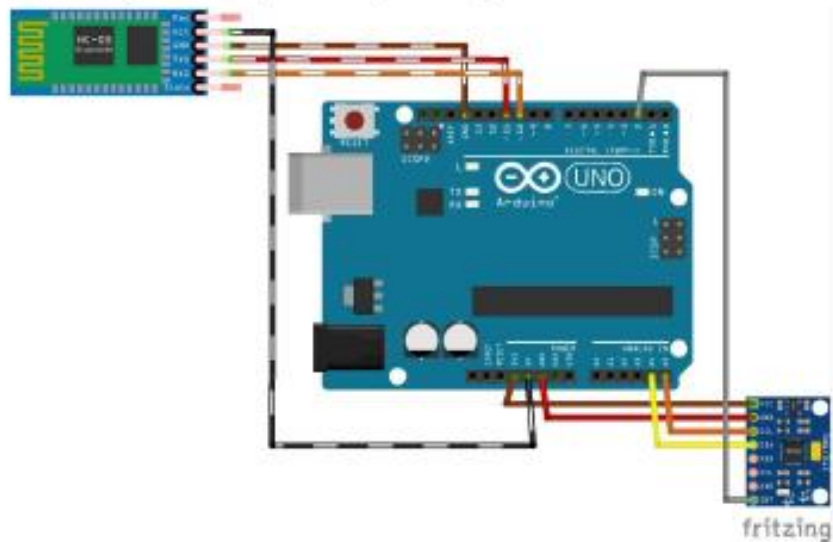
Figura 15 - Sistema sem fio e sem necessidade de programação, com sensores inteligentes ("Plug and Play").



Sistemas sem fio e sem necessidade de programação com sensores inteligentes "plug and play"

Fonte: Bittencourt (2013, p. 13)

Figura 21 - Protótipo Idealizado para a realização do monitoramento remoto.



Fonte: Própria autoria (2019)

Própria autoria (2019)

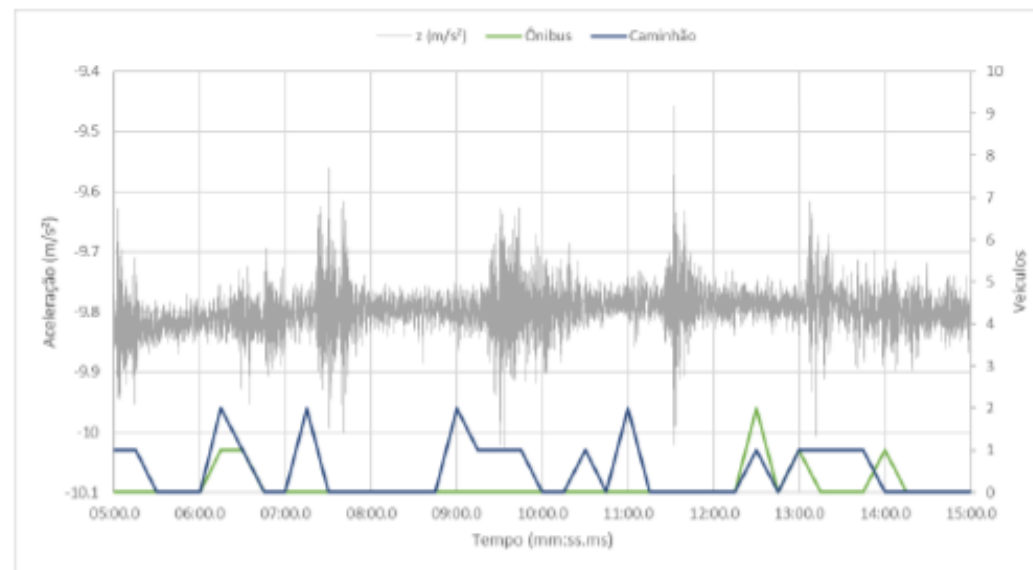


Gráfico 26 - Interação entre o Tráfego e a Aceleração Z, obtida pelo celular.

Própria autoria (2019)

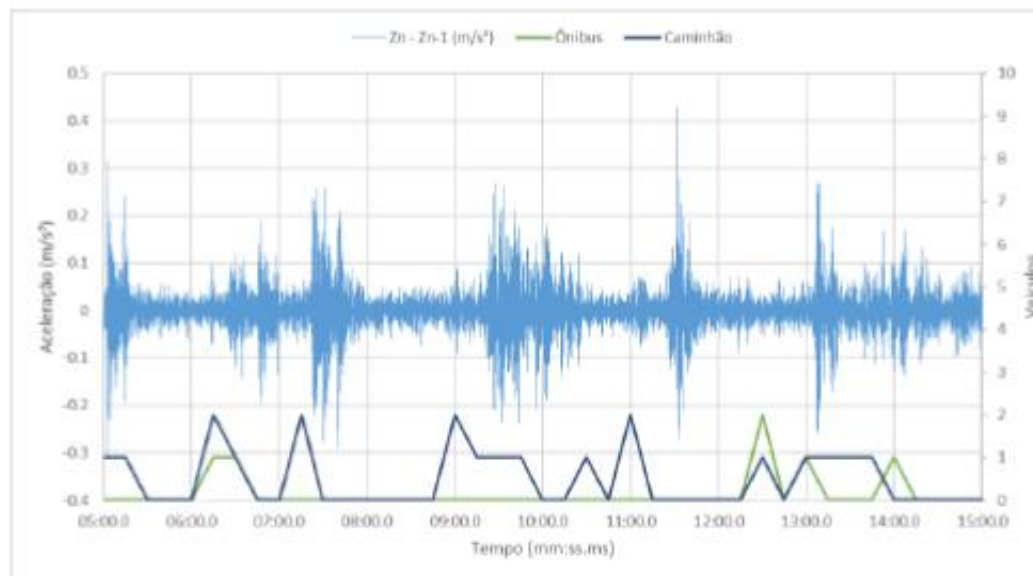
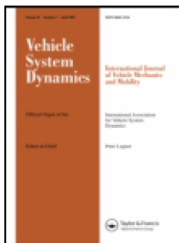


Gráfico 28 - Interação entre o Tráfego e a Amplitude Z1-Z1-1, obtida pelo celular.



Vehicle System Dynamics

International Journal of Vehicle Mechanics and Mobility

ISSN: 0042-3114 (Print) 1744-5159 (Online) Journal homepage: <https://www.tandfonline.com/loi/nvsvd20>

A comparative study on fault detection methods of rail vehicle suspension systems based on acceleration measurements

Xiukun Wei , Limin Jia & Hai Liu

Sensors 2015, 15, 20115–20139; doi:10.3390/s150820115

OPEN ACCESS
sensors
 ISSN 1424-8220
www.mdpi.com/journal/sensors

Review

Review of Trackside Monitoring Solutions: From Strain Gages to Optical Fibre Sensors

Georges Kouroussis ^{1,*}, Christophe Caucheteur ², Damien Kinet ², Georgios Alexandrou ¹, Olivier Verlinden ¹ and Véronique Moeyaert ²

¹ Department of Theoretical Mechanics, Dynamics and Vibrations, University of Mons—UMONS, Faculty of Engineering, Place du Parc 20, B-7000 Mons, Belgium;

E-Mails: geoalexan@hotmail.com (G.A.); olivier.verlinden@umons.ac.be (O.V.)

² Department of Electromagnetism and Telecommunications, University of Mons—UMONS, Faculty of Engineering, Place du Parc 20, B-7000 Mons, Belgium;

E-Mails: christophe.caucheteur@umons.ac.be (C.C.); damienv.kinet@umons.ac.be (D.K.);

veronique.moeyaert@umons.ac.be (V.M.)



KTH Royal Institute of Technology

Railway Applications of Condition Monitoring



Image source: © Claude Truong-Ngoc / Wikimedia Commons

Há iniciativas em todos o mundo para desenvolver soluções mais simples, práticas e econômicas para avaliação da qualidade superficial das ferrovias

Table 1. Performances of typical transducers for railway monitoring.

	Contributing Parameters	Requirements/Limitations
Strain gage	Wheel/rail force Vehicle position	Accurate positioning (neutral axis) Sensitive to electromagnetic interferences Difficulty of gluing and/or soldering (except waterproof or embedded sensor systems)
Accelerometers	Track deflection Vehicle position	Absolute motion Sensitive to external excitation Specific signal processing
Gyroscopes	Track deflection Vehicle position	Absolute motion Sensitive to external excitation Limited frequency range
LVDT	Track deformation	Specific mounting Limited frequency range
MDD	Foundation deflections	Specific installation

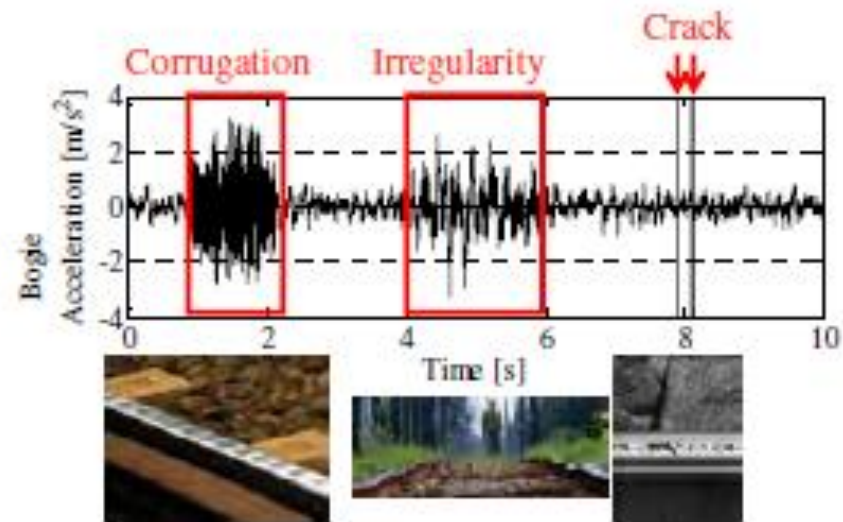
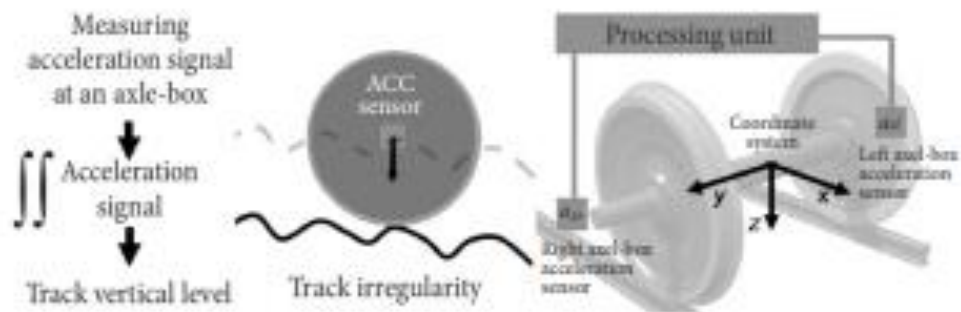
Tsunashima *et. al.* Condition Monitoring of Railway Track Using In-Service Vehicle

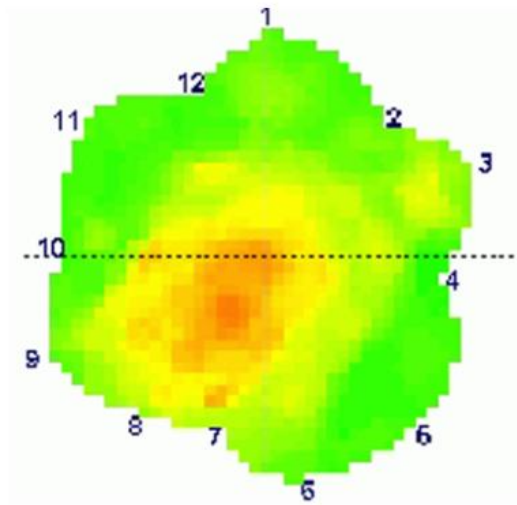
Fig. 1. Inertial track measurement at vertical level and application diagram

A instalação de acelerômetros e giroscópios nas rodas interligados com sistemas de georreferenciamento mostram-se promissores na identificação de anomalias pontuais

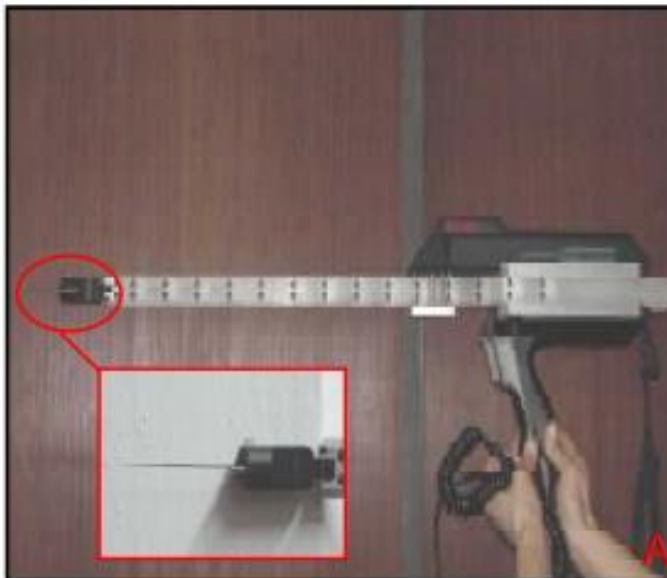
ÁRVORES -



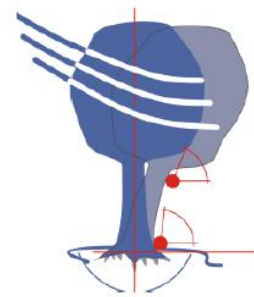
Tomógrafo de impedância



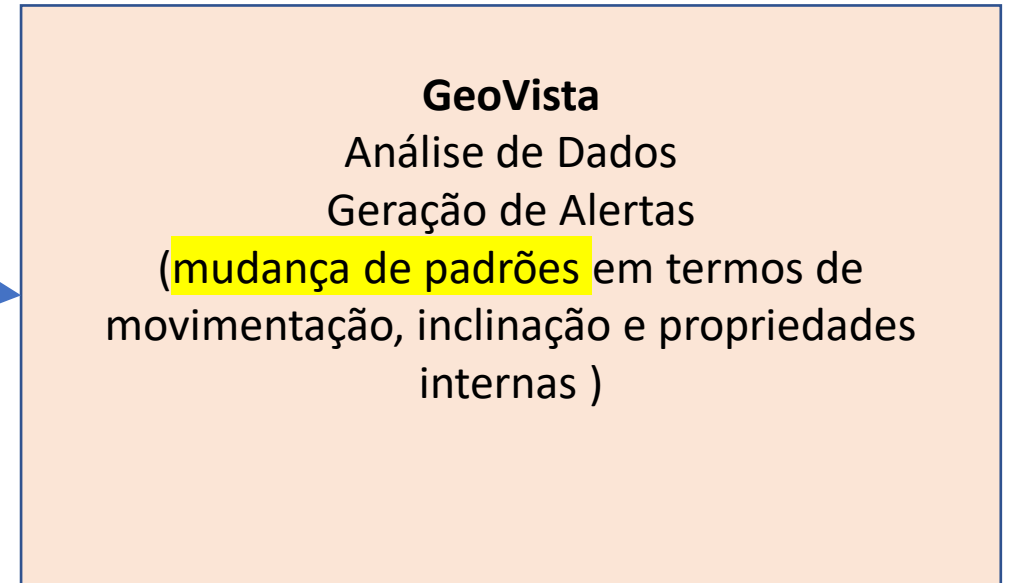
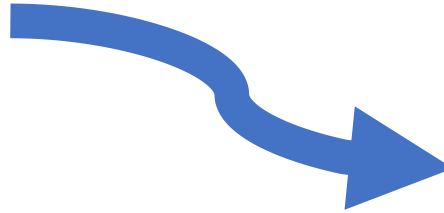
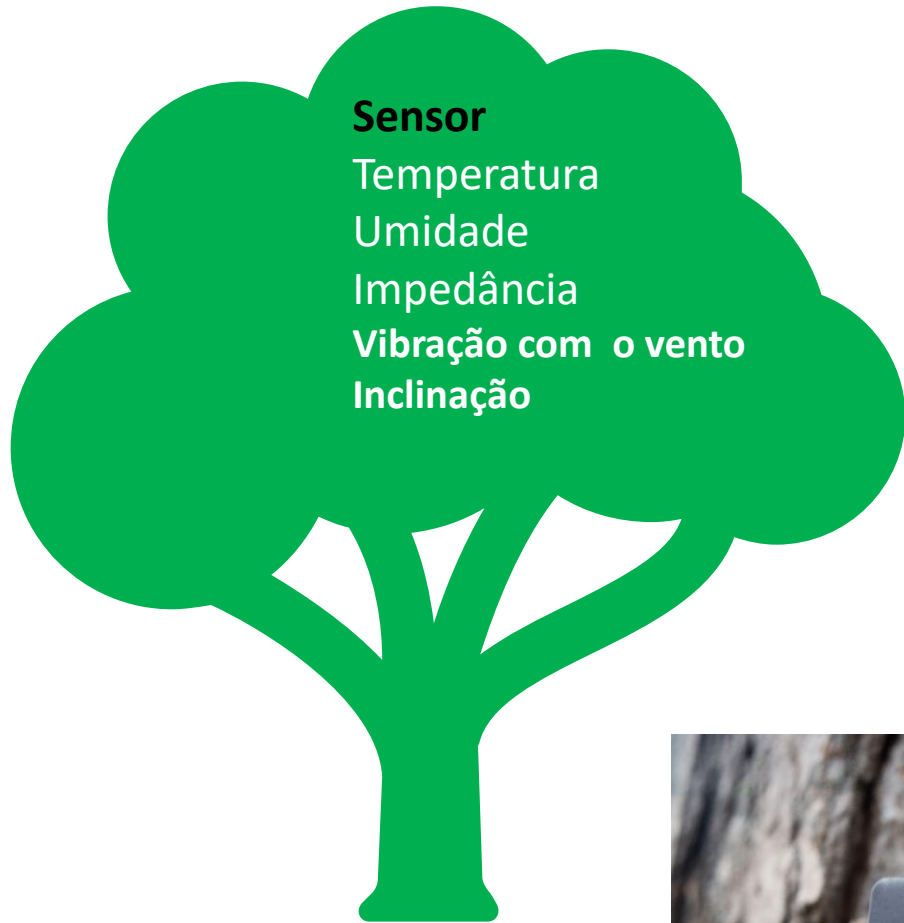
Inclinômetro



Penetrômetro



Sensores de movimento



Share Tweet Favorite Report Problem

Japanese Pagoda Tree ●

Styphnolobium japonicum



[Species Map and Details](#)

ID Number: 3751573

Trunk Diameter: 16 inches

Closest Address

299 ADELPHI STREET, BROOKLYN, NY
11205



Tree Care Activity

Date	Activity
10/31/2016	You Watered

Record Your Care



NYC Street Tree Map

nyc.gov/parks/treemap



NYC Parks



Zoom to Location



[Species Map and Details](#)

ID Number: 2113813
Trunk Diameter: 21 inches
[Suggest an Edit](#)
Closest Address
84 JANE STREET, NEW YORK, NY 10014



Tree Care Activity

Date	Activity
06/30/2018	A member of Trees New York Watered

Get tips on tree care activities in the [Learn](#) section.

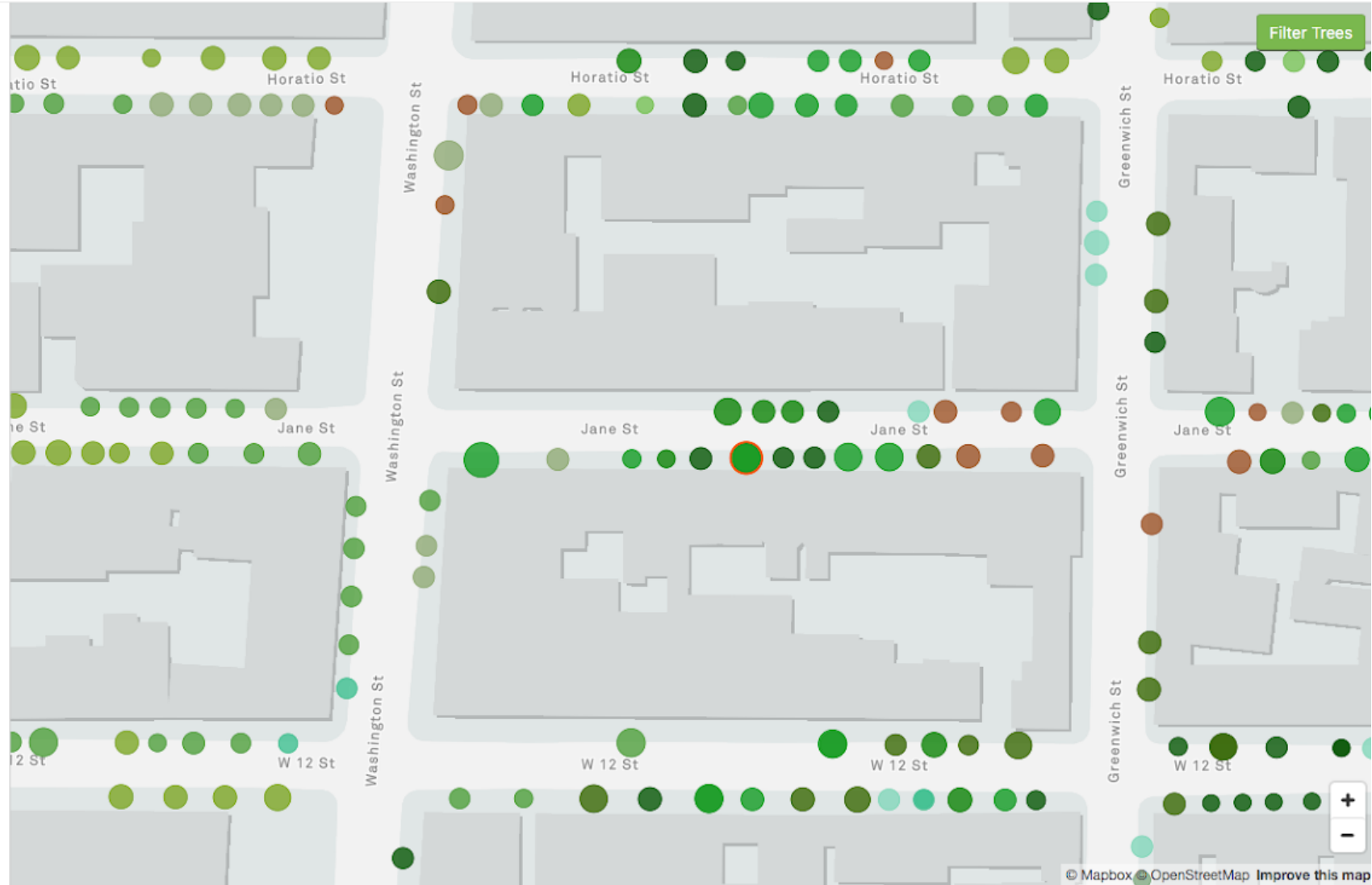
[Record Your Care](#)

Ecological Benefits

Benefits are calculated using formulas from the U.S. Forest Service. Learn more about the [benefits of trees to NYC](#) →

💧 **Stormwater intercepted each year**
2,956 gallons Value: \$29.27

⚡ **Energy conserved each year**



Exercício:

Identifique o cliente e o driver de inovação do artigo lido e apresentado