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Aplicação da metodologia BIM na monitorização da segurança de barragens de aterro

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ptBIM

4º Congresso Português de
'Building Information Modelling'

APLICAÇÃO DA METODOLOGIA BIM NA MONITORIZAÇÃO DA SEGURANÇA DE BARRAGENS DE ATERRO

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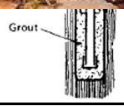
Topics

ptBIM

- Safety control of embankment dams and objectives
  - General aspects
  - Pitfalls and Opportunities
  - Workflow proposal
- Integrates framework for safety control of embankment dams
  - General implementation
  - Geometry modelling
  - Database
  - BIM connection and BIM object
  - Interact dashboard and visualization data
- Case study – Odelouca dam
  - General information
  - Instrumentation
  - Framework application and results
- Conclusion

Safety control of embankment dams and objectives

Figure 2 – Instruments examples (a)piezometer (b)surface settlement (c)settlement platforms (Fell, MacGregor and Stapledon, 1992; Dunnicliff, 1988)



Safety control of embankment dams and objectives

- General aspects
  - Dam have been built since antiquity
  - Different uses such as hydroelectric power, navigation, flood control, water source and others
  - Dam failure cam cause a big social, environmental and economic impact.
  - The most common of dam construction around the world and the most common that occurs failures are the embankment dans
  - Safety control done by visual inspection, instrumentation monitoring and analysis of data.

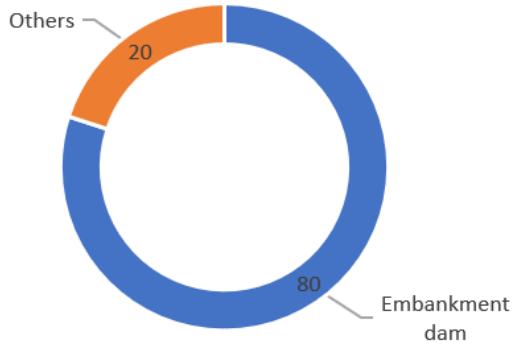


Figure 1 – Dam type construction around the world (modified from Vallejo, 2016)

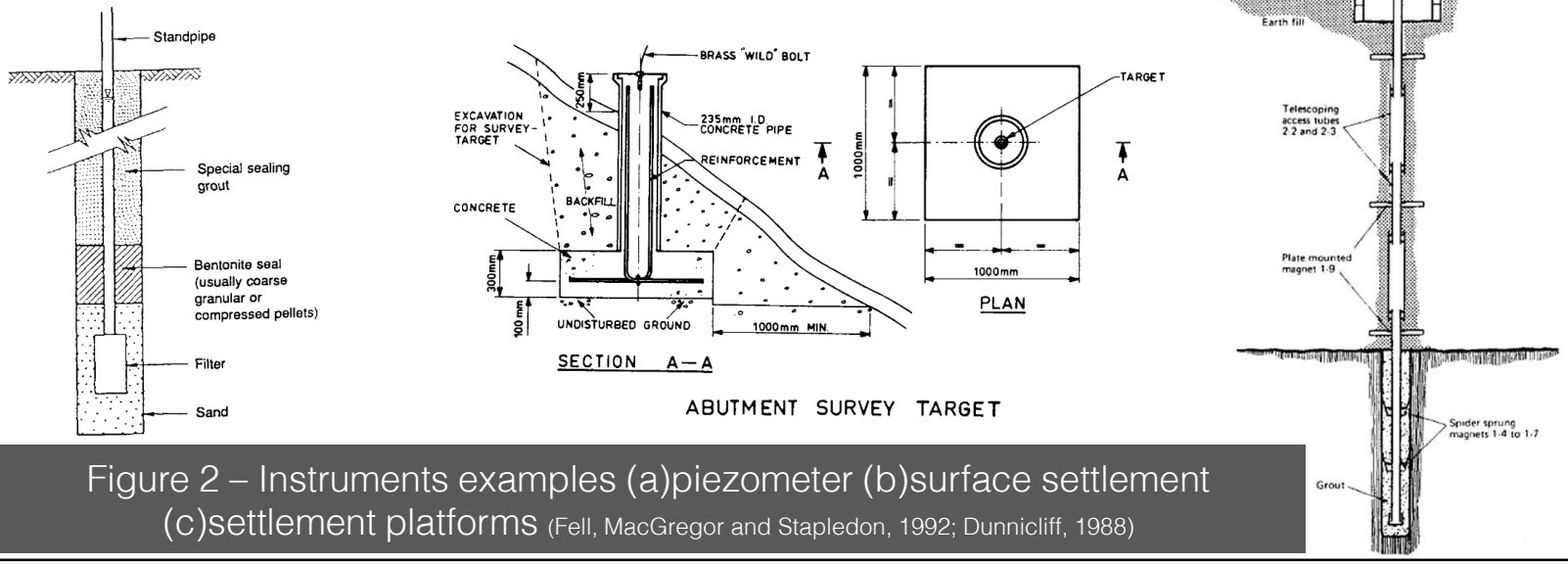


Figure 2 – Instruments examples (a)piezometer (b)surface settlement (c)settlement platforms (Fell, MacGregor and Stapledon, 1992; Dunnicliff, 1988)

Safety control of embankment dams and objectives

- Pitfalls
  - Manual measurement of the instrumentation parameter. High time between measurement data and availability to analysis
  - Presence of several files or spreadsheets for analysis the information
  - Visual inspection and instrumentation measurement performed periodically

- Opportunities
  - Real-time instrumentations by using IoT to automatized the data acquisition and connected to database and BIM model
  - Database and BIM model to standardize and concentrated all the data information in a same workplace.
  - Automatic inspection by using Unmanned Aerial Vehicle (UAV), connected with database, BIM model and use of Artificial Intelligence (AI).

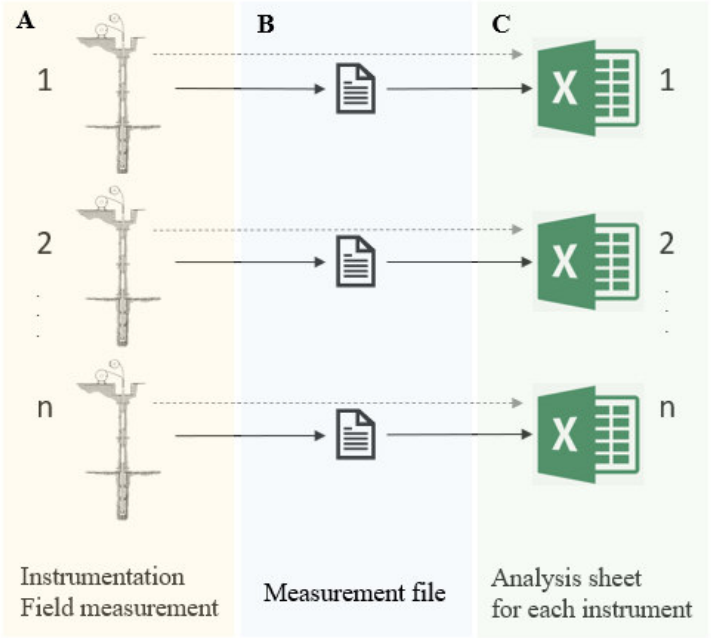


Figure 3 – Example of current workflow to measurement data

Safety control of embankment dams and objectives

- The main objectives of this work is developing a BIM model to help during the instrumentation for the data analysis of existing embankment dams. This process intends to automate some activities to solve some pitfalls identified during the manual data analysis process, such as:
  - data available in different files, not allowing a concentrated and integrated analysis,
  - lack of automated processes to connect information in different types of data analysis and visualization tools

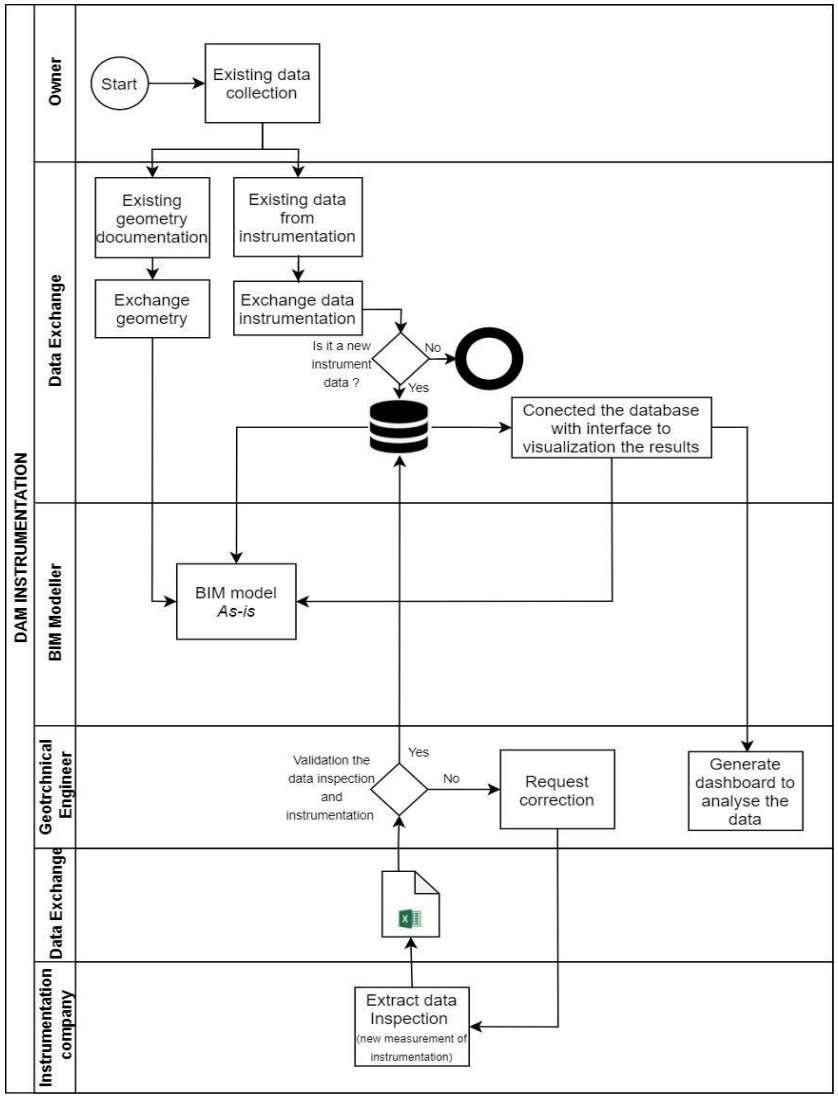


Figure 4 – Workflow proposal

Integrates framework for safety control of embankment dams

- General implementation

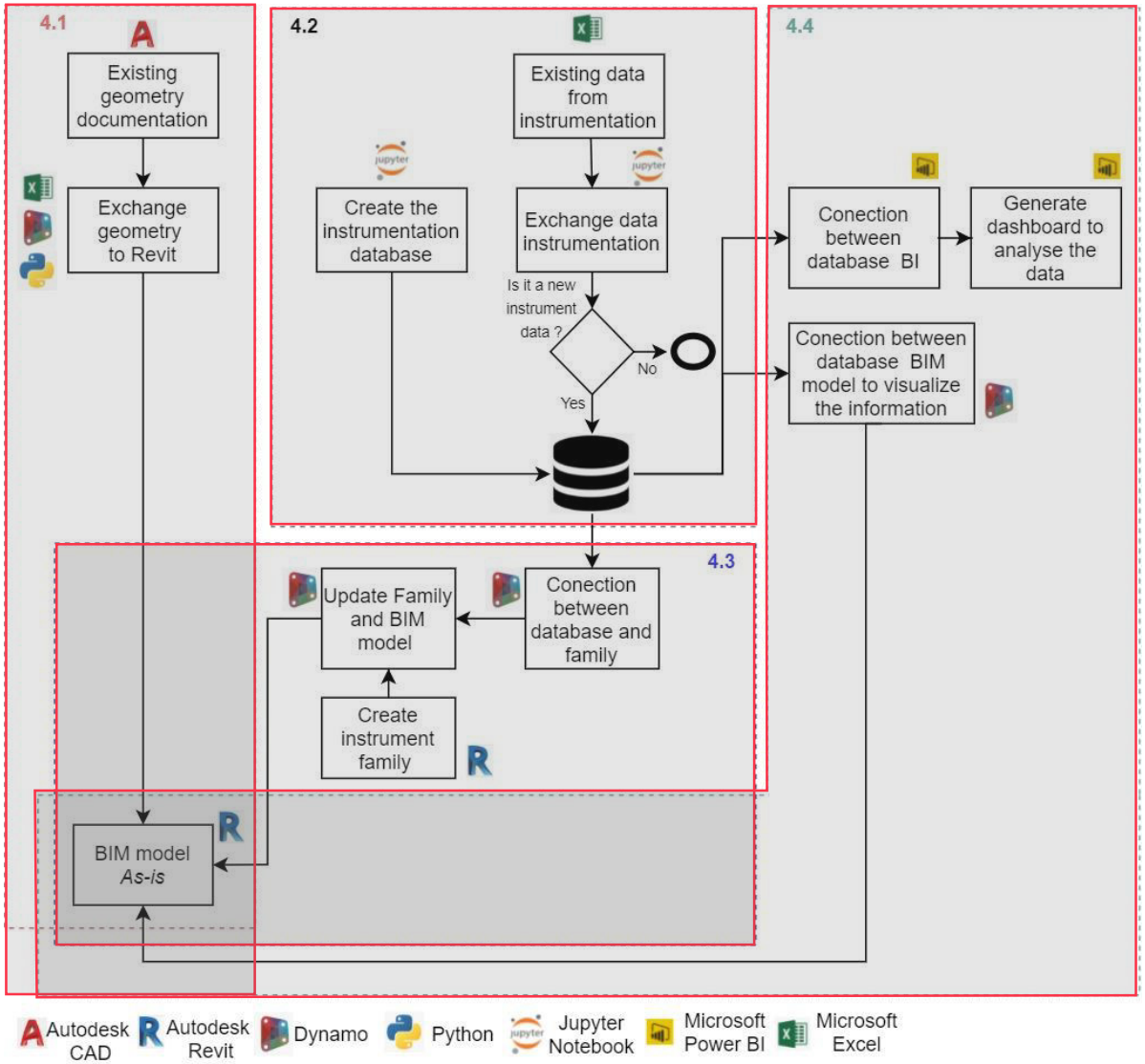
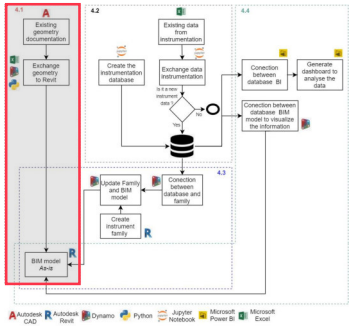
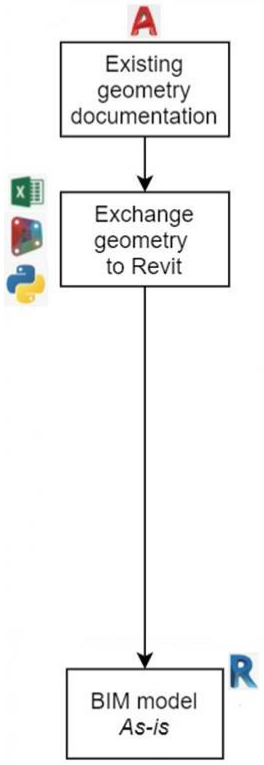


Figure 5 – Computational Workflow

- Geometry modelling





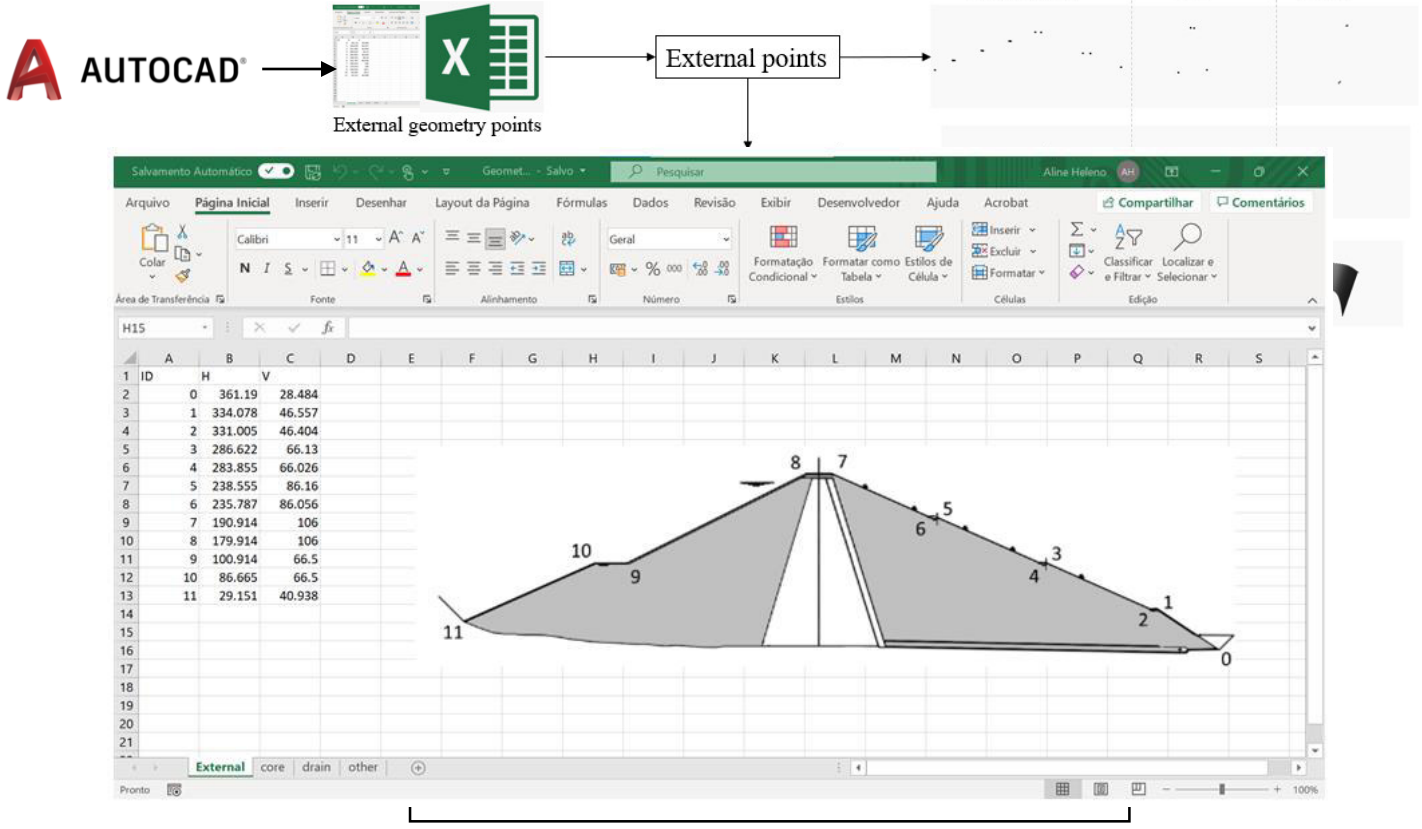
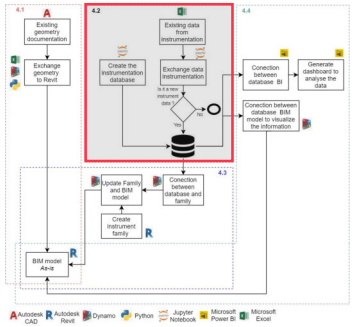
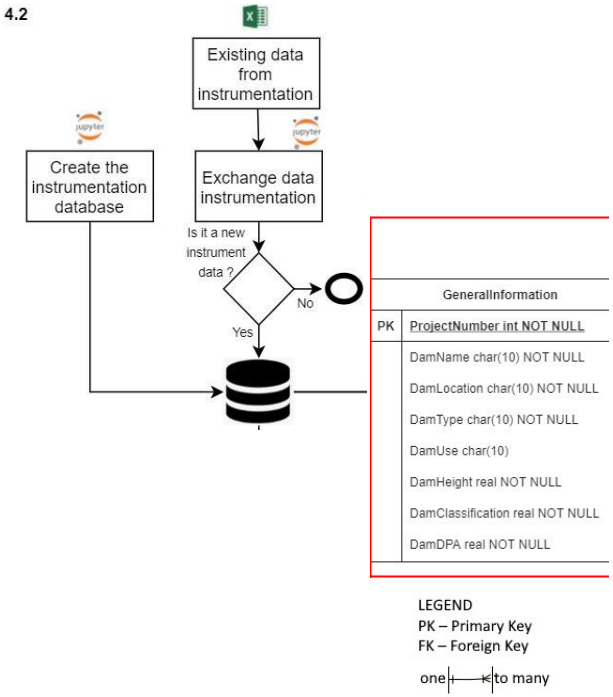


Figure 6 – Geometry process generation

Integrates framework for safety control of embankment dams

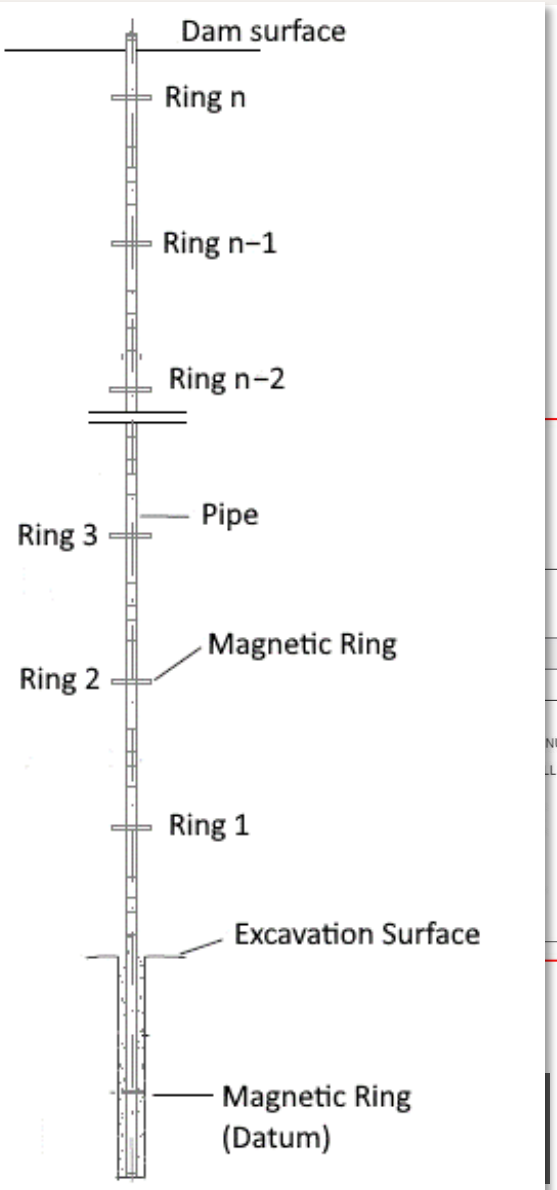
- Database





GeneralInformation	
PK	ProjectNumber int NOT NULL
	DamName char(10) NOT NULL
	DamLocation char(10) NOT NULL
	DamType char(10) NOT NULL
	DamUse char(10)
	DamHeight real NOT NULL
	DamClassification real NOT NULL
	DamDPA real NOT NULL

LEGEND
PK – Primary Key
FK – Foreign Key
one to many



SS_General	
PK	SSM_ID int NOT NULL
FK1	SS_ID int NOT NULL
	SS_X real NOT NULL
	SS_Y real NOT NULL
	SS_Z real NOT NULL

SP_Measurement	
PK	SGM_ID int NOT NULL
FK1	SP_ID int NOT NULL
FK2	SP_Ring_ID char(20) NOT NULL
	SPDownM1 real NOT NULL
	SPDownM2 real NOT NULL
	SPUpM1 real NOT NULL
	SPUpM2 real NOT NULL
	SPAverage real NOT NULL
	SPRingElevation real NOT NULL
	SPRingSettlement real NOT NULL

SP_Ring	
PK	SP_RingID char(10) NOT NULL
FK1	Inst_ID int
	SPRingName char(20) NOT NULL
	SPRingRadius real NOT NULL
	SPInstallationDate char(20) NOT NULL
	SPInitialLevel real NOT NULL

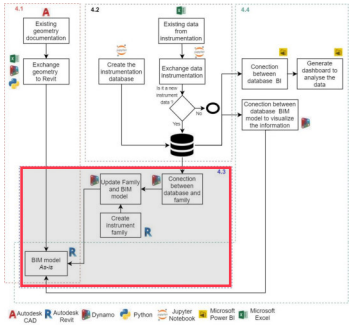
Inc_Measurement	
PK	IncM_ID int NOT NULL
FK1	Inc_ID int NOT NULL
	IncHeight real NOT NULL
	IncDepth real NOT NULL
	IncElevation real NOT NULL
	IncUp real NOT NULL
	IncDown real NOT NULL
	IncLeft real NOT NULL
	IncRight real NOT NULL

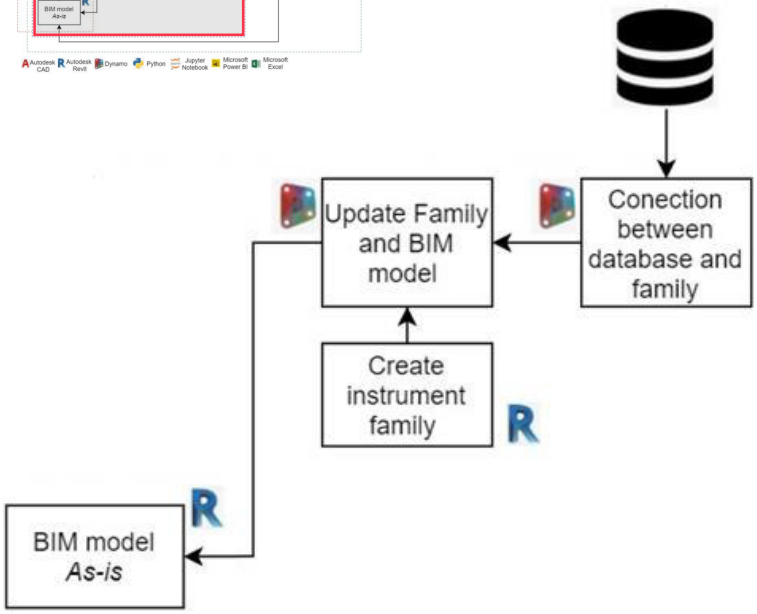
Inc_Calc	
PK	IncC_ID int NOT NULL
FK1	IncM int NOT NULL
	IncUpDown real NOT NULL
	IncLeftRight real NOT NULL
	IncDistDown real NOT NULL
	IncDistSumDown real NOT NULL
	IncOlastOfirstDown real NOT NULL
	IncDistUp real NOT NULL
	IncDistSumUp real NOT NULL
	IncOlastOfirstUp real NOT NULL

PZ_General	
PK	PZM_ID int NOT NULL
FK1	PZ_ID int
	PZ_PoreWaterPressureElev real NOT NULL

Integrates framework for safety control of embankment dams

- BIM connection and BIM object





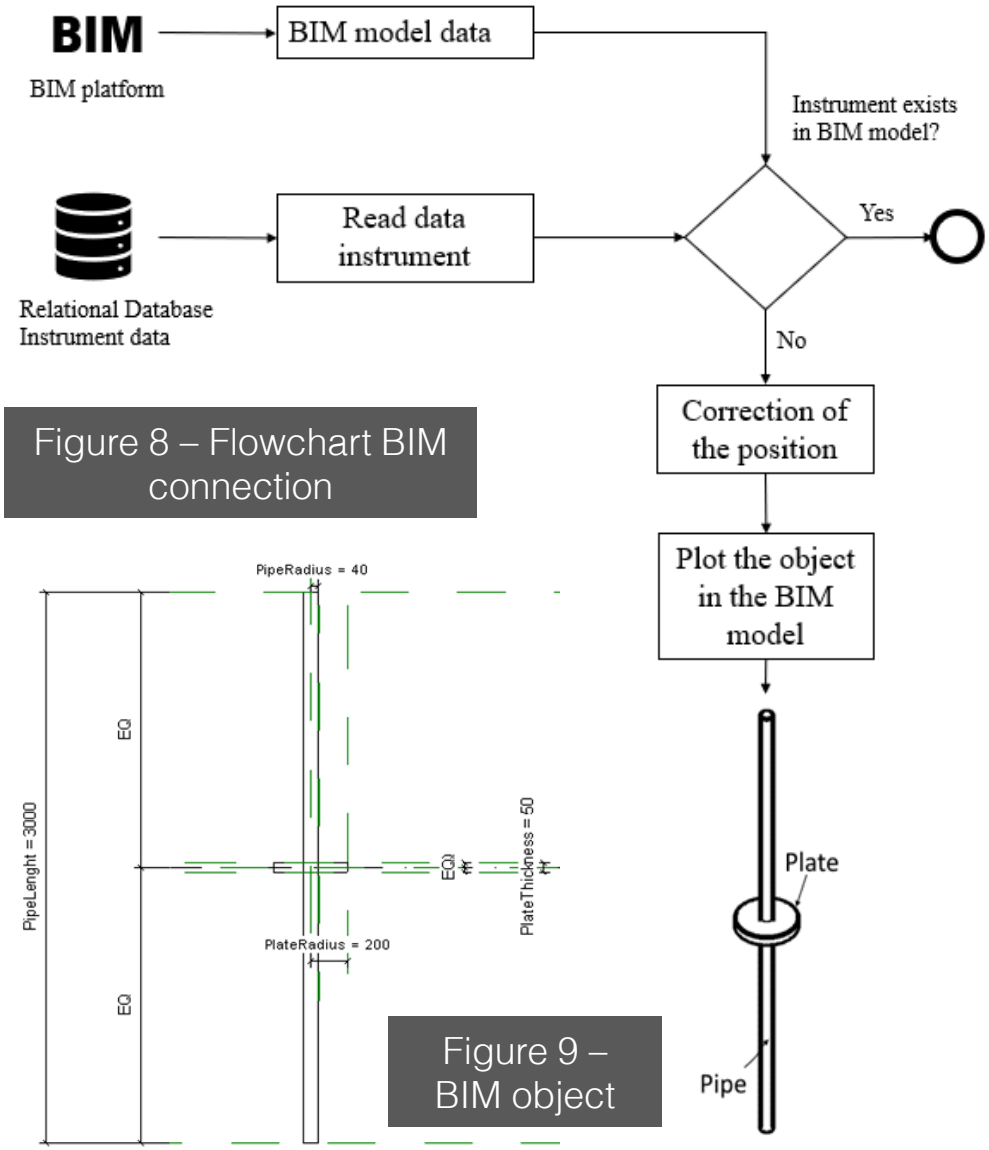
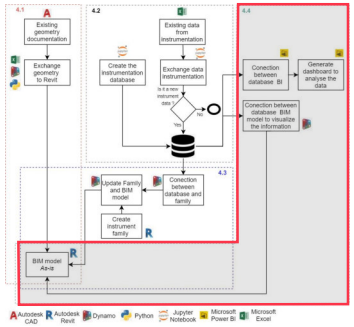


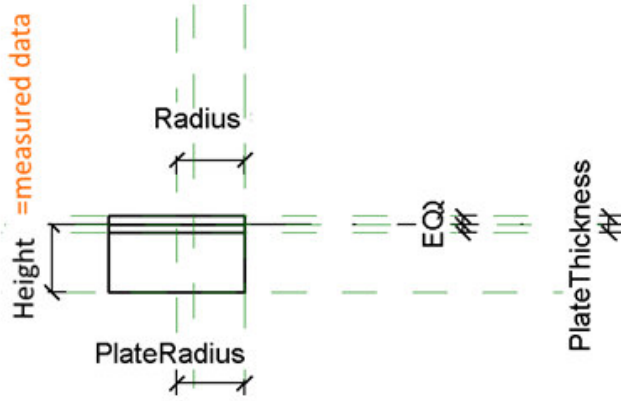
Figure 8 – Flowchart BIM connection

Figure 9 – BIM object

Integrates framework for safety control of embankment dams

- Interact dashboard and visualization data





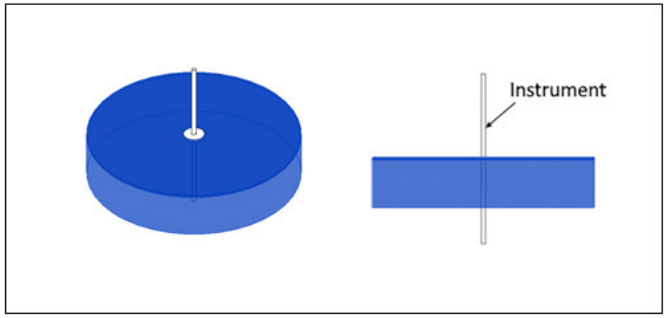


Figure 10 – BIM object to visualize the results in BIM Model

Case study – Odelouca dam

- General information
  - Embankment dam and each structures
  - South of Portugal, north of Silver
  - Water supply

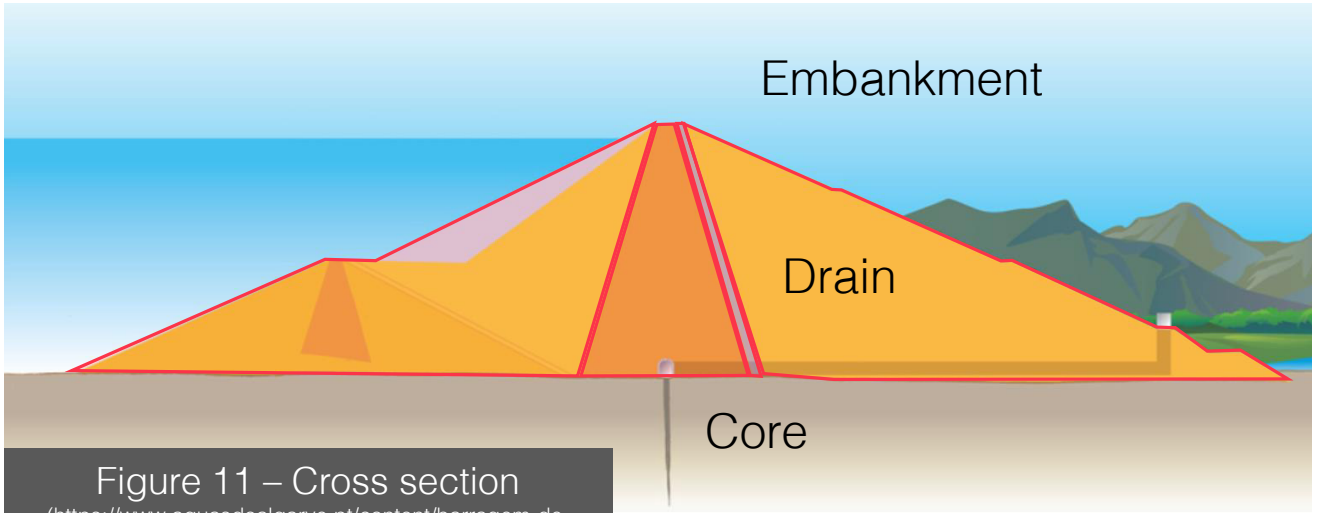


Figure 11 – Cross section
(https://www.aguasdoalgarve.pt/content/barragem-de-odelouca-0)

Figure 12 - Reservoir and dam overview
(https://www.aguasdoalgarve.pt/content/barragem-de-odelouca-0)

- Instrumentation install

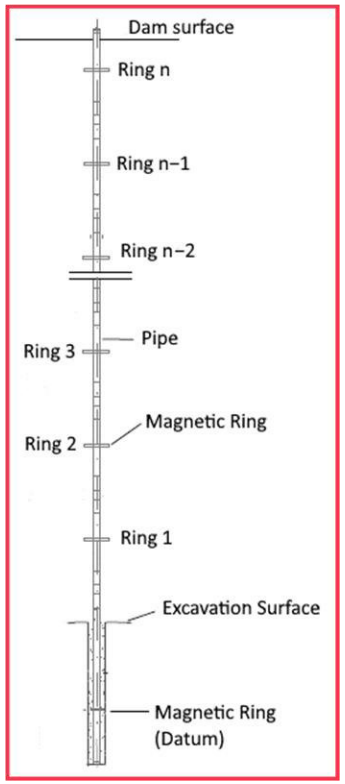


Figure 13 – Instrument database implemented

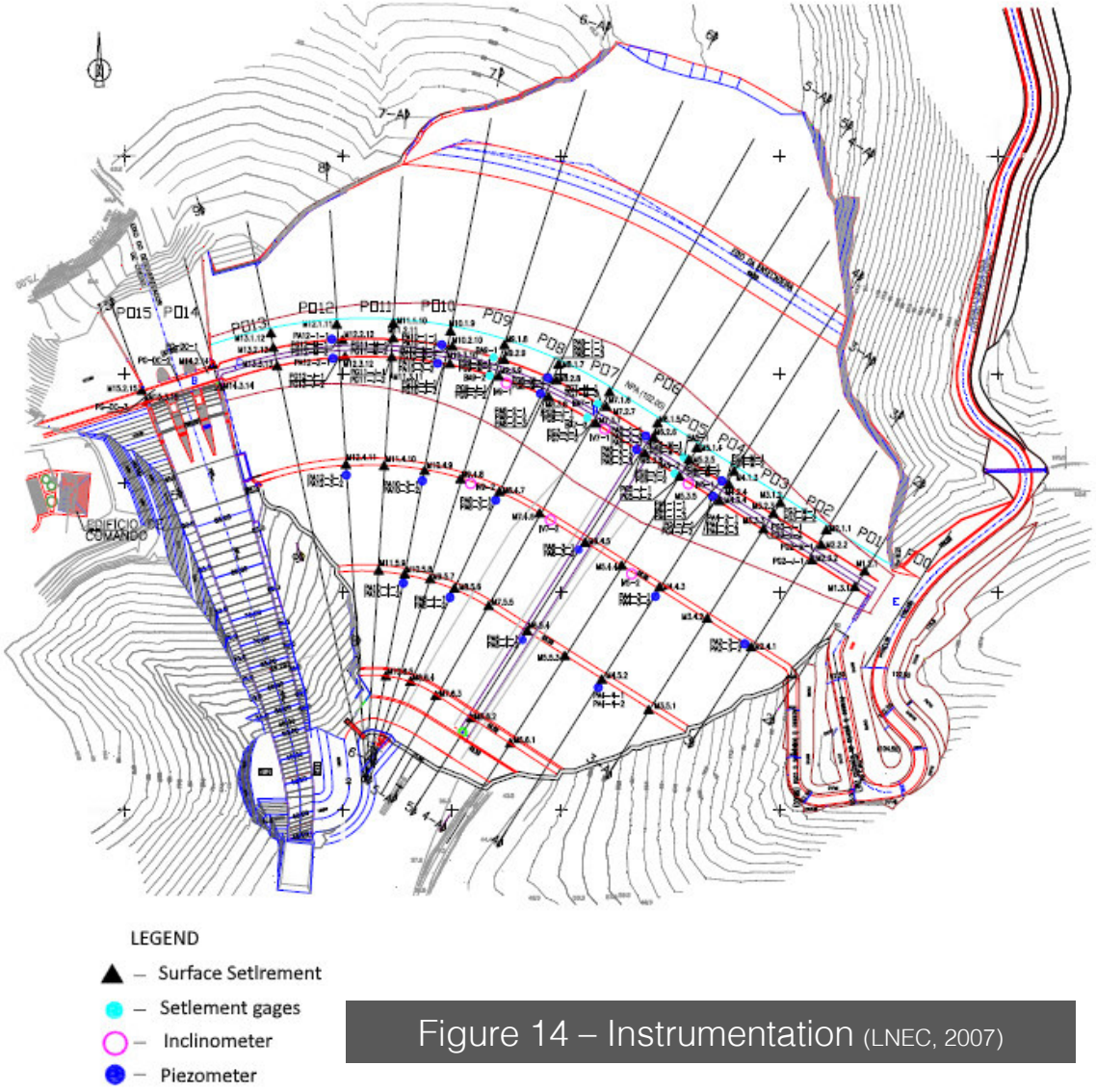
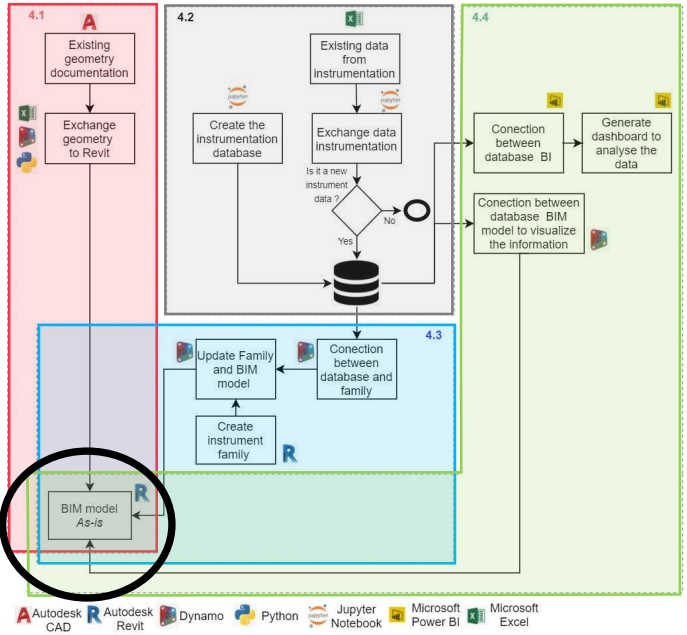
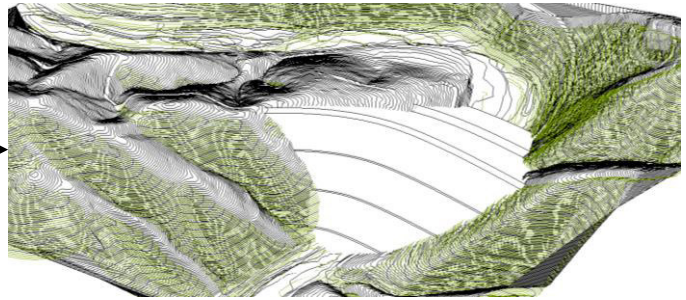


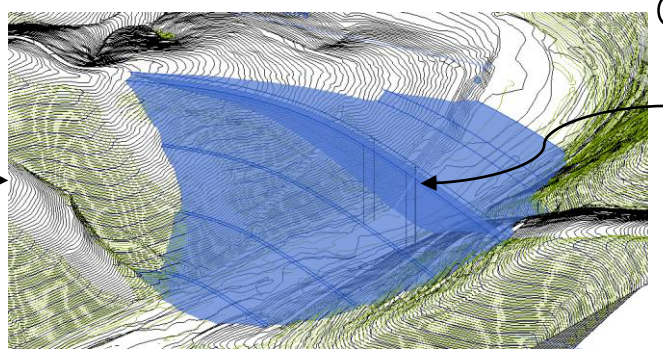
Figure 14 – Instrumentation (LNEC, 2007)

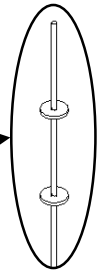
Case study – Odelouca dam

- Framework application and results









BIM model

Geometry

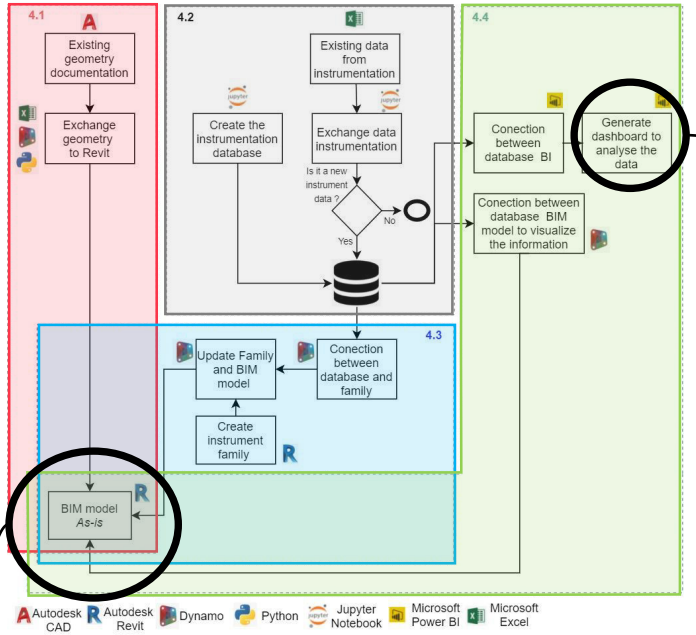
Database connection BIM model, by instrument BIM object

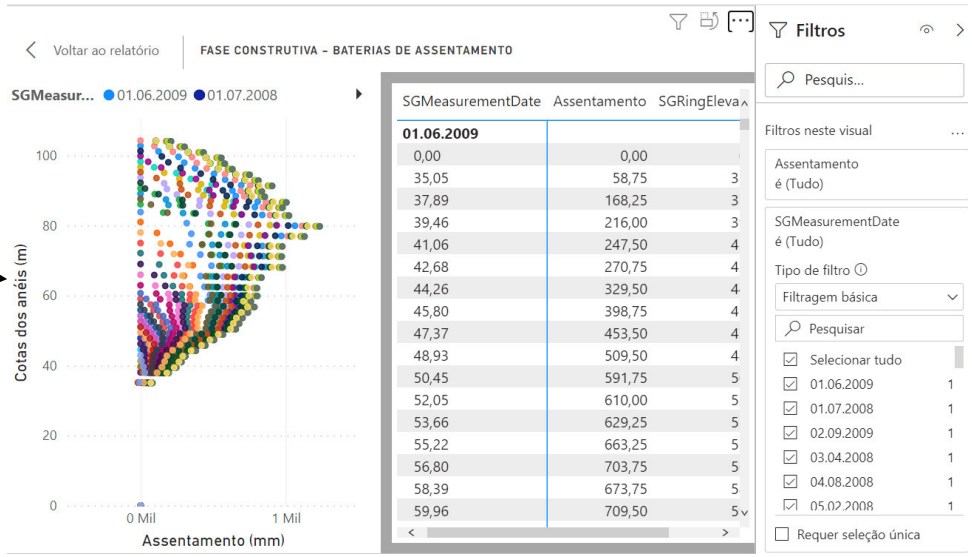
Instrument visualization, geometry and metadata

Instrument result visualization

Case study – Odelouca dam

- Framework application and results





BIM model

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Database connection BIM, by instrument BIM object

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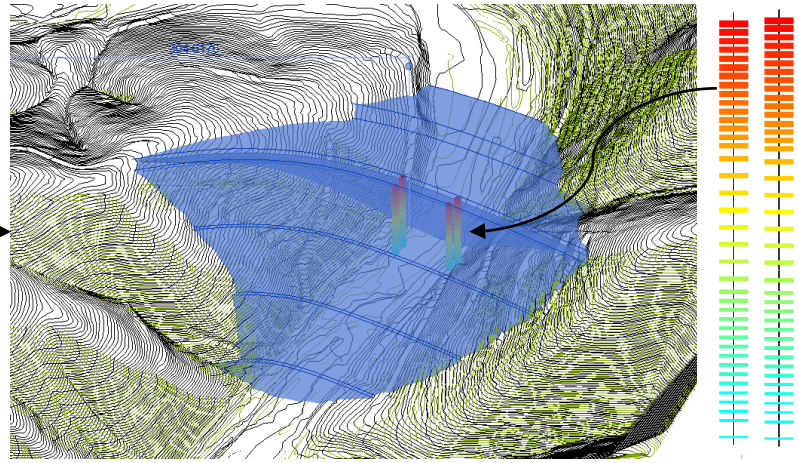

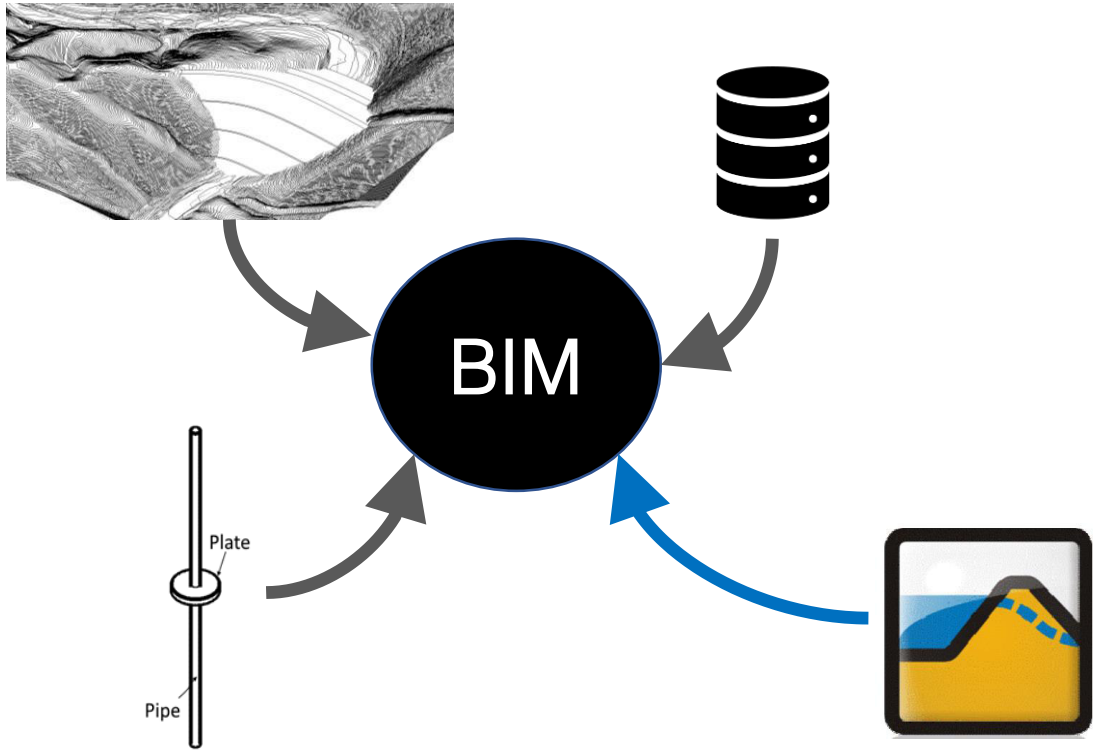
BIM
Plate
Pipe

Obrigada!