When talking about functional requirements it is important to note that:

- there is a lot of confusion about 'what is functional'
- there are several levels of functionality and requirements

Methodology – types of requirements

When is a requirement a functional requirement?

- often all requirements that do not specify a technical solution are called 'functional'
- however as a functional requirement is a specification of the functionality for which the object or system is created (e.g., carrying traffic), many solution – free requirements appear to be non – functional
- so the environmental requirement that the pavement materials should not pollute the ground water is non - functional (it is a constraint rather than a functional requirement) because this is not a functionality for which we would create a pavement

Methodology – types of requirements

- so we never have only functional specifications
- there always are (usually much more) non – functional specifications which describe how the system or object must function or be. These requirements can concern many aspects
- as the term 'non – functional' does not sound too attractive, these requirements are called 'aspect requirements' in the Netherlands
- furthermore there are requirements that are imposed by surroundings; these are called 'interface requirements'.
- these can overlap aspect requirements (e.g., noise requirements)

Methodology – generating requirements

Functional requirements follow from function analysis (what should the system do)

- why do we make pavements?
- because we invented the wheel
- a very useful invention
- however it had one bad habit
- it tended to ‘dig in’
- this called for a next invention
Methodology – generating requirements

- so the functional requirement which a pavement fulfills is
  - a ‘provision’ over which wheels can roll freely
- therefore the bearing capacity requirements in the contract are the only functional requirements

Aspect requirements (how should the system fulfill its function) follow from considering the various aspects and related possible issues

- availability —> without frequent maintenance
- safety —> with a certain level of skid resistance
- sustainability —> without polluting subsoil and ground water
- sustainability —> with minimum CO₂ emission at construction
- health —> without producing too much noise
- etc

Interface requirements (what requirements follow from interfaces with other objects) follow from an inventory of project interfaces and possible problems arising from these

- bridges —> pavements under them may not be too high

Interface requirements (what requirements follow from interfaces with other objects) follow from an inventory of project interfaces and possible problems arising from these

- bridges —> pavements under them may not be too high
- bridges —> pavements over them may not be too heavy
Functional specification – methodology

Interface requirements follow from an inventory of project interfaces and possible problems arising at these interfaces

- bridges -> pavements under them may not be too high
- bridges - > pavements over them may not be too heavy
- bridges - > pavements should protect these from salt e.d.
- existing pavements -> new pavements must connect to them without height or slope differences
- etc.

Methodology – requirements decomposition

- requirements have different levels
- low – level requirements can still be functional or function - related
- requirements on raw materials and building materials
- requirements on elementary material behaviour
- requirements on construction behaviour
- requirements on material behaviour
- requirements on materials and building materials

Methodology – system decomposition

Typical risks that remain with the client are

- Political risks
  - reliability and availability of road network
- Social risks
  - safety
  - health
  - sustainability
  - aesthetics
- Financial risks
  - long term maintenance costs
  - demolition costs
Methodology – system decomposition

**Road infrastructure system**
- Road
- Embankment
- Pavement
- Guard rails and barriers
- Noise reducing provision
- Service area
- Dynamic Traffic Management
- Eco passage

**Subsystems**

**Moveable span bridge**

**Rigid bridge**

**Tunnel**

**Component specifications**

- For each component of the road, DVS has Component Specifications
- These are separate documents that contain the non-project specific requirements
- The requirements are formulated in solution-independent terms as much as possible
- For each requirement a verification method is given
- However, verification methods are often solution specific; e.g., the design verification for asphalt roads is different from that for concrete roads

**Component specifications - example**

**BO VH 02**

**SAFETY - breaking deceleration**

**Overlying requirements**
- Each wearing course or temporary wearing course must enable a breaking deceleration of 5,2 m/s².

**Underlying requirements**
- Verification method:
  - Design verification: Demonstrate according to Protocol G that the proposed wearing course can meet the requirement
  - Product verification: Braking tests according to Annex I

**BO DV 02**

**CARRYING TRAFFIC - bearing capacity of new pavements in continuously reinforced concrete on embankment**

**Overlying requirements**
- New pavements in continuously reinforced concrete must be able to carry the traffic loads according to Appendix A of the Output Specification during the design periods according to Appendix B of the Output Specification.

**Underlying requirements**
- Verification method:
  - Product verification: Evidence that the pavement as installed complies with the design, based upon production quality registrations, layer thickness measurements and drilling core information.

**Methodology - contract management approach**

- System Oriented Contract Management
- Principle of this approach: check if the Quality System of the contractor is effective (contractor has to have a certified quality management system, based on NEN-EN-ISO 9001 Quality Management)
- This is done by a mix of system checks, process checks and product checks
Contract management approach

- System check: check if the integral quality management system of the contractor is correct
- Process check: check during realisation of a project if the contractor follows his own process instruction of a specific process
- Product check: check the reliability of the quality control results of the contractor
- Risk-based approach
- Balance in mix of checks adapted if necessary