10

Green Star SA audit

The investigation of a possible application of Green Star SA on Landscape Architecture (see chapter 2) has shown that 44,2% of the rating tool can be applied.

The author concluded in chapter 3 that water appears to be the golden thread that links most on site systems and eco-system services; therefore all *green* aspects of the project was conceptually approached through investigating the role of water in every part.

From this the technical investigation of the project (see chapter 9) focussed on the three on site water systems: river system, rain and runoff system and grey water system. Where detail lacks in other technical aspects of the design, an informed assumption was made.

The self assessment audit (table 14) rates the project 37%. The score can now be divided by 44,2% to relate it back to the landscape applicable categories. Thus the project scores 83,7% which would be a six star rating.

Comparing Green Star SA Office V1 with the outcomes of the Sustainable Sites Initiative (SSI) investigation

Main themes form the SSI includes

- Conserving water sources and the systems they support while optimising the use of on site water and reducing the need for potable water
- Preserving existing natural and on site region appropriate biomass
- Using renewable- and waste minimising materials that does not pollute through manufacturing, application or after installation
- Optimise human use and health benefits by integrating the on site systems to improve the experience of man's environment

Through the Green Star SA Office V1 rating process and the study of eco-system services (listed above), the author found that the Green Star SA rating system addresses most of the themes from the SSI investigation.

The positive result of the audit might not be as accurate as one would hope because a lot of assumption had to be made with regard to basic building information that was required and estimated.

From the comparison

The author believes that converting the Green Star SA rating tool into a fully fledged landscape rating tool is well within reach. In the envisaged tool, there should

be an fundamental relationship between the 'Water' and 'Land Use & Ecology' categories as water is a basic building block in terrestrial ecology; this link does not exist in the current Green Star SA Office V1 rating tool.

An integration of the human use and health benefits with storm water and other systems into this category would be advisable.

Green Star SA - Office Design v1

Credit Summary

Urban Water Centre

Category	Title	Credit No.	Points Available	Points Achieved	Points to be Confirmed	Percent of Available Points Achieved	Weighting	Weighted Score
Management								
	Green Star SA Accredited Professional	Man-1	2	2	0			
	Commissioning Clauses	Man-2	2	2	0			
	Building Tuning	Man-3	2	2	0			
	Independent Commissioning Agent	Man-4	1	1	0			
	Building Users' Guide	Man-5	1	1	0			
	Environmental Management	Man-6	2	2	0			
	Waste Management	Man-7	3	3	0			
	Airtightness Testing	Man-8	1	na	0			
		TOTAL	**14**	**13**	**0**	93%	9%	**8.4**
Indoor Environment Quality								
	Ventilation Rates	IEQ - 1	3	na	0			
	Air Change Effectiveness	IEQ - 2	2	na	0			
	Carbon Dioxide Monitoring and Control	IEQ - 3	1	0	0			
	Daylight	IEQ - 4	3	na	0			
	Daylight Glare Control	IEQ - 5	1	na	0			
	High Frequency Ballasts	IEQ - 6	1	na	0			
	Electric Lighting Levels	IEQ - 7	1	na	0			
	External Views	IEQ - 8	2	2	0			
	Thermal Comfort	IEQ - 9	2	na	0			
	Individual Comfort Control	IEQ - 10	2	na	0			
	Hazardous Materials	IEQ - 11	1	1	0			
	Internal Noise Levels	IEQ - 12	2	na	0			
	Volatile Organic Compounds	IEQ - 13	2	#VALUE!	0			
	Formaldehyde Minimisation	IEQ - 14	0	na	0			
	Mould Prevention	IEQ - 15	1	na	0			
	Tenant Exhaust Riser	IEQ - 16	1	na	0			
	Environmental Tobacco Smoke (ETS) Avoidance	IEQ - 17	1	na	0			
		TOTAL	**26**	**4**	**0**	15%	15%	**2.3**
Energy								
	Conditional Requirement	Ene -	0	na	0			
	Greenhouse Gas Emissions	Ene - 1	20	0	0			
	Energy Sub-metering	Ene - 2	2	na	0			
	Lighting Power Density	Ene - 3	4	1	0			
	Lighting Zoning	Ene - 4	2	na	0			
	Peak Energy Demand Reduction	Ene - 5	2	na	0			
		TOTAL	**30**	**1**	**0**	3%	25%	**0.8**
Transport								
	Provision of Car Parking	Tra - 1	0	na	0			
	Fuel-Efficient Transport	Tra - 2	0	na	0			
	Cyclist Facilities	Tra - 3	3	0	0			
	Commuting Mass Transport	Tra - 4	5	5	0			
	Local Connectivity	Tra - 5	2	2	0			
		TOTAL	**10**	**7**	**0**	70%	9%	**6.3**
Water								
	Occupant Amenity Water	Wat - 1	5	0	0			
	Water Meters	Wat - 2	2	na	0			
	Landscape Irrigation	Wat - 3	3	3	0			
	Heat Rejection Water	Wat - 4	4	na	0			
	Fire System Water Consumption	Wat - 5	0	na	0			
		TOTAL	**14**	**3**	**0**	21%	14%	**3.0**

TABLE 14 - GREEN STAR SA SELF ASSESSMENT

Category	Title	Credit No.	Points Available	Points Achieved	Points to be Confirmed	Percent of Available Points Achieved	Weighting	Weighted Score
Materials								
	Recycling Waste Storage	Mat - 1	2	2	0			
	Building Reuse	Mat - 2	0	na	0			
	Reused Materials	Mat - 3	1	1	0			
	Shell and Core or Integrated Fit-out	Mat - 4	1	na	0			
	Concrete	Mat - 5	3	1	0			
	Steel	Mat - 6	0	na	0			
	PVC Minimisation	Mat - 7	1	na	0			
	Sustainable Timber	Mat - 8	2	1	0			
	Design for Disassembly	Mat - 9	0	na	0			
	Dematerialisation	Mat - 10	1	0	0			
	Local Sourcing	Mat - 11	2	1	0			
		TOTAL	**13**	**6**	**0**	46%	13%	**6.0**
Land Use & Ecology								
	Conditional Requirement	Eco -	0	0	0			
	Topsoil	Eco - 1	1	1	0			
	Reuse of Land	Eco - 2	2	2	0			
	Reclaimed Contaminated Land	Eco - 3	2	2	0			
	Change of Ecological Value	Eco - 4	4	2	0			
		TOTAL	**9**	**7**	**0**	78%	7%	**5.4**
Emissions								
	Refrigerant / Gaseous ODP	Emi - 1	1	na	0			
	Refrigerant GWP	Emi - 2	2	na	0			
	Refrigerant Leaks	Emi - 3	0	na	0			
	Insulant ODP	Emi - 4	1	na	0			
	Watercourse Pollution	Emi - 5	3	3	0			
	Discharge to Sewer	Emi - 6	4	0	0			
	Light Pollution	Emi - 7	1	1	0			
	Legionella	Emi - 8	1	na	0			
	Boiler and Generator Emissions	Emi - 9	0	na	0			
		TOTAL	**13**	**4**	**0**	31%	8%	**2.5**
						Sub-total weighted points achieved:		**36**
Innovation								
	Innovative Strategies & Technologies	Inn-1	5	1	0			
	Exceeding Green Star SA Benchmarks	Inn-2	5	0	0			
	Environmental Design Initiatives	Inn-3	5	0	0			
		TOTAL	**5**	**1**	**0**	(Innovation is not weighted)		**1**
						Total weighted points achieved:		**37**

Minimal standards for Green Star SA certification not met.

The GBCSA does not endorse any self-assessed rating achieved by the use of Green Star SA - Office v1. The GBCSA offers a formal certification process for ratings of Four Stars and above; this service provides for independent third party review of points claimed to ensure all points can be demonstrated to be achieved by the provision of the necessary documentary evidence. The use of Green Star SA - Office v1 without formal certification by the GBCSA does not entitle the user or any other party to promote the Green Star SA rating achieved.

Weighted Score	Rating
45-59	Four Star
60-74	Five Star
75+	Six Star

Conclusion

Themes from the abstract, hypothesis and problem statement

- The role of water in urban Landscape Architecture
- Water as the base of *green* Landscape Architecture
- Awareness and conservation of on site water
- Context specific strategies based on ecosystem services as described in the SSI and the formulation of aims and strategies
- Managing the South African water crisis through strategies that addresses watercourses, storm water, irrigation and planting on individual sites
- The contribution of a systems approach to site design in the maintenance of ecological function and adding to biodiversity

Findings

The need for water is shared by people and industry around the world, and it is this basic need (see chapter 4) that draws people to water. Water is one of the building blocks of nature and ecosystems (see chapter 3), but urban environments alienates the urbanite from nature.

Landscape Architecture that provides meaningful encounters with water in a green *way, addresses more than a physical element, but reminds man of his dependency on nature.*

All possible projects and sites around the world, whatever the climate or use might be, are influenced by or dependant on water. Rain is the most common source of water, although sometimes overlooked as a resource and runoff is treated as an inconvenience. While rivers and water bodies are scarce resources, most of the sites humans use generates some waste water. Thus the themes of waste water and rainwater is universal, and core strategies for utilising and managing them are universal as well. Because of the critical role of water in our lives and the ecology that supports us, awareness needs to be heightened regarding the qualities, uses and importance of water. This awareness is raised through creating memorable experience with water. The wave-like bridge and seating deck reminds of the volume, power and motion of water. The tank-like rain meters educate us on rainfall volumes and frequency, while creating anticipation around rain events and ultimately combines all of this in a relaxing, interesting and inviting space. Small groups or individuals can enjoy these spaces that are enriched by the way water refracts light and distorts images. The water wheel adds motion activity and sound to the site and tells us of the energy of water that can be utilised. The play ponds that fills up and drains through the vortex creates an ever changing scene where children and adult alike can feel the cool, clear water of the river on their hands and feet and discover crabs, insects and water plants in the constructed stream that drains into the channel.

These vivid experiences are created through the introduction of three visible on site water systems, namely the river base flow system, rain meter maze system and the grey water system (see chapter 9). The path of water through each system can be observed and will be elaborated on through informative signage.

Focussing green *design purely on technical and economic approach to on site water neglects the role of water in social and environmental systems. Thus while basic strategies for water harvesting and conservation are universal, each site needs to express the cultural, historical and emotional aspects of on site water (see chapter 8) through relevant and exciting designs that evoke meaning, introspection and celebration.*

Consequently this thesis utilises water as a fundamental component of urban Landscape Architecture and capitalise on the physical and emotive

qualities of water. The design creates places of reflection and introspection through shaded seating areas that overlooks the pools and constructed stream. The energising and life giving aspects of water is celebrated in joyfully animated motion activated water fountains.

Water thus becomes a recreational catalyst, an educative tool, a building block for ecology and a money saving resource.

The site design contributes towards managing the South African water crisis through realising that problems with river water quality should be addressed on a catchment and site specific scale. Balancing planting design, planting area and irrigation needs to create an optimal water budget, treating water as a vital and precious resource that needs to be conserved and used wisely.

The systems approach that the author investigated led to an understanding of the complex components that creates functional systems. The river base flow system, the rain meter maze system and the grey water fountain system contributes towards reaching the design intent. For example, the river base flow system's design intent was to let people interact with the river water. This aim is simple in concept, but challenges like getting the water out of the channel, improving the quality of the water and addressing the different properties of water called for a very intricate system.

Understanding the critical parts of the system and what it depends on led to achieving the design intent.

The investigation of the SSI ecosystem service matrix led to the conclusion that water supports the following overarching aims (see chapter 3):

- Conservation of water sources and the systems they support while optimising the use of on site water and reducing the use of potable water
- Introducing and preserving existing natural and on site region appropriate biomass
- Using appropriate materials
- Optimising human use and health benefits by integrating the on site systems to improve the experience of man's environment

These aims become overarching ideals that are integral to the design approach and must become part of the mind-set of the designer.

Strategies formulated through the design exploration

- *Design a rainwater and runoff harvesting system that supplies in the total irrigation and on site water feature needs*
- *Use surplus water for sanitation purposes*
- *Design planting areas and irrigation as a system where availability of water influences surface area sizes and plant material selection*
- *Use region appropriate plant material and group plants with similar water needs together*
- *Protect, use and re-use on site trees and plant material where appropriate*
- *Re-use on site materials*
- *Use materials sourced from invasive species (gum poles from the Apies River valley, see chapter 8)*
- *Use renewable materials*
- *Use materials that does not pollute through manufacturing process, installation or after installation*
- *Integrate rainwater and storm water harvesting systems into the spatial experience of the site to provide an emotional link between the user and nature that sustains us*

Themes from the design brief and objectives

- Create a repose in the city where the influence of the river on the city grid is celebrated
- Address the division of the city through unifying the site
- Enhance and protect the openness of the site
- Address and utilise the small base flow, accommodate flash floods while softening the channel
- Entice use throughout the day
- Expose the ecological, historical and cultural memory of the site
- Utilize the introduced system components to create diverse ecosystem components

Findings

The design deals with city scale challenges and protects the openness of the site. This is done by providing a building edge that focuses inwards towards a large green core of the site. The green core functions as a series of social interaction spaces. The alignment of the buildings speak to the change in grid from the old city core to the suburbs due to the Apies River. The introduced grid responds to the rigid concrete channel and the pedestrian link (see chapter 1) follows this grid diagonally across the site. The rigid grid of the city is portrayed in the paving design where square blocks are aligned to the new grid. The paving grid also comments on the different scales in the city. A 3x3 meter grid in the paving signifies large public open spaces while 1x1 meter pavers are used for main circulation zones and 0.5x0.5 meter pavers are used in places designed for smaller gatherings and use of individuals.

The environmental, historical and cultural significance of Apies River were introduced via celebrating the memory the river. An abstracted line where the river used to run (from the SG diagrams of the Erfs, see chapter 7) intersects and influences the concrete channel and comments on the physical changes made to the river. By the reintroduction of vegetation that was removed with the building of the channel (descriptions from historical records and books) one is reminded of the environmental conditions that existed around the river. An old flood control rock wall is celebrated as a form giver at a pedestrian entrance at the corner of Vermeulen Street and Ockerse Street. The existing building of the BMW motorcycle shop will be converted into a restaurant and integrated into the proposed built fabric of the site.

Use throughout the day is enticed by:

- *Providing opportunities for kids to play after school and in lunch breaks (interview with headmaster of SA Private School)*
- *Creating spaces for students to laze around, read and socialise*
- *Supplying pedestrians with appropriate space to rest, use the tuck shops and retail facilities*
- *Luring residents from the surrounding suburbs to the park through creating a green space to relax and play in*
- *Opening restaurants and cafe's that cater for different income groups and tastes*

Integrating Green Star SA, the SSI investigation and General Systems Theory into a design project

Figure 155 explains the design process that was followed; it indicates when and how each component of theory and investigation steered and influenced the design and thought processes.

The theoretical investigation led to an informed design process that culminated into the integration of the social, emotional and experiential needs of the user with the economic, technical and environmental aspects of *green* Landscape Architectural design.

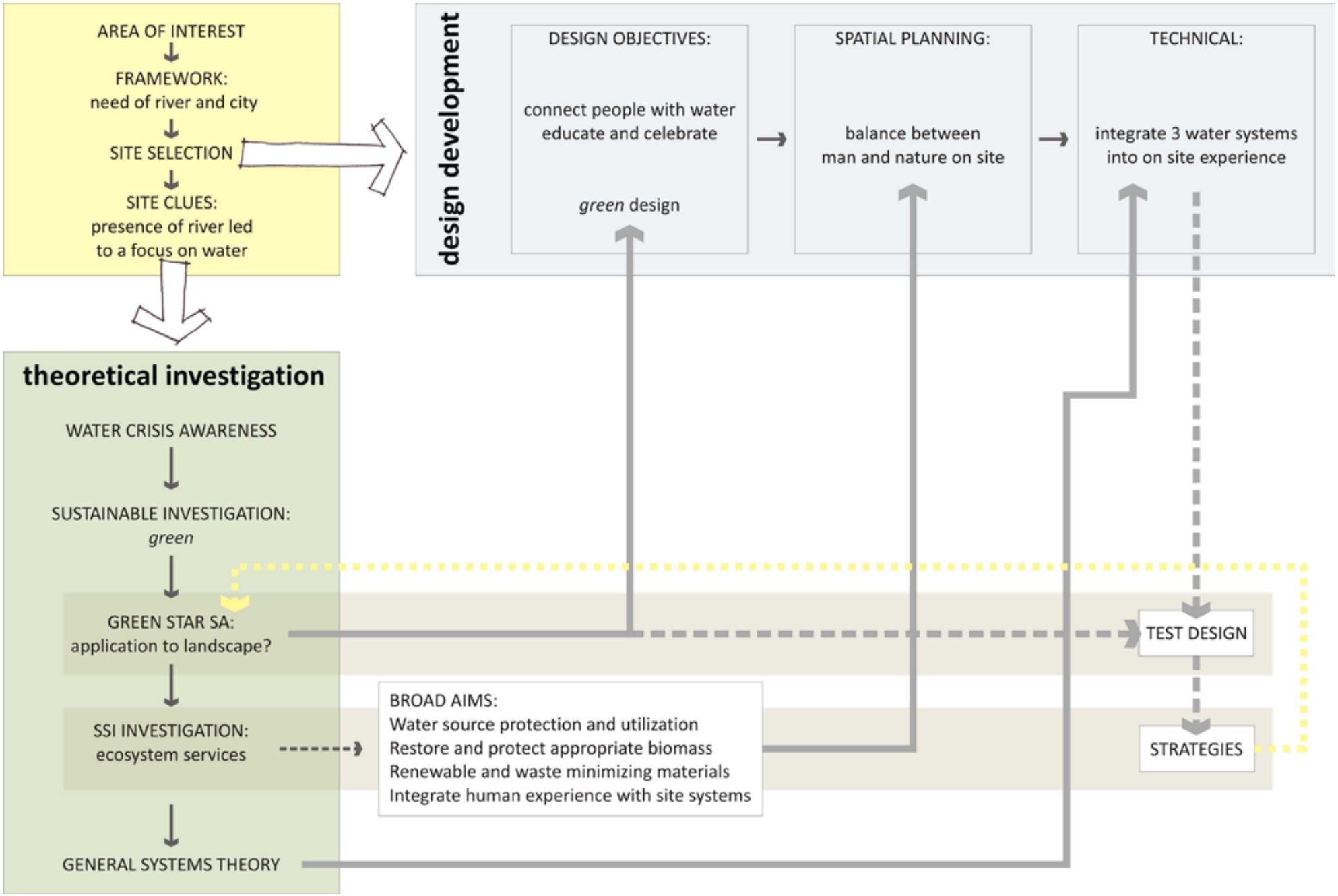

FIGURE 181. DESIGN INTEGRATION

the end

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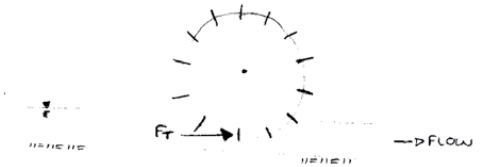
TEORETIESE BENADERING: WATER VERPLASING DEUR WATERWIEL

KONSEP ONTWERP

- DOEL: WATERVERPLASING OF ENERGIEVERPLASING NA POTENSIËLE ENERGY (HOOGTE) DEUR KINETIESE ENERGIE (VLOEI) TE GEBRUIK
- METODIEK: BESKOU WATERWIEL AS STATIES/DINAMIESE LIGGAAM EN EVALUEER KRAGTE → TOEGEPAS ≠ REAKSIE.

TOEGEPASTE KRAG

DIE ENIGSTE TOEGEPASTE KRAG IN DIE VRY-ROTERENDE STELSEL, IS DIE VLOEIKRAG VAN DIE KANAALVLOEI OP DIE WIEL, F_T



VOLGENS MOMENTUM VAN VLOEI,

$$F_T = \rho . Q . (V_2 - V_1)$$

WAAR DIE KRAG UITGE-OEFEN DEUR DIE WATER GEGEE WORD AS DIE PRODUK VAN DIE DIGTHEID ($1000 kg/m^3$), die vloei (m^3/s), EN DIE SNELHEIDSGRADIENT (m/s).

AANGESIEN HIERDIE WAARDE DEUR KANAAL HIDROLIKA GEMANIPULEER KAN WORD, IS DIT MINDER KRITIES

REAKSIE KRAG

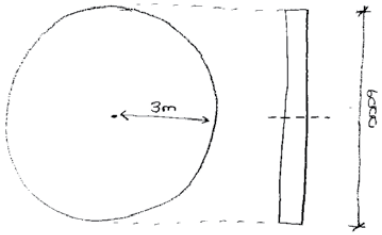
DIE VOLGENDE REAKSIEKRAGTE WORD VERWAG:

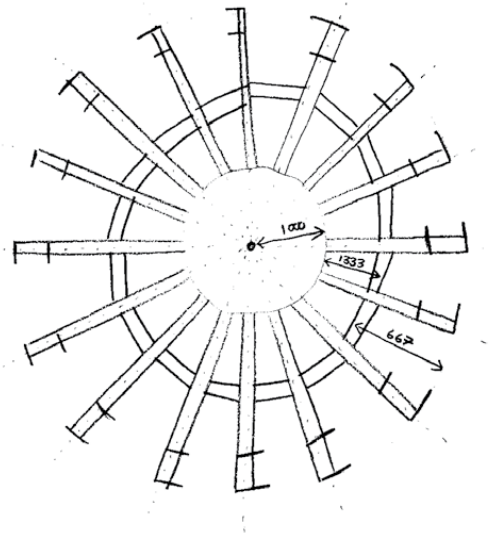
1. WEERSTAND TEEN WIELROTASIE - WRYWING OP AS — GENEEM AS 0 (VRYROTEREND)
2. MASSA VAN WIEL - GEGEE IN VERHOUDING WAAR $F = m.a$ (NEWTON)
3. MASSA VAN WATER IN BAKKIES - GEGEE AS $F = m.a$ (NEWTON)

DUS:

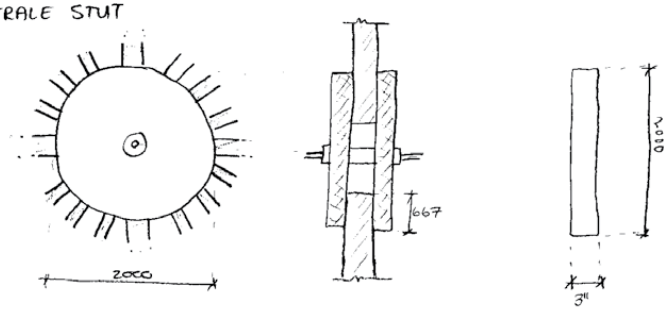
WIEL ONTWERP

DIE VOLGENDE WORD VOORGESTEL AS EERSTE BENADERING, EN IS AANPASBAAR

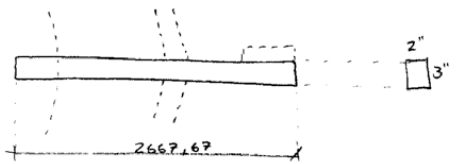




AS / SENTRALE STUT

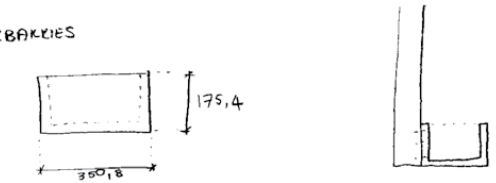


SPEKE



DWARSBALKE

WATERBAKKIES



④ STRUCTURAL TIMBER @ $\rho = 850\ kg/m^3$ OR SIMILIAR

BEREKENINGS

BEPAAL TOEGEPASTE, F_T, EN REAKSIEKRAGTE, F_{Ri}, EN NEEM MOMENTE OM SENTRALE AS, 'O'

NEEM $F_T = 1\ kN$

F_{Ri} → MASSAKOMPONENT VAN INDIWIDUELE DELE + MASSA KOMPONENT VAN WATER

$$\therefore \Sigma M_o = (2)(-99,33)(3000\cos 67,5°) + (2)(-99,33)(3000\cos 45) + (2)(-99,33)(3000\cos 22,5°) + (2)(-99,33)(3000) + (1000)(3)(1000)$$

$$= 1502\ N/m$$

→ HIERDIE IS DIE TOEGEPASTE ROTASIEKRAG OP DIE WIEL SE AS VIR DIE TYD WAT DIE WIEL IN KONTAK IS MET WATER

DIE VERHOUDING TUSSEN TOEGEPASTE MOMENT ("TORQUE") EN GEPAARTGAANDE VERSNELLING WORD GEGEE AS:

$$\Sigma M_o = I.\alpha$$

WAAR I → TWEEDE MOMENT VAN AREA / TRAAGHEID
α → HOEKVERSNELLING IN rad/s^2

$$I = \Sigma r_i^2 . m_i$$

$$= (16)(1,67)^2(0,0103)(850) + (16)(2,33)^2(0,0034)(850) + (16)(2,85)^2(0,0085)(850) + (10)(2,85)^2(0,01125)(1000)$$

$$= 2403,06\ kg/m^3$$

$\therefore$ DUS $\Sigma M_o = I.\alpha$

$$1502\ N/m = 2403,06\ kg/m^3 . \alpha$$

$$\therefore \alpha = 0,625\ rad/s^2$$

EN $a = \alpha . r$

$= (0,625)(3)$

$= 1,875\ m/s^2$ (VERSNELLING VAN INDIWIDUELE WATERBAK, GEMBLIKLIK)

$$s = \frac{2\pi r}{16} = 1,18m$$

④

BASIESE BEWEGINGSVERGELYKINGS : (1ST BEGINSELS)

$v^2 = u^2 + 2as$, met $u = 0$ (Beginsnelheid)

$v^2 = 2as$

$= 2(1,875)(1,18)$

$v = 1,486 \text{ m/s}$

∴ WATERWIEL VERVOER $0,0085 m^3$ water teen $1,486 m/s$ oor $1,18m$

$v = u + at$, met $u = 0$

$v = at$

$t = v/a = 0,793 s$

∴ $0,0085 m^3$ IN $0,793 s$

$Q_{gelewer} = 10,72 \ l/s$

2009/09/16
To: Tobias Mahne

REPORT BACK: WATERWHEEL CONCEPT DESIGN.

1. PURPOSE

The purpose of this report is to provide feedback on the concept design for a waterwheel in the Apies River

2. CONCEPT

The waterwheel will utilise kinetic energy from the force of flowing water, to translate water to a given elevation. This will be accomplished by converting the available kinetic energy to potential energy through applying a torque to the waterwheel, i.e. turning the waterwheel.

3. WHEEL DESIGN

For the purpose of this concept design and explanation, the wheel shall be as follows:

4. STATICS

In order to determine all the relevant forces acting on the waterwheel, and created by the waterwheel, it is necessary to create an imaginary control volume, within which all the forces can be quantified. These forces will be separated into *applied forces*, and *reaction forces*. Applied forces are those which act externally unto a system. Reaction forces are those forces *caused* by the applied forces.

4.1. APPLIED FORCES

The following applied forces are applicable:

- The force applied unto the waterwheel by the flow of water in the base channel, F_T;
- The weight of the waterwheel, m_1;
- The weight of the water in the buckets of the waterwheel at any time, m_2;

The first *applied* force is that cause by the obstruction in the free-flowing water channel (base channel). This force can be calculated by utilising the principle of momentum. Momentum is basically defined by the following relationship:

$$Momentum = m \cdot v$$

where

m = mass of object
v = velocity of object

The force caused by a sudden change in momentum, is simply the change in momentum. If the mass of the object does not change, then the force is calculated by the change in velocity. For water, this can be described as:

$$F_T = \rho \cdot Q \cdot (v_2 - v_1) \qquad (1)$$

where

F_T = momentum force, in N
ρ = density of water, in kg/m³
Q = flow rate, in m³/s
v_1 = initial velocity, in m/s
v_2 = end velocity, in m/s

In this case, the parameters are found to be:

ρ = 1000 kg/m³
Q = 1,148 m³/s
v_1 = 2,262 m/s
v_2 = 2,51 m/s
and therefore $\mathbf{F_T}$ = **1210 N** *(from 1)*

Since the weight of the waterwheel, m_1, is located symmetrically around the axis of the waterwheel, it was found to be inconsequential to the force analysis. This will be shown later.

The volume of each bucket is 0,01133m³, or 11,33l. Of this volume, approximately 75% will be filled with water. Thus, the weight of the water, m_2, is

$$\mathbf{m_2} = (0{,}75)(0{,}01133)(1000)(9{,}81)$$
$$= \mathbf{83{,}36\ N}$$

4.2. REACTION FORCES

All the applied forces results in a rotation force (torque) being applied around the axis of the waterwheel. This force can be found by taken the sum of the all the moments of the applied forces around the axis (because the weight of the wheel is symmetrical around the axis, its moment is equal to zero):

$$\sum M = \sum(F.d)$$
$$= 1498\ \text{N.m}$$

Thus, the rotation force *caused* by the applied forces, is **1 498 N.m.**

5. DYNAMICS

In order to determine the available discharge from the waterwheel, the rotation speed of the wheel needs to be calculated.

Because the reaction moment around the axis is known, the angular acceleration can be calculated as follows:

$$\sum M_0 = I \cdot \alpha \qquad (2)$$

where

M_o = total moment around axis, in N.m
I = second moment of area, in kg/m³
α = angular acceleration, in rad/s;

In its turn, the second moment of area, I, is defined as:

$$I = \sum r_i^2 \cdot m_i$$

and is calculated as

I = 2403,06 kg/m³

Note that this is a constant value for the given weight characteristics of the waterwheel. Should the design or construction materials change, this value will change with it.

Now the angular acceleration can be calculated from (2), and is found to be:

α = 0,625 rad/s

The corresponding acceleration of the water buckets is:

a = α.r
= 1,875 m/s²

With each bucketful, the wheel will turn

s = (2.Π.r)/16
= 1,18 m

Now, by basic movement equations, we find that the velocity of the wheel will be

v = 2,51 m/s

The discharge is therefore:

Q = v.V
= (2,51).(0,75).(0,01133)
= 9,03 l/s

6. BASE CHANNEL DESIGN

Discharge can be calculated with the following equation:

$$Q = \frac{1}{n} \cdot \frac{(A)^{\frac{5}{3}}}{(P)^{\frac{2}{3}}} \cdot S^{\frac{1}{2}}$$

where

Q = discharge, in m³/s
n = Mannings roughness coefficient;
A = cross-sectional area, in m²
P = wetted perimeter, in m
s = slope, in m/m

Therefore a channel of 1,45m x 0,35m will discharge 1,148 m³/s with a velocity of 2,51 m/s at a slope of 1:200.

7. MATERIALS

For this concept design, structural timber with density of 850 kg/m³ was used. If any other material is to be used, it should be kept in mind that any increase in total weight will require more base channel flow, as the second moment of area is increased (I value). With structural design, alternative materials such as aluminium, steel or composites could effectively be used to obtain the same value of function.