10.Gearbox, Brake, Coupling

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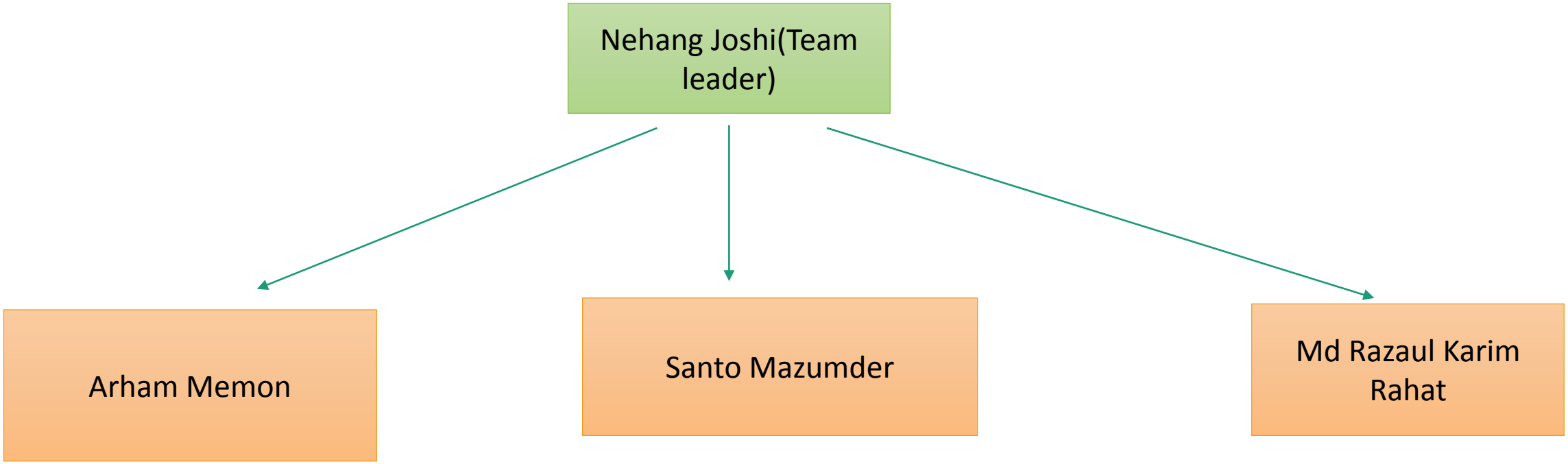
Agenda of the 1st week (21 July to 25th July)

- Study of last years documentation
- Research for appropriate mechanical drive train system and gearbox layout
- Research on relevant standards and guidelines
- Research on gearbox variants, mechanical brake systems and couplings (high speed side)
- Benchmark and definition of gearbox, brakes and coupling

- ***Research on possible suppliers suitable for delivering to Syria***

Study of last years documentation

- So basically we did research on previous year documentation and we came up with short ideas that how it should be work and how it could be done for this year as well for Syria project 2025-26.
- There are three parts for components we have to divided into three with four members as of now we all are working on same line like all the members including team leader are doing only research on this topic.



Research for appropriate mechanical drive train system and gearbox layout

- High speed drivetrains (3-4 gears)
  (Ref.Optimus Shakti)
- Gearbox: • Complex design requirements due to many gears:

o Many components (gears, bearings, shaft-hub-connections,..)

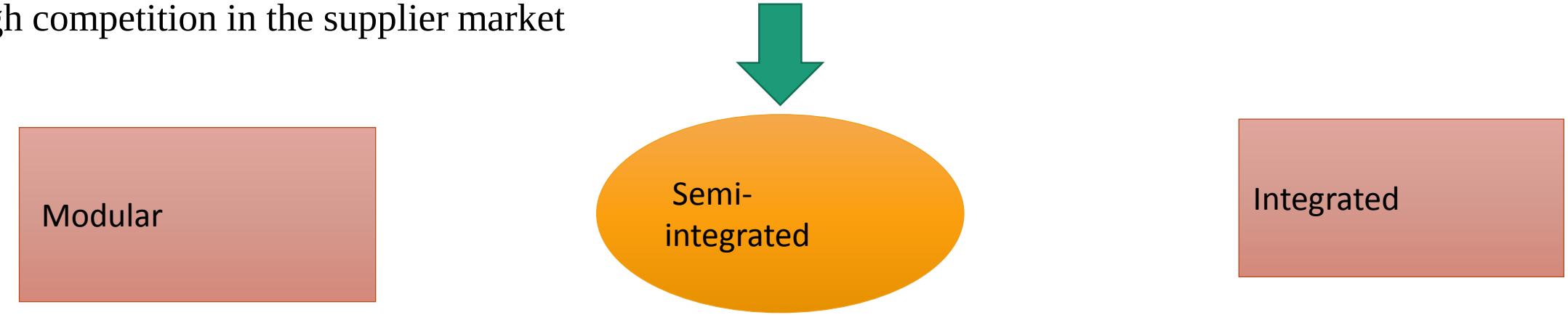
o Complex dynamics (many excitation frequencies, ‚soft' toothing,..)

- Critical to noise

• Just one lubricant despite unequal conditions in the different gears - In general very cost competitive due to high competition in the supplier market

Recommendation for project

1. Modular
2. **Semi-integrated (BEST Value provider)**
3. Integrated



Semi-integrated design (so-called 3-point-suspension)

- According to pervious year report (ref.optimus Shakti) they chosen semi-integrated drive train concept.

Why ?

rotor bearing system is partly integrated in the gearbox.

- ❖ The fixed bearing is connected to the machine bed, the floating bearing is part of the gearbox.
- ❖ rotor loads (forces and moments) are transferred through the housing of the gearbox into the machine bed.
- ❖ separated 2nd bearing housing is not required anymore(as per our decision this is the main advantage of this drive train system using for Syria project 2025-26 (But still needs to research)……

Semi-integrated design (so-called 3-point-suspension)

- Company in Germany which is using this kind of concept.

a. Senvion
b. Vestas
c. Siemens
d. Nordex
e. GE

(Task and aim is to do research that is they are also provider in Syria)?.....

Research for appropriate mechanical brake system.

- Caliper Design

Floating / Fixed

Actuation

Active/passive

Energy supply

Hydraulic/Electromechanic

Friction Plates → Organic/Sintered

- Caliper design

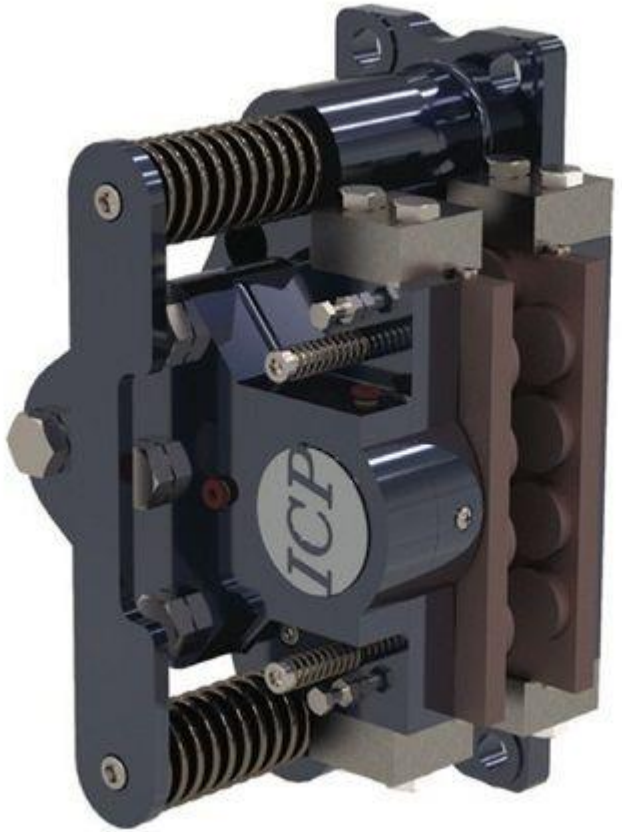
https://www.windsourcing.com/en/spare-parts-and-repair-material/brakes/brake-calipers/

https://www.ktr.com/de/en/products/brake-systems/

Fixed caliper brake (disk brake) is a typical hydraulic service brake used on the low torque side. All features of these hydraulic brakes are designed to operate reliably under adverse ambient conditions while generating low operating expenses.

- A floating caliper brake for a wind turbine works by utilizing a caliper that can slide or "float" on guide pins, allowing it to self-align with the brake disc. When activated, hydraulic pressure forces a piston against the brake pad, which then clamps onto the rotor, slowing or stopping the turbine's rotation. Springs release the brake when pressure is removed, allowing the rotor to spin freely again.
- Here's a more detailed explanation:
- 1. Components:
- **Caliper:** A housing that holds the brake pads and is designed to slide or "float" on guide pins.
- **Brake Pads:** Friction material that makes contact with the rotor to slow it down.
- **Piston:** A component within the caliper that is forced outward by hydraulic pressure.
- **Brake Disc (Rotor):** The rotating component that the brake pads clamp onto.
- **Hydraulic System:** Provides the pressurized fluid that actuates the piston.
- **Springs:** Return the brake pads to their resting position when hydraulic pressure is released.
- **Guide Pins:** Allow the caliper to slide axially on the brake carrier.
- 2. How it works:
- **Braking:**
- When hydraulic pressure is applied to the piston, it pushes the brake pad against the rotor. The caliper, able to slide on the guide pins, self-aligns to ensure even contact with the rotor.
- **Releasing:**
- When the hydraulic pressure is released, the springs push the piston back, retracting the brake pads and allowing the rotor to spin freely.

3. Floating Caliper Design:
The ability of the caliper to slide on the guide pins is crucial for ensuring proper and even braking force application, even if the rotor is slightly misaligned.
This floating action also helps to distribute the braking force evenly across the brake pad, reducing wear and tear.



4. Applications in Wind Turbines:
Rotor brakes (also known as fast speed dynamic brakes) are used to control over-speed conditions, preventing the turbine blades from rotating too fast in emergency situations or during parking.
They can be mounted on either the low-speed shaft (rotor) or the high-speed shaft (generator).
Floating caliper brakes are particularly useful in wind turbines due to their compact design and self-aligning properties, especially in applications where space is limited.
They are also used in yaw brakes, which hold the nacelle (the housing at the top of the tower that contains the generator and other components) in a fixed position.

5. Benefits:
Self-alignment: Compensates for slight misalignments in the braking system.
Compact design: Allows for installation in tight spaces.
Even braking force: Distributes pressure evenly across the brake pads.
Fast response: Springs retract the brakes quickly upon pressure release.

Ref. https://www.twiflex.com/en/newsroom/2016/02/is-caliper-brake-solutions-for-wind-turbines

Floating Caliper Rotor Brake

Ref below

- https://antec-group.com/wp-content/uploads/2021/12/Catalogo-Wind-2022.pdf
- https://www.youtube.com/watch?v=G1I3Zyvx1V0
- https://www.youtube.com/watch?v=Un0o51F9Pmw
- https://www.youtube.com/watch?v=adOYIvi_s1k
- https://www.youtube.com/watch?v=1y17pDLC0E0&pp=0gcJCfwAo7VqN5tD
- https://www.youtube.com/watch?v=er9op2FdMN8

- https://www.twiflex.com/en/newsroom/2016/02/is-caliper-brake-solutions-for-wind-turbines

Research for appropriate mechanical coupling system.

Coupling types

- Flexible shaft

- Multi Disc for wind turbines

Research on relevant standards and guidelines (AS per pervious year)

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IEC 61400-1:2019, Wind energy generation systems —Part 1: Design requirements

- IEC 61400-4:2012, Wind turbines —Part 4: Design requirements for wind turbine gearboxes
- ISO 6336-2:2019, Calculation of load capacity of spur and helical gears —Part 2: Calculation of surface durability (pitting)
- ISO 6336-3:2019, Calculation of load capacity of spur and helical gears —Part 3: Calculation of tooth bending strength
- ISO/TS 6336-4:2019, Calculation of load capacity of spur and helical gears —Part 4: Calculation of tooth flank fracture load capacity
- VDMA Specification 23903, Basic design requirements for plain bearings in main gearboxes of wind turbines
- VDMA Specification 23904, Reliability assessment for wind energy gearboxes

Research on possible suppliers suitable for delivering to Syria

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- Got some idea about from the internet and some website that is **Winenergy** group of company which origin of the German possible to provide in Syria because they have large production of gearbox which can gives good amount of work output and higher generation rates.
- Enercon company is also leading for supplies in Syrian region.
- ZF wind power Antwerpen also who is responsible to provide in this country
- ZF wind power and giants company like Siemens and flander 40-50% stockholder for this project for suppliers.

  (Above companies are located **in European region** mostly are capable enough)

- Goldwind and Dongfang is also could become leading for suppliers of gearbox,brake,coupling (**Asian region** and these companies located in china)

- **Remarks-** possibility for some other companies can do still research and proof required for supply chain

Summary work of our group this week (21st July to 25th July)

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- Research on previous year documents and got information about gearbox,brake,coupling

Remarks- Fully research is still pending due to unable to access file through ***GitHub and Microsoft account. (40% completed and 60% remain)***

- Research on appropriate drive train concept and gearbox

Remarks- Got mostly idea about which is most relevant concept for wind turbine in Syria region but still need conformation about the variants of the drive train and gearbox (***70% work done and 30% still remain***)

- Research on brake system and coupling for wind turbine

Remarks- Got idea about various kind of brake system and coupling which is use for most advance developments and which is most suitable for turbine but still needs to be use other medium to get more information about it (like research paper, YouTube, company gernals and documentation. (***40 % work done and 60% pending***)

- Research on standards and guild line and benchmarks for gearbox,brake,coupling

Remarks- Mostly aware and filmier with standards but still required to few ***(80% done and 20% pending)***

- Research on Syrian market and know about suppliers

Remarks- Research on possible suppliers suitable for delivering to Syria is stll remain just because lack of knowledge and new country for project which is quite far from wind turbine market. ***(30% done and 70% pending) cost and value maybe play major role.***

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Work load and media used for this week.

- **8 hours / This week**

- **<u>Media used</u>**

(Google chrome , YouTube , WhatsApp, research paper, companies pdf and documents)

- **<u>Medium of compunction with team mates</u>**

(WhatsApp group) **Remarks- will try to improve for offline as well as online meeting (zoom, WebEx)**

Next week plan in advance description (28th July to 1st august) 2nd week

- Complete pervious week work better to do fully
- Software installation (Solidworks,Anysys,Dlubal)
- YouTube videos gearbox design , brake, coupling tutorial learning
- Get some idea about calculation
- Get more information or gathering from companies website , articles and generals
- Familiar with wind turbine data trough research paper
- **Practice and try to improve data and information about topic.**