#### **Load Analysis**

* **Sensor Weight:**  
  Given that the **mass** of the LiDAR sensor is **1 kg**, the gravitational force acting on it is:  
  Fg=mg=(1 kg)(9.81 m/s2)=9.81 N
* **Wind Load:**  
  At **80 km/h (22.22 m/s)**, assuming a **frontal area** of **0.01 m²** and an **air density** of **1.225 kg/m³**, the aerodynamic force is: Fw=½(Cd*ρv*²A
* Assuming a drag coefficient **Cd≈1.2**  
  Fw=½(1.2)(1.225)(22.22)²(0.01) ≈ 3.63 N
* **Vibration and Impact Loads:**  
  For design considerations, a **dynamic factor of 3** is applied:  
  Fdyn=3×(Fg+Fw)=3×(9.81+3.63)=40.32 N
* **3. Material Selection & Stress Analysis**

The mounting bracket will experience:

* **Axial tension/compression** from the weight and wind force.
* **Bending moments** due to cantilevered mounting.
* **Shear forces** at attachment points.

Assuming a **simple cantilever beam** with a length of **L = 0.2 m**, the **bending moment** at the fixed end due to dynamic force is:

M=Fdyn×L=(40.32)×(0.2)=8.06 Nm

Using the **bending stress equation**:

σ=McI\σ

where:

* I=bh³/12 (moment of inertia for a rectangular cross-section),
* c=h/2 (distance from the neutral axis).

Let’s assume a **rectangular cross-section** with **b = 30 mm** and **h = 10 mm**.

I=(0.03)(0.01)³/12=2.5×10^-10 m^4   
c= 10/2 =5 mm=0.005 m

𝜎=(8.06)(0.005)2.5×10−10

σ= 2.5×10 −10(8.06)(0.005)

𝜎=161.2 MPa

Now, we compare this stress to the allowable limits of the materials:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Material** | **Allowable Stress (MPa)** | **Yield Strength (MPa)** | **Elastic Modulus (GPa)** | **Density (kg/m³)** |
| **Carbon Steel (A Grade)** | 149 | 207 | 200 | 7850 |
| **Aluminum 6063 T5, T52** | 79 (55 MPa near welds) | 110 | 69 | 2710 |
| **Stainless Steel (302, 304, 316)** | 207 | 345 | 193 | 7500 |

* **Carbon Steel**: The stress **exceeds the allowable limit** of **149 MPa**, making it **risky**.
* **Aluminum 6063-T5**: The stress is **more than double the allowable limit (79 MPa, or 55 MPa near welds)**. This material is **not suitable**.
* **Stainless Steel**: The stress is **within the allowable limit** of **207 MPa**, making it the **best choice**.
* **Best Material Choice: Stainless Steel (302, 304, 316)**
  + **Meets strength requirements** (σ = 161.2 MPa < 207 MPa).
  + **Resistant to corrosion** (important for environmental durability).
  + **Lightweight compared to carbon steel** (density 7500 kg/m³ vs. 7850 kg/m³).
  + **More expensive than aluminum, but ensures safety**.

**Alternative:** If **weight is a higher priority**, **carbon steel** can be considered but requires **redesign** (increased thickness or different shape).