For the Y-axis of our system, we chose to use 6202-2ZZ bearings, which are a widely used and highly reliable option. This decision was based on several factors. First and foremost, the 6202-2ZZ is a standard, affordable, and readily available bearing-commonly stocked in most hardware stores due to its broad use in gearboxes, bearing holders, and general mechanical assemblies. Its accessibility ensured that replacements or extras could be sourced quickly during development or testing without delays.

Additionally, the 15 mm inner diameter of this bearing proved to be particularly well-suited for our design, as it allows for a robust 3D-printed axle with a larger cross-sectional area. This is critical when working with PLA, which has its weakest mechanical properties in the Z-direction due to layer adhesion limitations. The larger axle diameter helps distribute shear forces more evenly, reducing the risk of delamination or snapping under load. Assuming a Z-direction layer adhesion strength of approximately 15 MPa for PLA, and using the inner surface area of the bearing-axle interface as  
*A = π × r² = π × (7.5 mm)² ≈ 177 mm²*,  
theoretical shear force capacity becomes:  
*F = σ × A = 15 MPa × 177 mm² = 2655 N*,  
which confirms the mechanical feasibility of this setup under expected loads.

Finally, our design approach followed a component-first philosophy, where we selected the bearing early in the process and designed the rest of the mechanical system around it. This is a practical and time-efficient methodology in prototyping environments, as it avoids the need for custom or hard-to-source parts later in the design phase. Choosing a standard bearing from the outset streamlined the workflow and helped ensure structural reliability and cost-effectiveness.

For one of the main rotational components, we initially selected a 30212 tapered roller bearing. This type of bearing is designed to handle both radial and axial loads and is commonly used in heavy-duty applications such as wheel hubs and industrial machinery. While it is a mechanically robust and durable choice, its use in our project turned out to be largely overengineered and physically oversized for the specific requirements we were dealing with. The 30212 is a comically large bearing in the context of our application, and its inclusion introduced several complications during assembly and testing.

One of the key issues encountered was that the 30212 bearing can be dismantled into three separate components-the inner race, outer race, and tapered rollers-which are not held together unless mounted with proper preload or retained structurally. During rotation, this led to unwanted play and instability, as the top and bottom components of the system did not apply consistent force to hold the bearing tightly together. To resolve this, we had to design and install a custom spacer ring between the top rotating base and the stationary bottom base to minimize movement during operation. This added design step was entirely avoidable and only became necessary due to the oversized and loosely constrained nature of the bearing.

The main reason this issue persisted was due to the bearing being selected very early in the process, before any real-world testing could be done. By the time we realized it was not the ideal component, the purchasing window had already closed, and we were locked into using what we had. This highlights a critical lesson: component testing should happen before final purchasing, especially when dealing with structural or rotational elements. In hindsight, a smaller, sealed deep-groove ball bearing would have been far more appropriate-simpler to mount, more compact, and still more than capable of handling the required loads.