Imagen que contiene Logotipo

Descripción generada automáticamente![Logotipo, nombre de la empresa

Descripción generada automáticamente](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4REwRXhpZgAATU0AKgAAAAgABAE7AAIAAAAjAAAISodpAAQAAAABAAAIbpydAAEAAABCAAAQ5uocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEdlcm3DoW4gQW5kcsOpcyBEaSBGb256byBDYXR1cmVnbGkAAAAFkAMAAgAAABQAABC8kAQAAgAAABQAABDQkpEAAgAAAAM0OAAAkpIAAgAAAAM0OAAA6hwABwAACAwAAAiwAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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UNIVERSIDAD POLITÉCNICA DE MADRID

ESCUELA TÉCNICA SUPERIOR DE INGENIEROS INDUSTRIALES

MÁSTER EN AUTOMÁTICA Y ROBÓTICA

DISEÑO Y CONTROL DE ROBOTS – PEC 1

DISEÑO, DESARROLLO Y CONTROL DE UNA PLATAFORMA ROBOTIZADA MÓVIL PARA EL ROBOT MANIPULADOR IRB 1520ID DE ABB

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# Introducción y Objetivos

El objetivo general que se busca con este proyecto es el de diseñar y controlar una plataforma robotizada móvil para que se coloque encima suya el robot antropomórfico IRB 1520ID de ABB. También se pretende calcular las características de los motores necesarios para mover las articulaciones de este robot antropomórfico e implementar un control sobre el mismo.

Este proyecto estará dividido en tres partes (pruebas de evaluación continua – PECs -), de manera que cada parte se corresponda con un informe en el que se irán mostrando los avances progresivos del diseño y el control de la plataforma robotizada y el control del robot antropomórfico.

Este informe se corresponde con la primera prueba de evaluación continua (PEC 1) y los objetivos específicos que se pretenden alcanzar son los que se enumeran a continuación:

1. Diseño del chasis de la plataforma robotizada móvil mediante el software Inventor Professional de Autodesk.
2. Cálculo y elección de los motores necesarios para mover la plataforma robotizada móvil.
3. Elección de las baterías para suministrar energía eléctrica a los diferentes motores del sistema robotizado.
4. Modelado y simulación de la plataforma robotizada móvil empleando la herramienta Simscape de Simulink (Matlab).
5. Modelo de la dinámica inversa del robot manipulador IRB 1520ID para determinar sus curvas de respuesta y poder calcular los motores necesarios de sus tres primeras articulaciones.

# Diseño de la plataforma robotizada móvil

## Descripción general

La plataforma robotizada móvil que se ha diseñado para este proyecto utilizando el software Inventor Professional consta de las siguientes piezas:

* Un chasis diseñado con perfiles de aluminio.
* Dos ruedas motrices conectadas mecánicamente cada una de ellas con su correspondiente motor para permitir el movimiento de la plataforma.
* Cuatro ruedas directrices (rueda *caster*, giratorias) que permiten que la plataforma sea movida con mayor facilidad y que se reparta mejor el peso total de la plataforma más la del robot entre todas las ruedas en las que se apoya.
* Dos tablones de aluminio colocados en la parte superior e inferior del chasis donde se colocará finalmente el robot, las baterías y los componentes del circuito de control.

El diseño de esta plataforma robotizada móvil es el que se muestra en la *Figura 1*.

![Imagen que contiene ventana, edificio, tabla

Descripción generada automáticamente](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4REwRXhpZgAATU0AKgAAAAgABAE7AAIAAAAjAAAISodpAAQAAAABAAAIbpydAAEAAABCAAAQ5uocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEdlcm3DoW4gQW5kcsOpcyBEaSBGb256byBDYXR1cmVnbGkAAAAFkAMAAgAAABQAABC8kAQAAgAAABQAABDQkpEAAgAAAAM1NAAAkpIAAgAAAAM1NAAA6hwABwAACAwAAAiwAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Figura 1. Diferentes vistas del diseño de la plataforma robotizada móvil.

La masa total de la plataforma es de 160 kg aproximadamente. En cuanto a sus dimensiones, tiene una anchura de 690 mm, una profundidad de 780 mm y una altura de 652 mm.

A continuación, se explican detalladamente cada uno de los componentes utilizados en el diseño de la plataforma robotizada móvil con sus respectivas características.

## Chasis

Para el diseño del chasis se han utilizado 12 perfiles de aluminio de la serie 45 de la empresa MiniTec[[1]](#footnote-1), concretamente el perfil de aluminio 45 x 90 S (ver *Figura 2*).

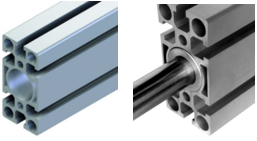


Figura 2. Perfil de aluminio 45 x 90 S.

En la *Tabla 1* se muestran las características específicas de estos perfiles.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sección transversal del perfil** | **Material** | **Momentos de inercia ()** | **Momentos resistentes ()** | **Masa** |
|  | Aluminio galvanizado y anodizado (E6/EV1) |  |  | 3.860 kg/m |

Tabla 1. Características del perfil 45 x 90 S de MiniTec.

En cuanto a la longitud de los perfiles utilizados, se ha decidido escoger una longitud de 600 mm para aquellos que están dispuestos paralelos al plano del suelo y una longitud de 500 mm para aquellos que están colocados perpendicularmente a este. Por lo tanto, la masa de cada uno de los perfiles horizontales es de 2.328 kg, mientras que la de los perfiles verticales es igual a 1.940 kg. En definitiva, la masa total del chasis es de 26.384 kg.

Para unir los perfiles y formar el chasis de la plataforma robotizada se han utilizado 16 escuadras metálicas de la empresa MiniTec[[2]](#footnote-2) (ver *Figura 3*). Cada escuadra pesa 0.281 kg.

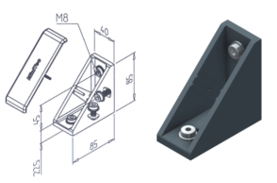


Figura 3. Escuadras metálicas 45 x 90 GD-Z.

## Tablones de Aluminio

Para que la plataforma robotizada móvil pueda sostener el robot manipulador de ABB, las baterías y los controladores se han diseñado dos tablones de aluminio con Inventor Professional cuyas características se muestran en la *Tabla 2.*

El tablón de aluminio situada en la parte inferior de la plataforma ha sido diseñado con el objetivo de colocar sobre él las baterías y los controladores. Este tablón posee un agujero de 100 mm de diámetro justo en su centro para poder pasar los cables que se conectan al motor que hace girar las ruedas motrices. Además, en este tablón se ha dejado un determinado espacio necesario que permita encajar las pletinas diseñadas para sujetar las ruedas motrices con el chasis.

Por otro lado, el tablón de aluminio colocado en la parte superior de la plataforma se encarga de soportar el robot manipulador.

|  |  |  |  |
| --- | --- | --- | --- |
| **Tablones** | **Figura y dimensiones** | **Material**  **y densidad (g/cm3)** | **Masa (kg)** |
| Tablón inferior |  | Aluminio 6061 | 39.431 |
| Tablón superior |  | Aluminio 6061 | 40.464 |

Tabla 2. Características de las tablas de aluminio de la plataforma robotizada móvil.

La masa total de los dos tablones de aluminio juntos es igual a 79.895 kg.

## Ruedas Directrices

La función principal de las ruedas directrices o ruedas *caster* es repartir el peso de la plataforma en varios puntos de apoyo y permitir el movimiento ejercido por las ruedas motrices. Estas ruedas giran en torno a dos ejes, uno vertical y perpendicular al suelo que permite la orientación y otro horizontal y paralelo al suelo que permite el avance. La orientación y el avance de las ruedas *caster* se realiza según la dirección de la fuerza resultante ejercida sobre ellas al aplicar un determinado par sobre las ruedas motrices.

El criterio utilizado para la selección de las ruedas directrices se basa en la carga límite que es capaz de soportar la rueda. La masa total de la plataforma más la del robot soldador colocado encima se ha estimado que es de 330 kg aproximadamente. Para determinar esta carga, se han tenido en cuenta las masas de cada uno de los elementos que forman parte de la plataforma y del robot manipulador, incluyendo valores de masas estimados para las ruedas, los motores, las baterías y los controladores.

Al disponer de una plataforma con seis ruedas (2 motrices y 4 directrices), cada rueda soporta una masa igual a 55 kg. De acuerdo con las diferentes posibilidades de acoplamiento de las ruedas directrices con los perfiles escogidos para el chasis se decide elegir el modelo *Swivel Castor Without Brake D100 x 135, ESD* de la empresa MiniTec[[3]](#footnote-3) (ver *Figura 4*). También se tuvo en cuenta la posibilidad de incluir frenos a estas ruedas, pero finalmente se decidió que las ruedas motrices fuesen las que bloqueasen el movimiento de la plataforma móvil.

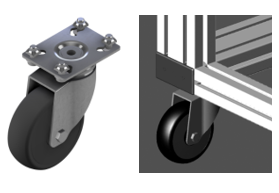


Figura 4. Ruedas directrices de la plataforma robotizada móvil.

En la *Tabla 3* se muestran las principales características del modelo seleccionado.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Dimensiones de la rueda directriz** | **Material de la estructura** | **Material de la fijación** | **Capacidad (kg)** | **Masa (kg)** |
|  | Acero galvanizado | Acero y zinc | 90 | 0.765 |

Tabla 3. Características de las ruedas directrices.

Al utilizar cuatro ruedas directrices, la masa total de todas ellas es de 3.06 kg.

Las ruedas directrices que se han elegido son más cortas en cuanto a altura que las ruedas motrices seleccionadas en el siguiente apartado. Esto significa que, si se colocan todas las ruedas sobre el chasis de la plataforma, las ruedas *caster* no tocarían el suelo. Por lo tanto, se ha decido calzar las ruedas directrices para ajustar la altura de estas y que todas las ruedas se apoyen sobre el plano del suelo. Para ello, se ha diseñado la pieza de aluminio que se muestra en la *Figura 5*.

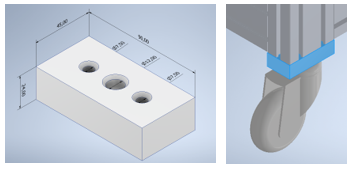


Figura 5. Pieza para el calzado de las ruedas directrices.

## Ruedas Motrices

Para que la plataforma robotizada móvil pueda moverse son necesarias al menos dos ruedas motrices que reciban un par motriz a través de unos motores. Aplicando el mismo par motriz a cada una de ellas en el mismo sentido de giro la plataforma avanza o retrocede siguiendo una trayectoria rectilínea, mientras que si se varía el sentido de giro de alguna rueda motriz o se aplica un par diferente a cada una, entonces la plataforma realiza trayectorias curvilíneas.

Para la elección de las ruedas motrices hay que tener en cuenta el peso total que recae sobre ellas y el par motriz que se necesita aplicarles para poder dotar de movimiento a la plataforma robotizada. Por lo tanto, se debe calcular el par motriz nominal necesario para mover la plataforma sobre un plano horizontal, y un par máximo que permita a la plataforma robotizada avanzar sobre una superficie inclinada unos 15.

Las ecuaciones que rigen el desplazamiento de la plataforma en el plano horizontal (ver *Figura 6*) son las que se muestran a continuación:

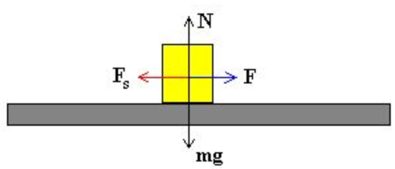


Figura 6. Movimiento de la plataforma robotizada sobre un plano horizontal.

Por otro lado, las ecuaciones que describen el desplazamiento de esta plataforma a lo largo de un plano inclinado (ver *Figura 7*) son las siguientes:

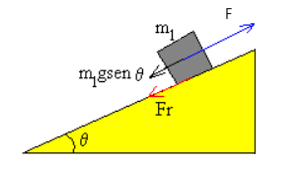


Figura 7. Movimiento de la plataforma robotizada sobre un plano inclinado.

Donde:

* : fuerza que se necesita aplicar para que la plataforma se desplace sobre un plano horizontal.
* : fuerza que se necesita aplicar para que la plataforma se desplace sobre un plano inclinado.
* : masa que soporta cada rueda motriz. Hay que tener en cuenta que se está estudiando este sistema desde el punto de vista de las ruedas motrices y, por lo tanto, la masa que soporta cada una de ellas se corresponde con la masa total de la plataforma más la masa del robot dividida entre el número de puntos de apoyo. En este caso, la plataforma dispone de 6 ruedas, dos motrices y cuatro directrices.
* a: aceleración de la plataforma al desplazarse. Para este parámetro se han utilizados los siguientes valores de aceleración:
* g: aceleración de la gravedad ().
* ángulo de inclinación de la superficie ().
* coeficiente de fricción estático ().

Para determinar la masa que recae sobre cada rueda motriz se han tenido que realizar algunas suposiciones, ya que se desconoce la masa de las ruedas motrices, la masa de los motores, la masa de las baterías y la masa correspondiente a la electrónica de potencia. Los valores de masa que se han escogido para estos elementos se especifican en la *Tabla 4.* Además, en esta tabla también se indican las más de los elementos ya conocidos (chasis, tablones, ruedas directrices y robot manipulador). Para el cálculo de la masa total del sistema se han despreciado las masas de las escuadras que unen los perfiles del chasis y los elementos que se han utilizado para el calzado de las ruedas directrices. Se ha hecho de esta manera porque el resultado de masa total final obtenido se ha sobredimensionado.

|  |  |
| --- | --- |
| **Elemento (s)** | **Masa** |
| Chasis | 26.38 kg |
| Tablones de aluminio | 79.90 kg |
| Ruedas directrices | 3.06 kg |
| Ruedas motrices | 10 kg (suposición) |
| Motores + Baterías | 15 kg (suposición) |
| Electrónica de potencia | 5 % de 134.34 kg = 6.72 kg (suposición) |
| Robot IRB 1520ID | 170 kg |
| Masa total = 311.05 kg | |

Tabla 4. Tabla de masas para el cálculo del par necesario en las ruedas motrices.

Como se ha mencionado anteriormente, la masa total se ha sobredimensionado y finalmente se ha elegido un valor de 330 kg para realizar los cálculos oportunos. Por lo tanto, se obtiene que cada rueda debe soportar una carga de .

Sustituyendo los valores de los diferentes parámetros de este sistema en las ecuaciones descritas anteriormente para el caso del plano horizontal e inclinado, se obtienen los siguientes resultados:

Una vez determinadas las fuerzas necesarias para el movimiento de la plataforma en un plano horizontal e inclinado, se debe obtener el par mínimo que debe ser capaz de ejercer cada rueda motriz en cada caso. Para ello, hay que tener en cuenta el radio de la rueda (70 mm).

Teniendo en cuenta los valores de par recién calculados se ha decidido elegir el modelo WD14050-5626-23C de la empresa Nanotec[[4]](#footnote-4) para las ruedas motrices de la plataforma robotizada móvil (ver *Figura 8*).

Además de cumplir con los requerimientos del par, se asegura que se cumple el criterio de capacidad superior a que debe aguantar cada rueda.

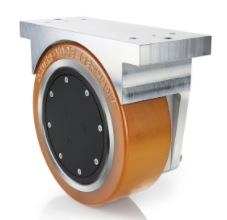


Figura 8. Modelo WD14050-5616-23C seleccionado para las ruedas motrices.

A pesar de que existen modelos inferiores que proporcionan un par también válido para el dimensionamiento anteriormente adoptado, este modelo no supone un gasto adicional, y además proporciona una relación de reducción de 26 lo que soluciona un problema encontrado en dimensionamiento del motor más adelante.

En la *Tabla 5* se detallan todas las características técnicas del modelo de rueda seleccionado. Además, en la *Figura 9* se muestran sus dimensiones.

|  |  |  |  |
| --- | --- | --- | --- |
| **Diámetro rueda** | 140 | **Altura** | 150 |
| **Ancho rueda** | 50 | **Material de la rueda** | Vulkollan |
| **Capacidad de carga** | 400 | **Reducción** | 26 |
| **Par de salida** | 29.1 | **Par máximo** | 39.4 |
| **Velocidad máxima de entrada** | 8988 | **Eficiencia** | 94% |
| **Momento de inercia** | 12 | **Peso** | 4.6 |
| **Protección IP** | IP54 | **Motores posibles** | NEMA 23, NEMA 24 |
| **Soporte de montaje** | Sí | **Temperatura de funcionamiento** | (-15 ºC , 90ºC) |

Tabla 5. Características técnicas del modelo de rueda WD14050-5616-23C.

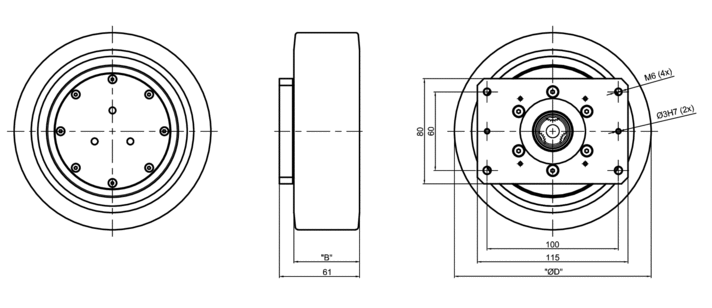


Figura 9. Dimensiones del modelo de rueda WD14050-5626-23C.

Para poder encajar las ruedas motrices con los perfiles del chasis de la plataforma se ha tenido que diseñar una pletina de dimensiones específicas con el software Inventor Professional. El resultado final del diseño de esta pletina es el que se muestra en la *Figura 10*.

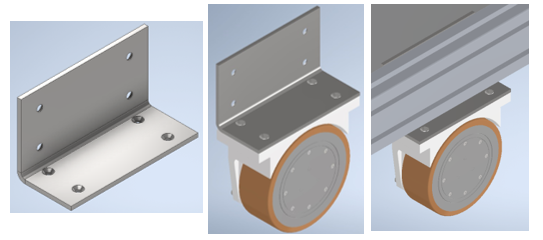


Figura 10. Resultado final del diseño de la pletina y del encaje de la rueda motriz con el chasis.

## Motores de la Plataforma

Los motores son los que se encargan de aportar el par necesario a las ruedas motrices para conseguir el movimiento de la plataforma robotizada móvil. Estos motores deben de corriente continua y tipo brushless, debido a su alta velocidad de giro. El criterio de dimensionamiento estos motores consiste en calcular la potencia necesaria para aplicar el par que necesitan las ruedas motrices para girar. El cálculo de esta potencia viene definido por la siguiente expresión:

Donde:

* : par que ofrece el motor a la salida.
* : velocidad angular salida en condiciones nominales.
* : potencia requerida del motor.

Las ruedas motrices elegidas en el apartado anterior, en condiciones nominales, trabajan con un par de 15.18 Nm y una velocidad lineal impuesta de 1 m/s. Por lo tanto, la potencia necesaria que debe suministrar el motor es de 216.86 W, tal y como se indica a continuación.

También es necesario tener en cuenta el par nominal y el par máximo tras la etapa de reducción a la hora de dimensionar el motor.

Debido a las características técnicas de la rueda motriz, la propia empresa Nanotec propone ciertos motores para que se acoplen correctamente con la rueda escogida. Teniendo esto en cuenta y la potencia calculada se escoge el modelo DB59C048035-A de Nanotec[[5]](#footnote-5) (ver *Figura 11*).

En la *Tabla 6* se indican las características técnicas del modelo de motor elegido. Además, en la *Figura 12* se muestran sus dimensiones.

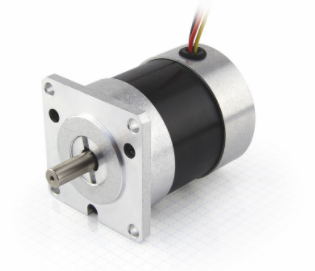


Figura 11. Motor brushless de corriente continua DB59C048035-A.

|  |  |  |  |
| --- | --- | --- | --- |
| **NEMA** | 23 | **Tamaño** | 56 |
| **Potencia** | 220 | **Tensión nominal** | 48 |
| **Torque nominal** | 60 | **Torque máximo** | 180 |
| **Intensidad nominal** | 6 | **Intensidad torque** | 18 |
| **Velocidad nominal** | 3500 | **Torque constante** | 10 |
| **Inercia del rotor** | 173 | **Resistencia** | 0.5 |
| **Inductancia** | 0.8 | **Longitud** | 93.6 |
| **Peso** | 0.95 |  |  |

Tabla 6. Características técnicas del motor brushless de corriente continua DB59C048035-A.

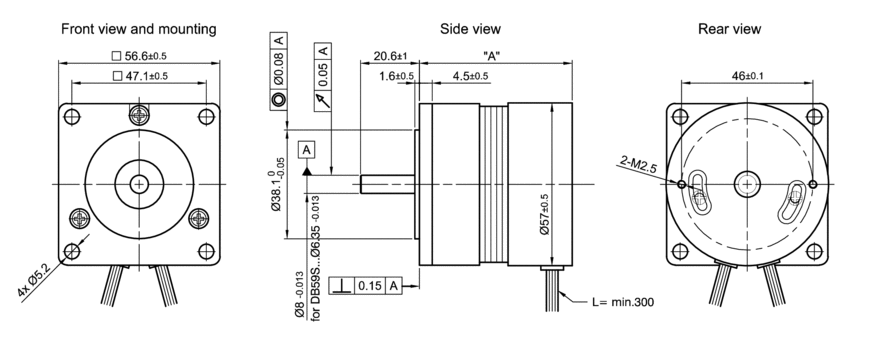


Figura 12. Dimensiones del motor brushless de corriente continua DB59C048035-A.

## Sistema de alimentación

Para dotar a la plataforma robotizada móvil de cierta autonomía es necesario el dimensionamiento de un sistema de alimentación que viene definido por la siguiente expresión:

Donde:

* : amperios hora.
* : potencia nominal.
* : horas de autonomía.
* : tensión de alimentación.
* : Fracción de reservas energéticas.

En cuanto a las características de diseño requeridas, se ha impuesto que la plataforma tenga una autonomía de 5 horas y unas reservas energéticas del 25%.

La selección de las baterías aún no se ha realizado para esta primera parte del proyecto, pero se ha estimado un peso de 13 kg.

# Modelado en Simscape de la plataforma

El modelo en Simscape utilizado para simular el comportamiento de la plataforma robotizada móvil en Matlab es el que se muestra en la *Figuras 13 y 14*.

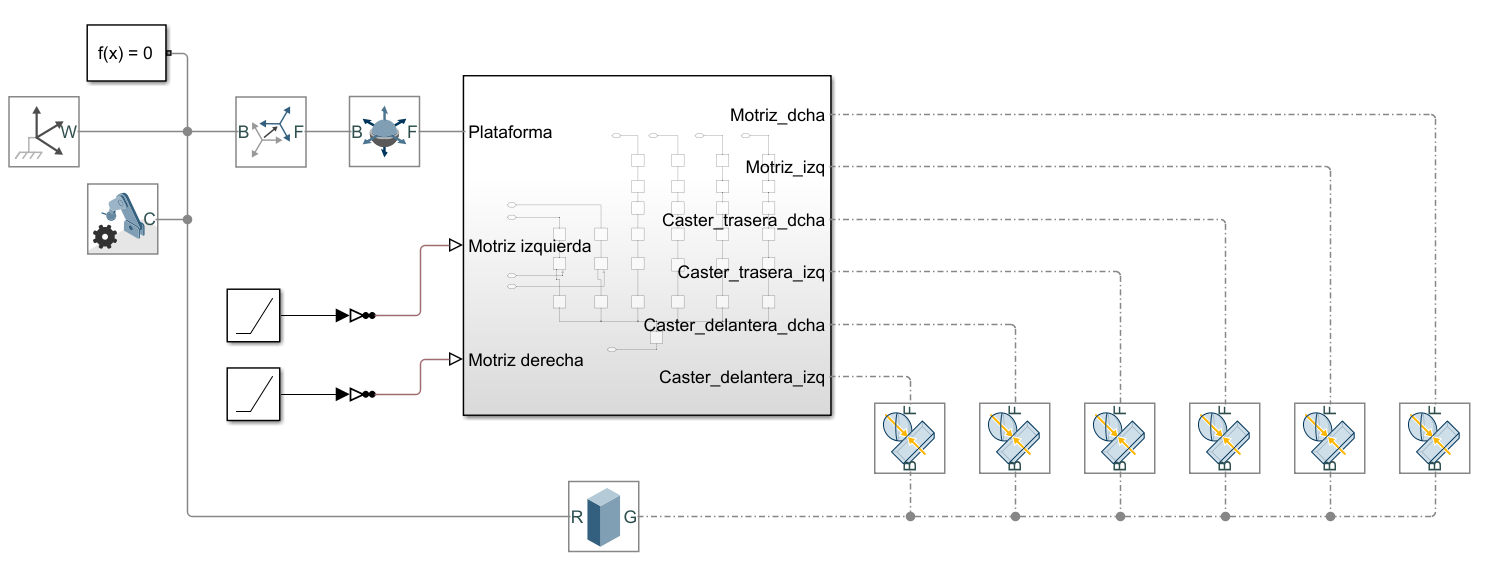


Figura 13. Modelo en Simscape de la plataforma robotizada móvil.

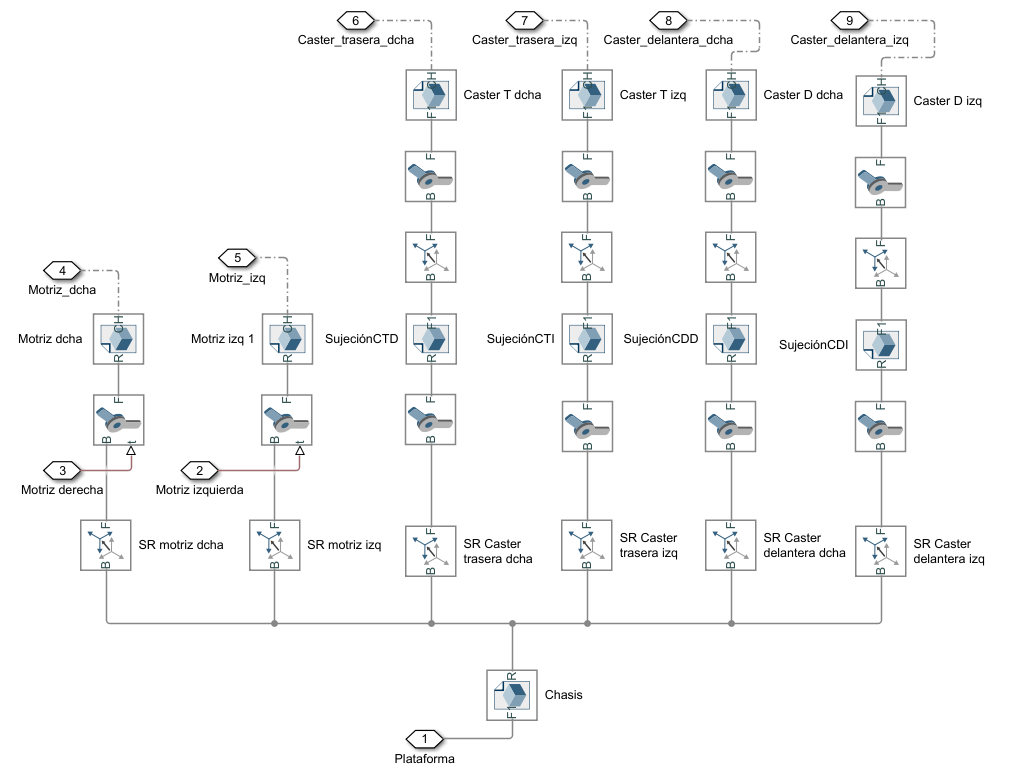


Figura 14. Subsistema del modelo en Simscape de la plataforma robotizada móvil.

A continuación, se explica de forma resumida cómo se ha implementado este modelo en Simscape.

En primer lugar, se ha importado el chasis de la plataforma mediante el bloque *File Solid*. El sistema de referencia utilizado para esta pieza se corresponde con el que se estableció en Inventor Professional durante su diseño (ver *Figura 15*).

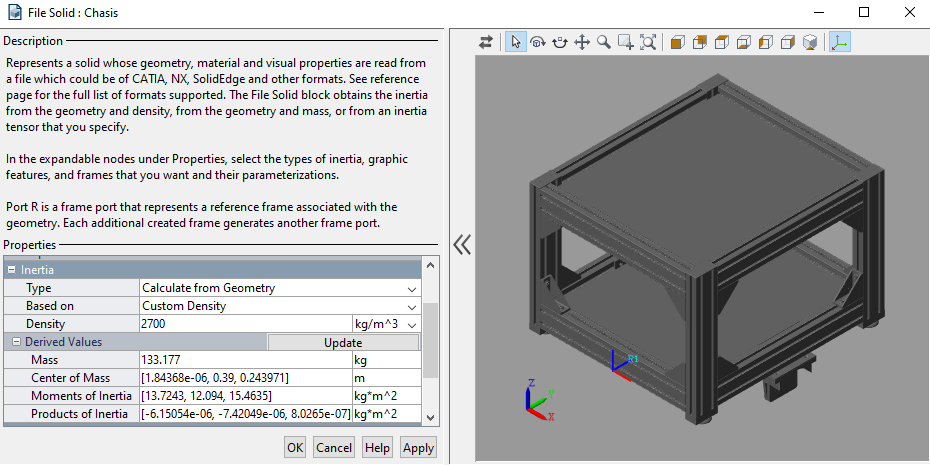


Figura 15. Bloque "Chasis".

Después, se han definido varios sistemas de referencia mediante el bloque *Rigid Transform* para indicar la posición de las ruedas y los ejes de giro de estas. En el caso de las ruedas motrices, se ha necesitado un único sistema de referencia para cada una, debido a que solo giran respecto un eje horizontal. Sin embargo, para las ruedas directrices se han definido dos sistemas de referencia, ya que estas giran respecto a dos ejes, uno vertial y otro horizontal. En la *Figura 16* se pueden observar dónde y cómo se han colocado estos sistemas de referencia. El eje Z de cada sistema de referencia se ha hecho coincidir con el eje de giro de la articulación.

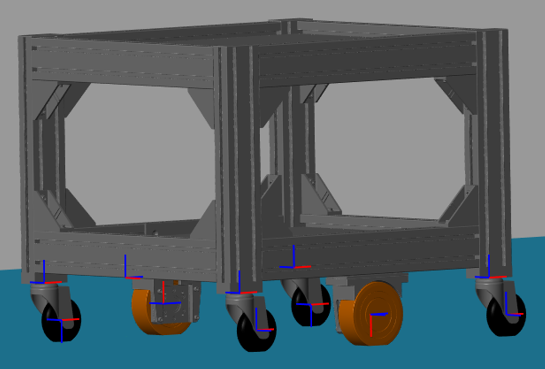


Figura 16. Sistemas de referencias para los grados de libertad de las ruedas de la plataforma.

Finalmente se han importado los diseños de las ruedas mediante diferentes bloques *File Solid* (ver *Figuras 17, 18 y 19*).

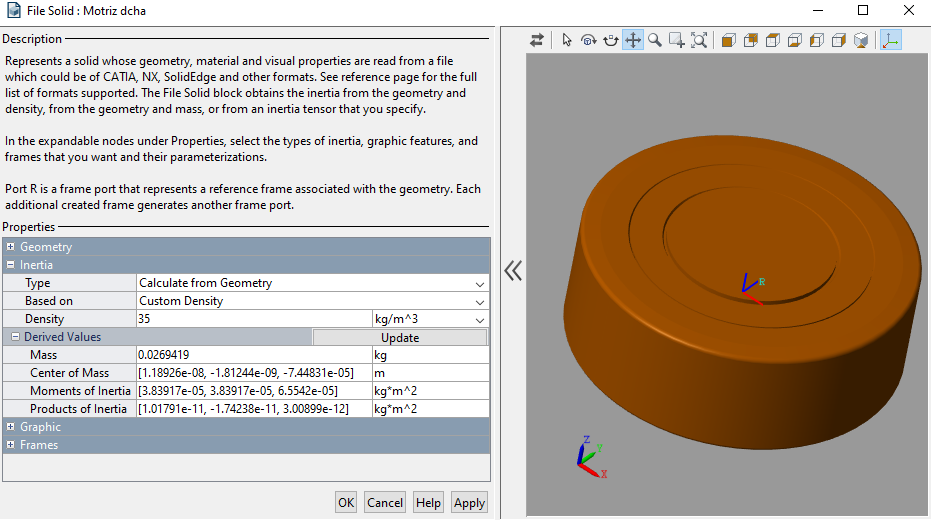


Figura 17. Ruedas motrices (giro en eje horizontal).

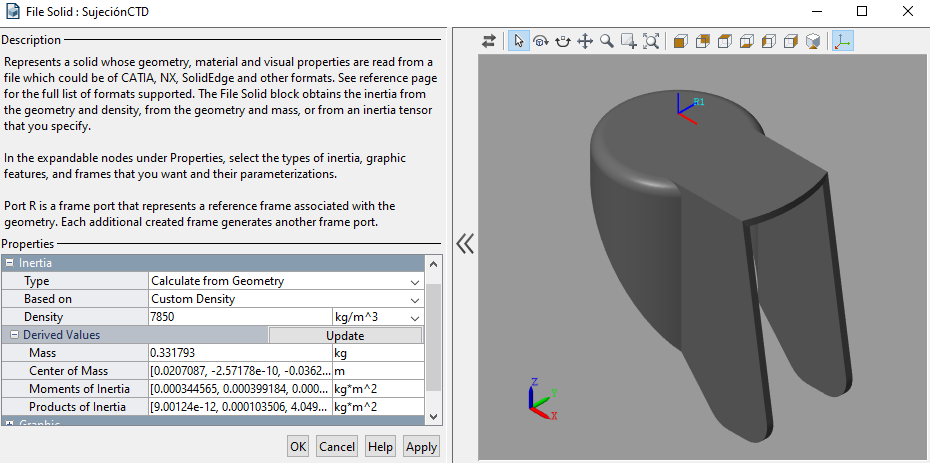


Figura 18. Sujeción de las ruedas directrices (giro en eje vertical).

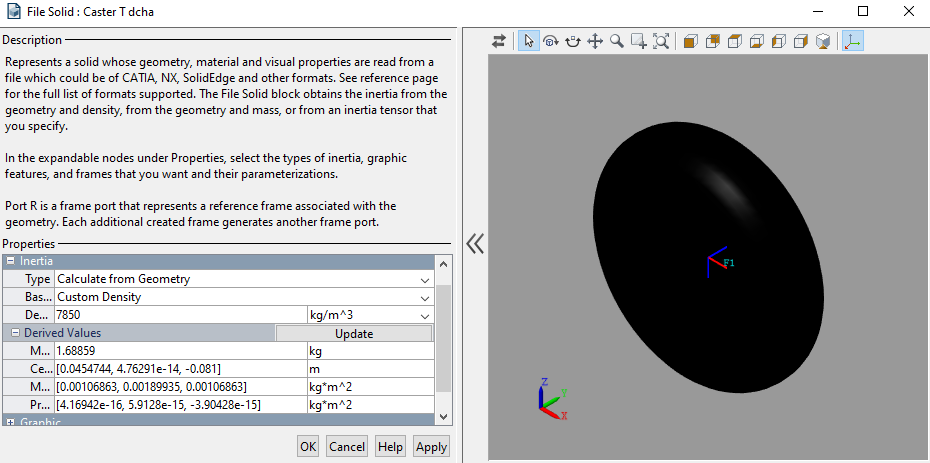


Figura 19. Ruedas directrices (giro en eje horizontal).

# Robot IRB 1520ID de ABB

## Características generales del robot IRB 1520ID

En esta sección se presenta el brazo robotizado que se va a utilizar para la resolución del presente trabajo, este robot de ABB es un modelo específicamente diseñado para la soldadura al arco de alta precisión. Goza de un paquete de mangueras totalmente integradas en el brazo, lo que significa que cuenta con todos los medios necesarios para la soldadura.

.

Figura 20 Robot ABB IRB 1520ID

|  |  |  |  |
| --- | --- | --- | --- |
| **Especificaciones** | | **Prestaciones (norma ISO 9283)** | |
| **Carga útil** | 4 | **Repetibilidad de la posición (RP)** | 0.05 |
| **Carga en el brazo** | 10 | **Repetibilidad del recorrido** | 0.35 |
| **Radio de trabajo** | 1.50 | **Conexiones eléctricas** | |
| **Número de ejes** | 6 | **Tensión de alimentación** | 380 |
| **Protección** | IP40 | **Consumo** | 0.6 cubo ISO |
| **Características físicas** | | | |
| **Dimensiones de la base** | 300 x 300 | **Peso del robot** | 170 |

Tabla 7 Características técnicas del modelo de ABB IRB 1520ID

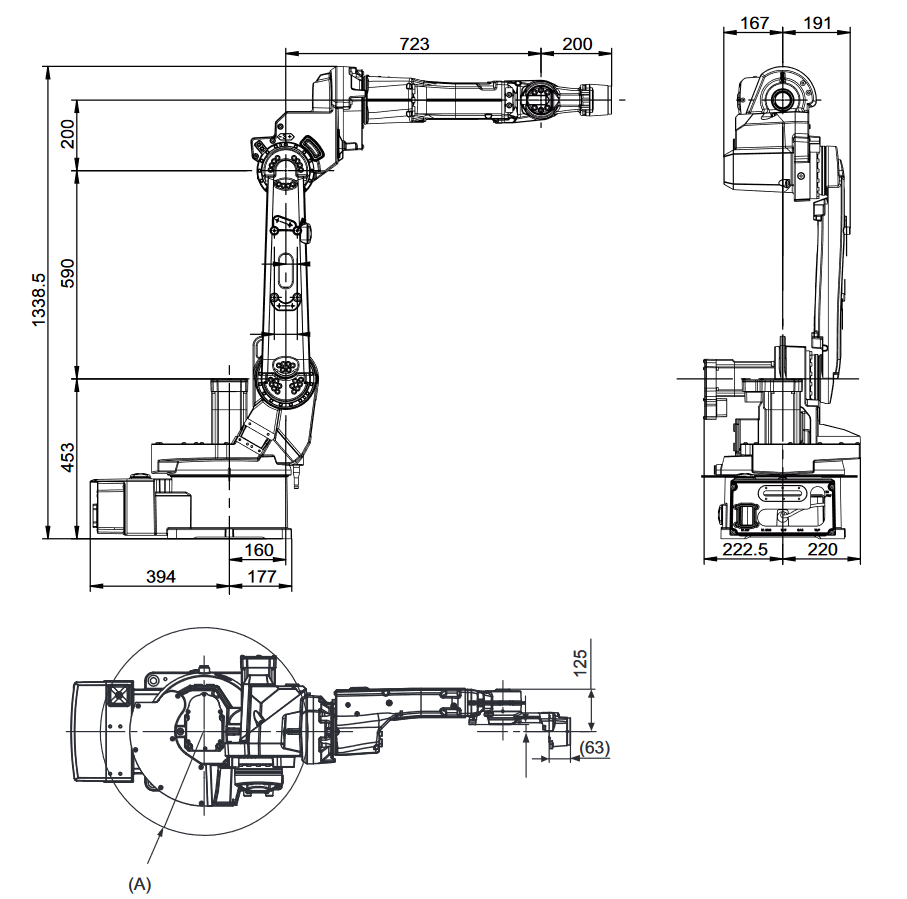


Figura 21 Dimensiones del modelo de robot IRB 1520ID. A corresponde al valor mínimo de giro cuyo valor es 307mm

## Modelado en Simscape del robot IRB 1520ID

Para la elección de los motores en las articulaciones del robot es necesario realizar un estudio previo del par demandado por cada una de las articulaciones. Dado un perfil de velocidades determinado y considerando la situación más desfavorable para la configuración de los eslabones del robot se determinan las características mecánicas para los motores.

El criterio de dimensionamiento adoptado es el del par nominal y el par máximo obtenidos por medio de Simulink. El robot soldador comienza el movimiento desde el reposo en la situación más desfavorable (véase *Figura 22*), su movimiento es definido por una función en MATLAB que proporciona los perfiles de velocidad y aceleración determinados. Finalmente, la simulación proporcionará el torque ejercido por el brazo en cada una de sus articulaciones. Se realizará este estudio para los motores de las tres primeras articulaciones del brazo robotizado.

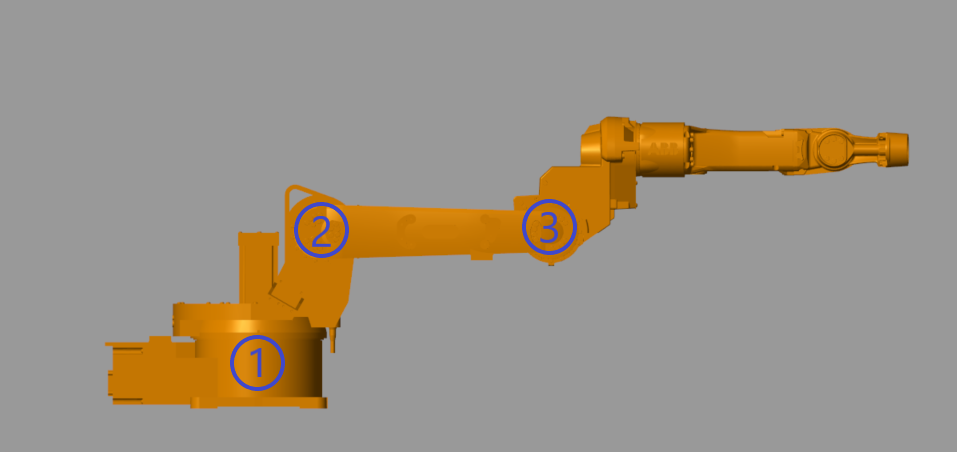


Figura 22 Robot ABB IRB 1520ID en su posición más desfavorable.

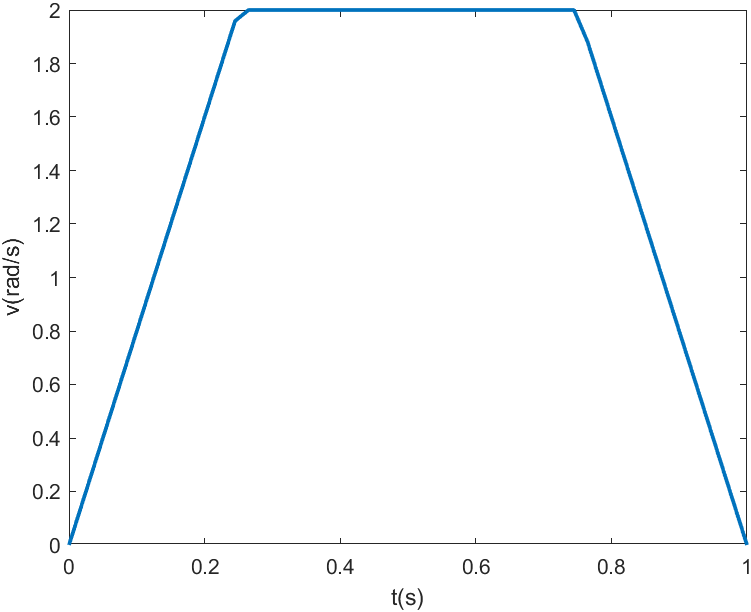
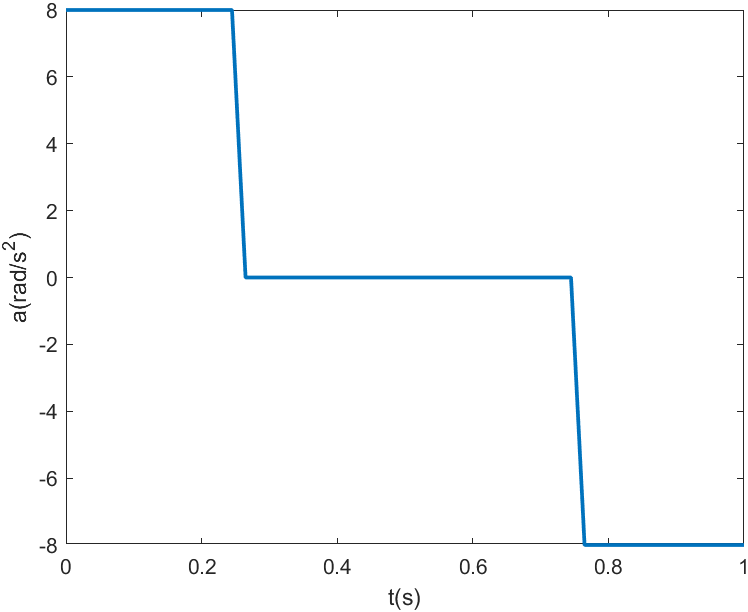
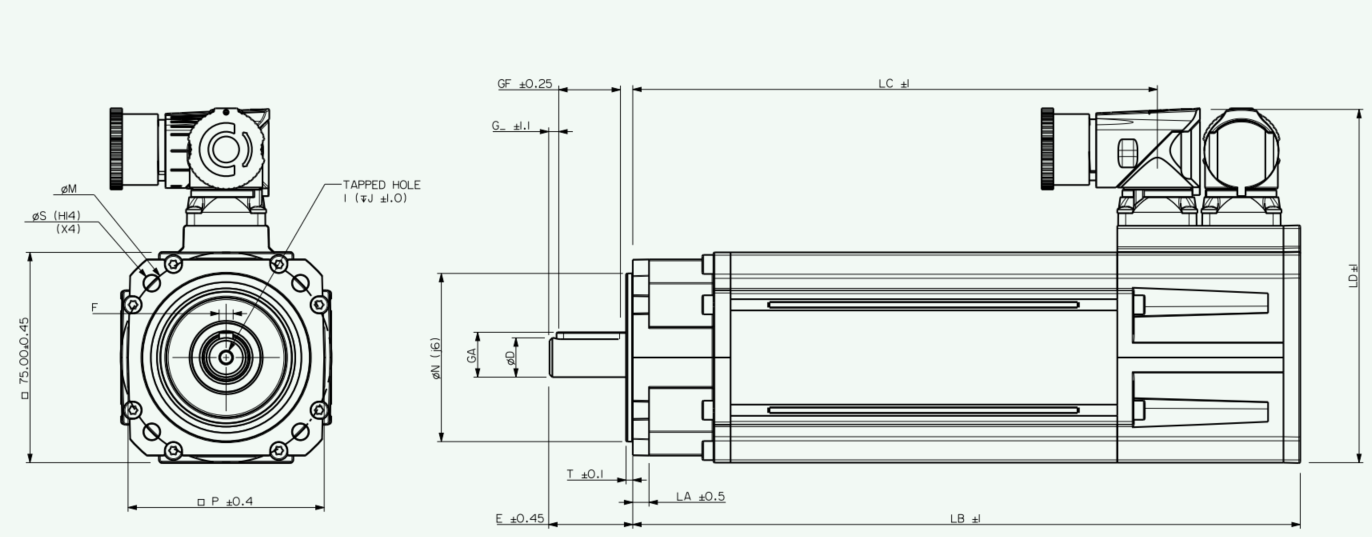
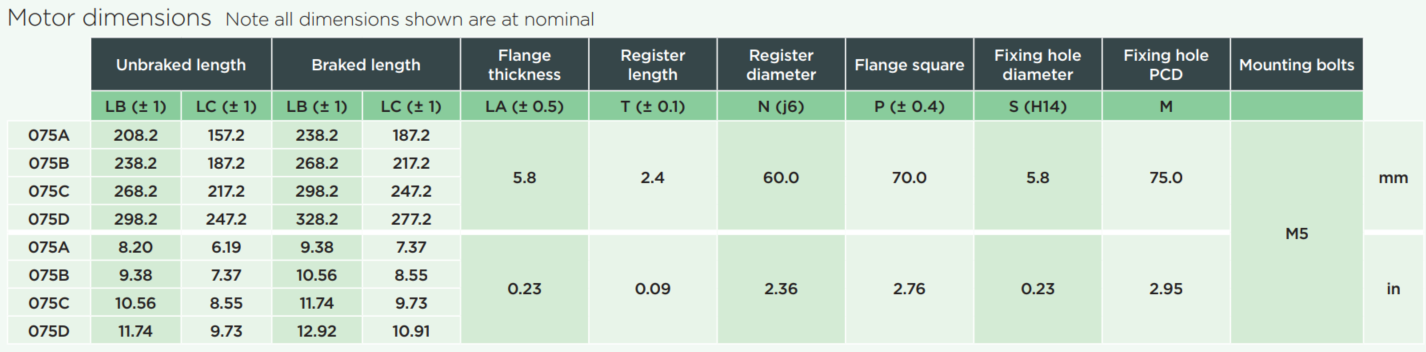


Figura 23 Perfiles de velocidad y aceleración impuestas en las articulaciones.

Como se puede observar en las *Figura 23*, la demanda de aceleración es bastante elevada y sucede de forma abrupta de forma que se requiere un par muy elevado ante la consigna aportada. Una vez se alcanza la aceleración nula, la velocidad se mantiene constante y, por tanto, se encuentra en la situación nominal de trabajo. Posteriormente se vuelve a requerir una aceleración repentina y de gran valor.

Por medio de una reductora de relación se consiguen transformar los pares de las articulaciones a los pares demandados por los motores. Una vez dimensionados, se seleccionan los motores de corriente alterna que cumplan con las características requeridas. Los modelos de motores seleccionados se encuentran en el catálogo ofrecido por Unimotor fm[[6]](#footnote-6). Con las especificaciones determinadas los tres motores bastarán con la serie de motores 075 - A que tienen las siguientes características comunes para todos sus modelos (*Figura 25)*.

Figura 24 Dimensiones y características comunes de la serie de motores de Unimotor fm 075 – A.



|  |  |  |  |
| --- | --- | --- | --- |
| **Par en parada** | 1.4 | **Constante de tiempo térmico de bobinado** | 63 |
| **Par máximo** | 4.3 | **Peso** | 2.9 |
| **Inercia** | 0.78 | **Número de polos** | 6 |

Tabla 8 Características técnicas comunes de la serie de motores de Unimotor fm 075 – A.

En la *Figura 25* se muestra el modelo en Simulink adoptado para la obtención de los pares requeridos para los motores. Cada Solid File es un eslabón del brazo robotizado y entre cada eslabón se encuentra un Joint que proporciona de una rotación a la articulación. También se pueden observar las llamadas a la función que proporciona los perfiles de velocidad y aceleración.

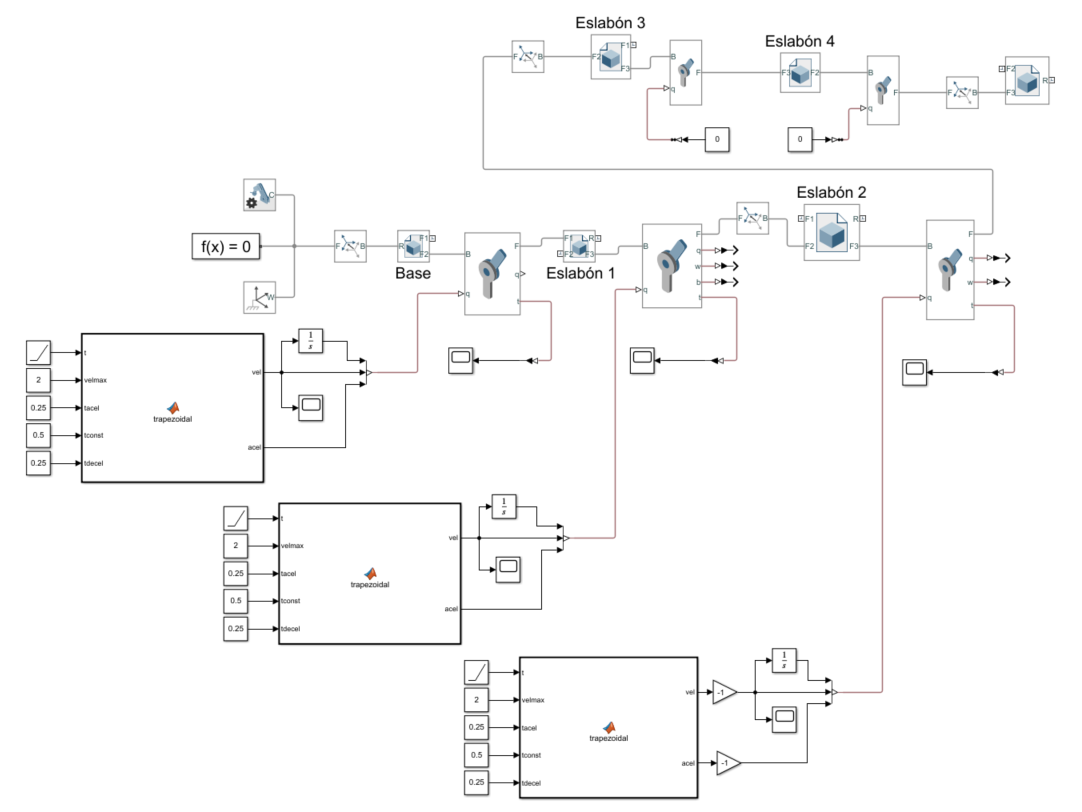


Figura 25 Modelo en Simscape del robot ABB IRB 1520ID

A continuación, se describen los resultados obtenidos tras la simulación del modelo mostrado en la *Figura 25* y se realiza la selección de los motores por cada articulación.

### Articulación 1 (base):

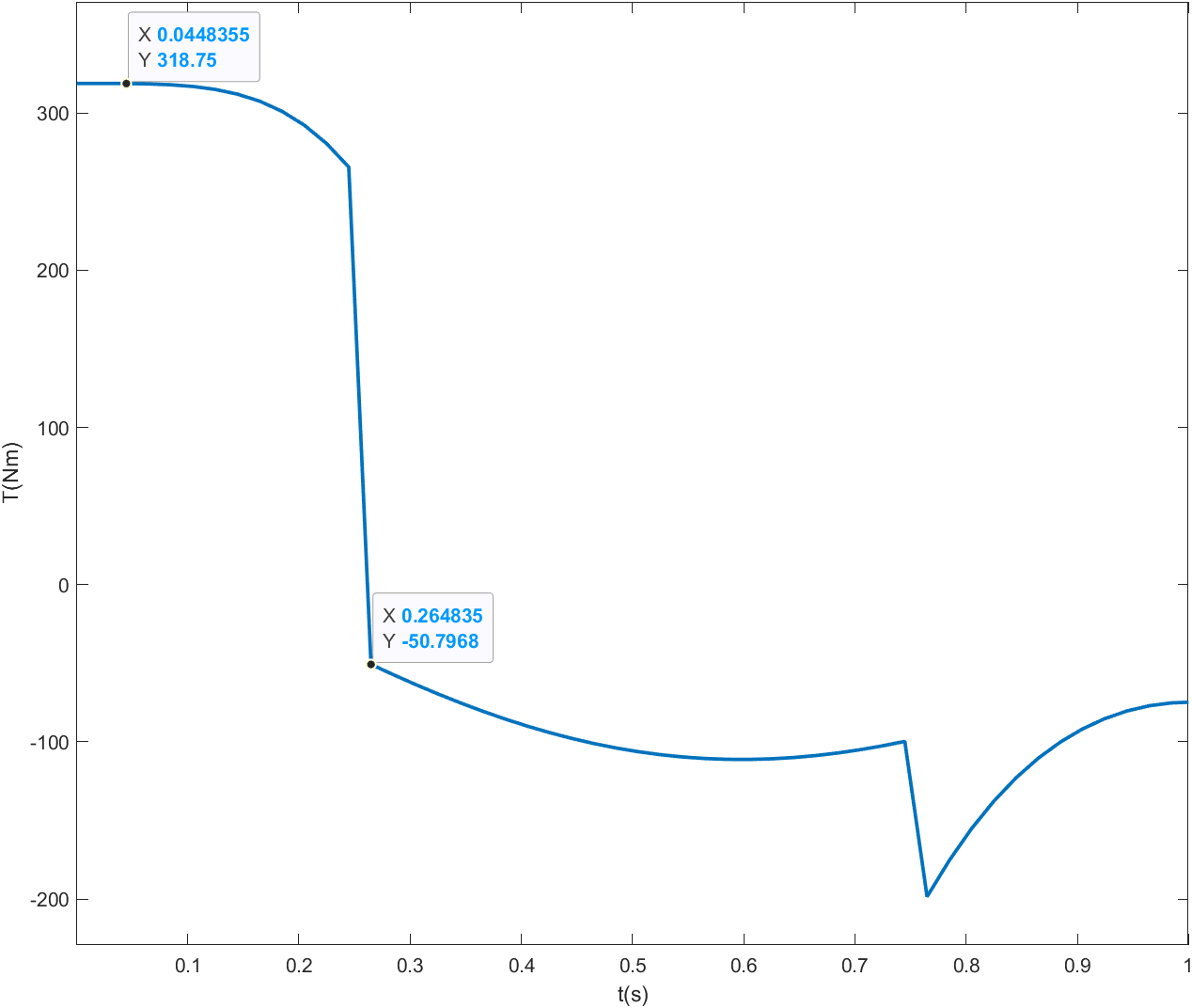


Figura 26 Perfil par motor ejercido por la primera articulación.

En este caso el modelo escogido es el de 6000 con las siguientes características:

|  |  |  |  |
| --- | --- | --- | --- |
|  | 0.47 | **Potencia nominal** | 0.68 |
|  | 28.5 /Krpm | **Resistencia** | 5.37 |
| **Par nominal** | 1.1 | **Inductancia** | 9.8 |
| **Corriente en el par máximo** | 3.06 | **Velocidad nominal** | 6000 |

Tabla 9 Caraterísticas técnicas del motor de corriente alterna 075 – A 6000 rpm.

### Articulación 2 (hombro):

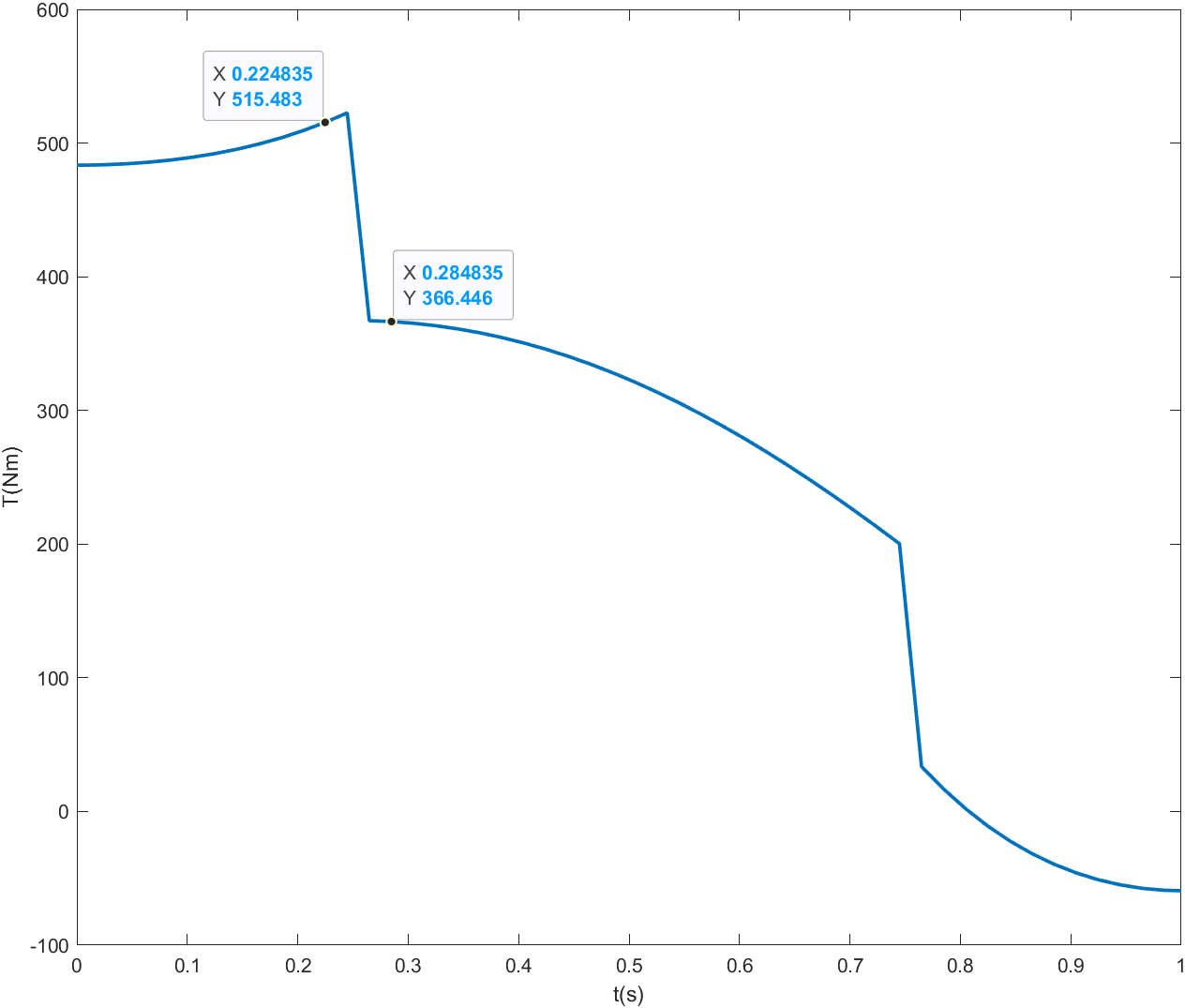


Figura 27 Perfil par motor ejercido por la segunda articulación.

En este caso el modelo escogido es el de 3000 rpm con las siguientes características:

|  |  |  |  |
| --- | --- | --- | --- |
|  | 0.93 | **Potencia nominal** | 0.41 |
|  | 57 /Krpm | **Resistencia** | 19.80 |
| **Par nominal** | 1.3 | **Inductancia** | 37.20 |
| **Corriente en el par máximo** | 1.55 | **Velocidad nominal** | 3000 |

Tabla 10 Caraterísticas técnicas del motor de corriente alterna 075 – A 3000 rpm.

### Articulación 3 (codo):

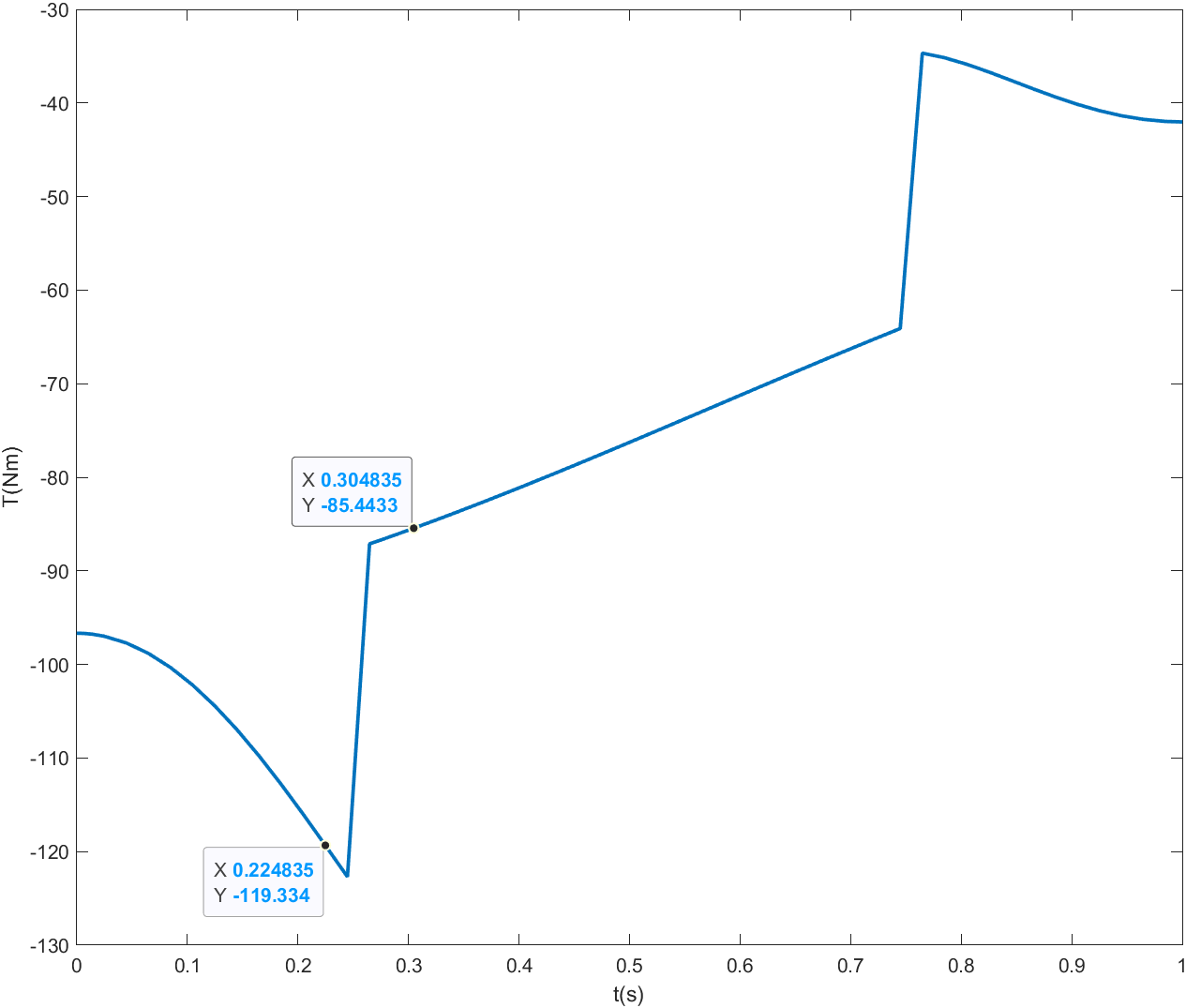


Figura 28 Perfil de par motor ejercido por la articulación 3.

En este caso el modelo escogido es el de 6000rpm con las siguientes características:

|  |  |  |  |
| --- | --- | --- | --- |
|  | 0.47 | **Potencia nominal** | 0.68 |
|  | 28.5 /Krpm | **Resistencia** | 5.37 |
| **Par nominal** | 1.1 | **Inductancia** | 9.8 |
| **Corriente en el par máximo** | 3.06 | **Velocidad nominal** | 6000 |

Tabla 11 Caraterísticas técnicas del motor de corriente alterna 075 – A 6000 rpm.

## Modelado del robot IRB 1520ID encima de la plataforma

En la *Figura 29* se observan los dos modelos anteriormente mostrados implementados en un mismo modelo de Simscape. De esta forma queda el robot posicionado sobre la plataforma móvil y por tanto basta con atribuir una intensidad a los motores de las ruedas de la plataforma para que todo el sistema goce de movimiento. Esto puede darse a la vez que el robot articulado realiza la cinética directa asignada.

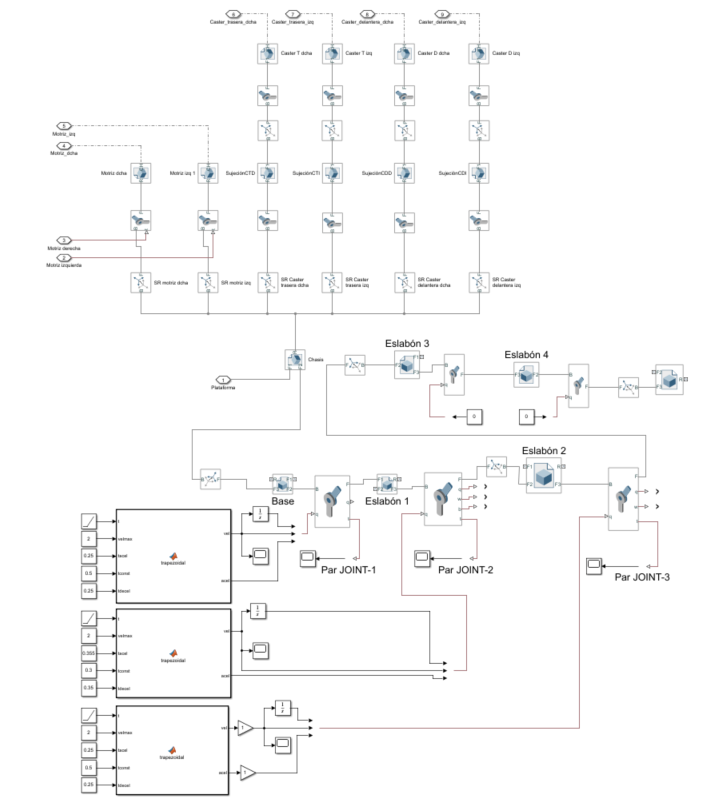
****

Figura 29 Modelo en Simscape del robot ABB IRB 1520ID sobre la plataforma móvil diseñada.

Tras aportar de movimiento tanto a la plataforma como al robot la simulación queda representada por la siguiente imagen.

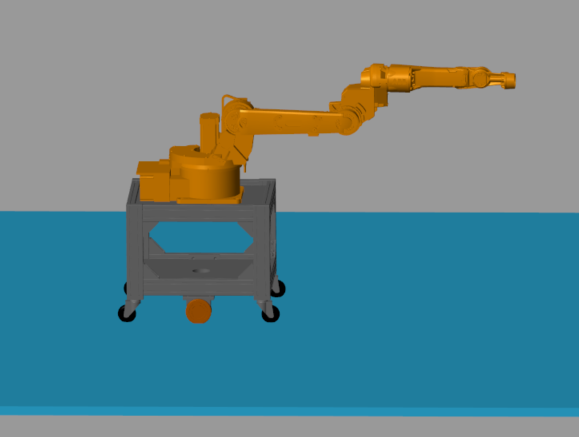


Figura 30 Imagen tras la simulación del robot ABB IRB 1520ID sobre la plataforma móvil diseñada.

# Observaciones y conclusiones

Una vez realizado el desarrollo de esta primera entrega se ha observado que el reto escogido es bastante ambicioso ya que se está hablando de atribuir movimiento sobre el plano a un brazo robotizado de soldadura, y por tanto su peso es bastante importante. Por otro lado, es una oportunidad de conocer las complicaciones que se pueden encontrar en el proceso del desarrollo de un sistema automatizado, desde el diseño (esta primera entrega) hasta el control.

Cuando se comenzó a diseñar la plataforma móvil no se pensó en todas las características necesarias para ello, por lo que se escogieron en un primer momento perfiles para el chasis que no aguantarían la carga total a la que iba a estar sometido el sistema. Además, los perfiles escogidos no gozaban de una sección que permitiese el acoplamiento de las ruedas directrices. Estas dos situaciones nos llevaron a cambiar los perfiles del chasis a unos que sí cumpliesen esos requerimientos.

Por otro lado, a la hora de dimensionar los motores para las ruedas motrices, se impusieron unas situaciones de trabajo que posteriormente, al ver los catálogos de los motores, se observó que serían mucho más complicadas de llevar a cabo. Por este motivo se redujeron los requerimientos y se sobredimensionaron las ruedas directrices. Esta ultima solución no supone un costo adicional mientras que sí permite la elección de un motor que fuera acoplable a las dimensiones dadas.

Se ha observado también que la alimentación para el brazo robotizado es en corriente alterna y además de muy alto voltaje, lo que supone un problema a la hora de la autonomía del sistema. Se propondrán soluciones en las siguientes entregas.

Por todo lo anteriormente mencionado, se concluye que los softwares de Inventor y Simscape son herramientas muy importantes y valiosas para un ingeniero, debido a que proporcionan una primera vista de requerimientos tanto físicos como eléctricos en el diseño, sin la necesidad de llevar a cabo ninguna comprobación física.

1. <https://www.minitec.de/en/products/profile-system/profiles/profile-series-45/profile-45-x-90-s> [↑](#footnote-ref-1)
2. 2 <https://www.minitec.de/en/products/profile-system/fastening-elements/mounting-angles/mounting-angles-profile-series-45/mounting-angle-45-x-90-gd-z> [↑](#footnote-ref-2)
3. <https://www.minitec.de/en/products/workplace-systems/esd-accessories/esd-rollers-accessories/swivel-castor-without-brake-d100-x-135-esd> [↑](#footnote-ref-3)
4. <https://en.nanotec.com/products/2929-wd14050-5616-23c-wheel-drive> [↑](#footnote-ref-4)
5. <https://en.nanotec.com/products/1820-db59s024035-a> [↑](#footnote-ref-5)
6. <https://acim.nidec.com/es-es/drives/control-techniques/products/servo-drives/ac-servo-motors/unimotor-fm> [↑](#footnote-ref-6)