T021: Advanced Hydraulic Press Controls

Introduction

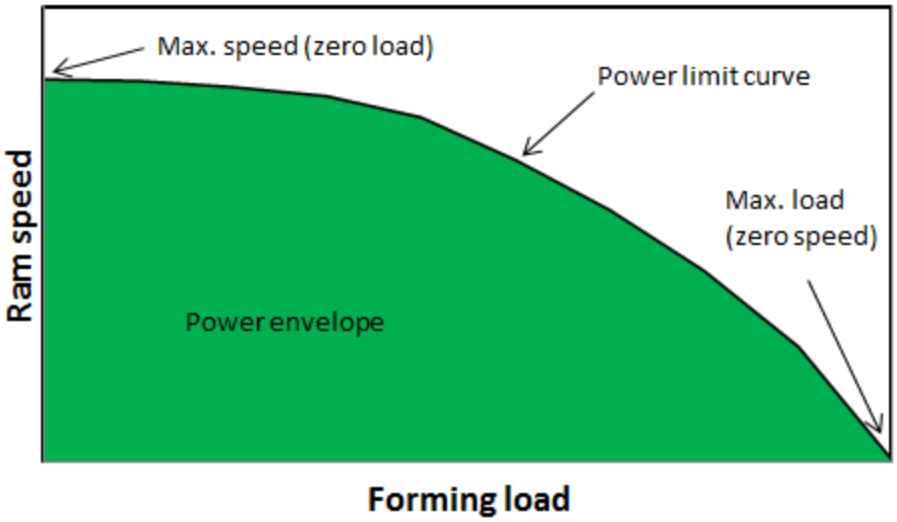
The following explains how to incorporate press limits and dwell into hydraulic press movement controls.

Problem Description

A "constant speed" movement control is often used to model hydraulic press movement. Yet, this simple definition is not always sufficient for modeling hydraulic press operations. In some situations, particularly with large parts, the speed of the press will decrease as load increases. In other situations, a constant load is held (dwells) at the end of a forming process in order to maximize die fill. These situations can be accounted for using power limit curves and forming dwell controls, respectively. Instructions for implementing these options are provided below.

Background Information

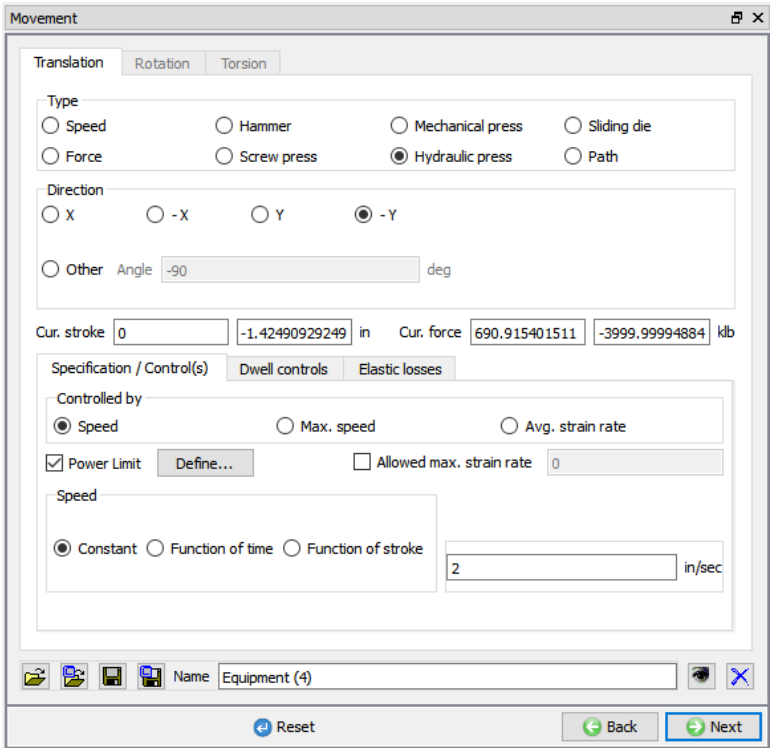
A power limit curve defines the maximum ram speed available across the range of possible forming loads. The curve represents how the ram decelerates as forming load increases when the hydraulic systems on the press "max out" and become a limiting factor. The area under the curve represents the "power envelope". The press can operate at any speed under the curve, while at a particular load, as long as that speed is within the envelope. Two important pieces of information are contained on the graph. First, the maximum press speed is defined by the point on the curve at zero load. Second, the maximum press load is represented by the point on the curve where speed is zero. This is the point at which the press stalls.



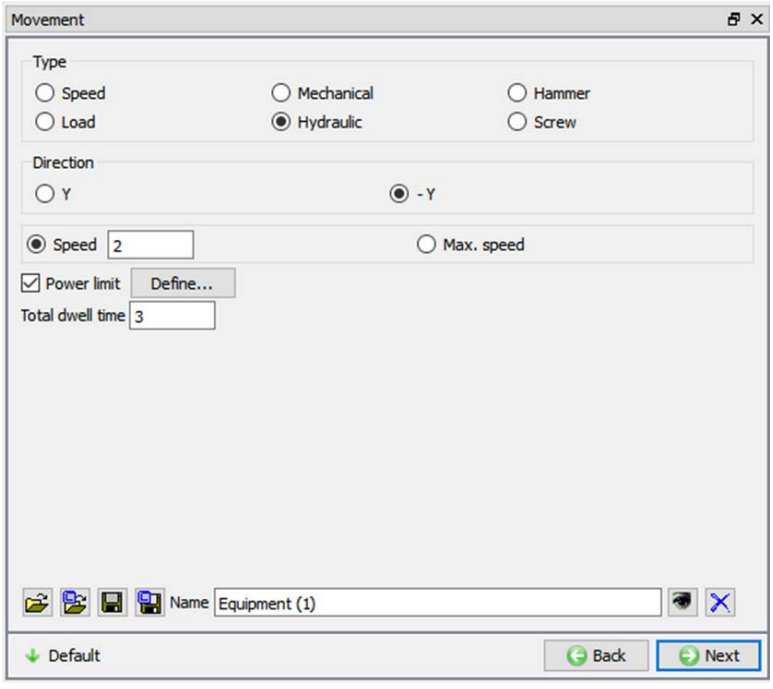
Solution

Power Limit Curve

Two movement setup steps are required when using a hydraulic press power limit curve. The first step is to define the general press parameters. The constant or the starting press speed must first be supplied to the movement control field. If the press is being run at the maximum possible speed, then choose the max speed option. Any speed inputs that fall within the power envelope (see below) are possible including speed (or load) as a function of time or stroke.



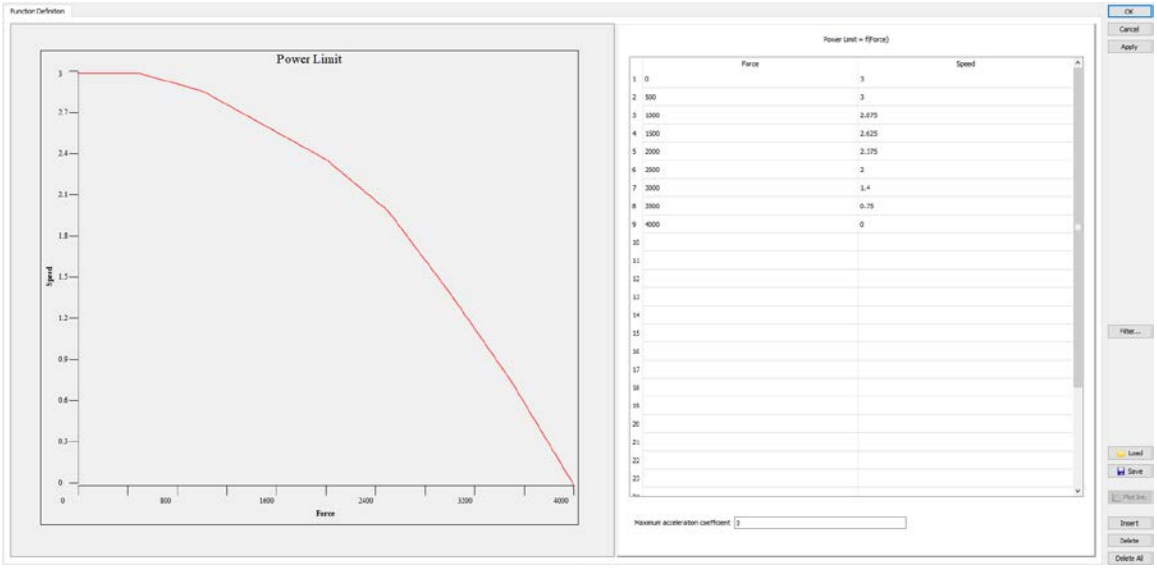
DEFORM 2D



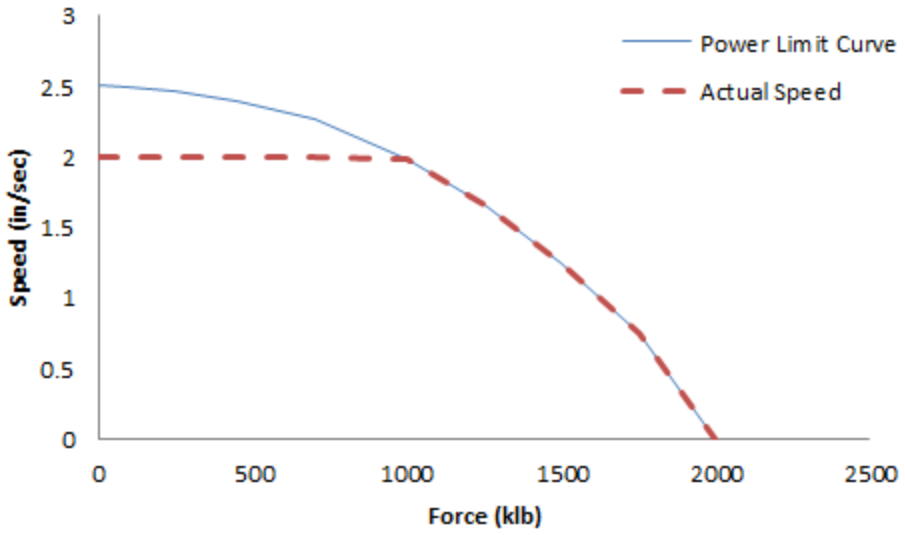
Forming Express 2D

The next step is to define the power limit curve. The power limit curve is specified in a table of speed as a function of force. The power limit curve data should be obtained from the manufacturing facility or press supplier. Typically five or more points can adequately define this limit. DEFORM will interpolate data between the points. The data must include a point at zero force and a point at zero speed.

If only the max speed and press tonnage is known, the attached excel document can be used to calculate an approximate power limit.



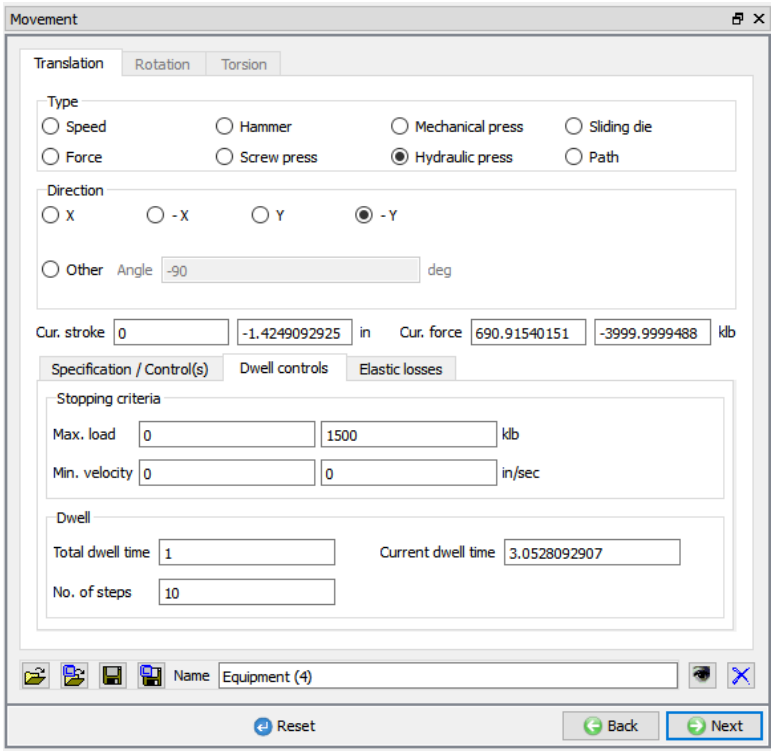
As noted earlier, the area under the curve represents the "power envelope". The graph shown below represents the output from an example simulation that used the hydraulic press settings shown in the previous two images. The power limit curve representing the press capability is shown in blue. The speed profile from the actual forming process is overlaid on the graph in red. Here it is apparent that, within the power envelope, the press runs at a speed of 2 inches per second. Once the power limit curve is reached, the speed is limited by load. The speed follows the curve and decreases toward zero as load increases further.



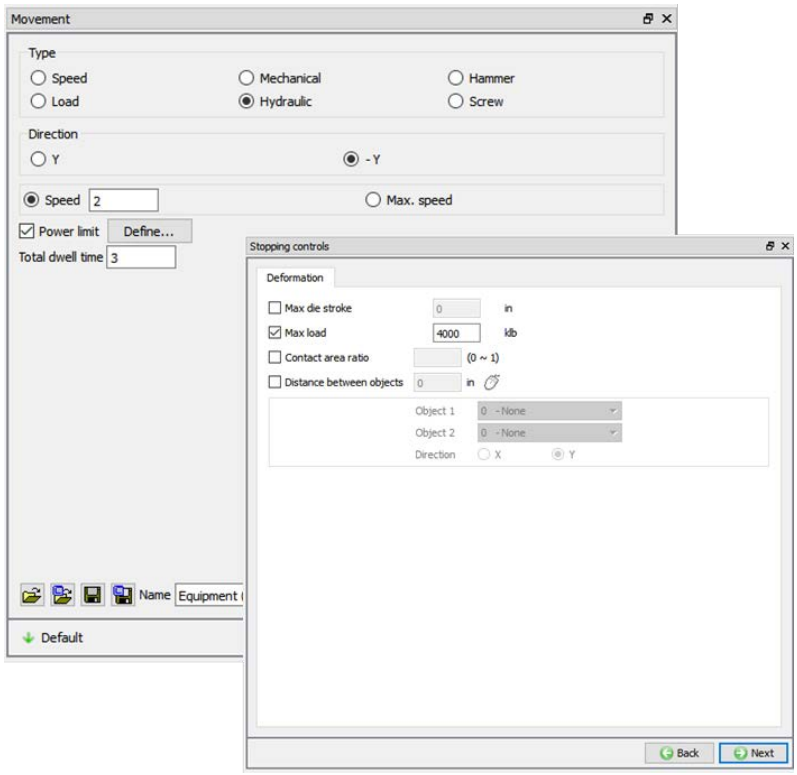
Forming Dwell

Forming dwell is a defined period of time where a constant forming load is held during the end of a forming process. When the hydraulic press model is active, the "Dwell controls" tab within the movement control dialog accepts the dwell settings. The maximum load stopping criteria must be set to match the desired dwell load. This must be applied in the appropriate direction. Then, the dwell details must be defined by inputting the total dwell time and the number of (dwell) steps. The time step used during the dwell process is automatically determined based on this information. The menu shown below models a 1 second dwell, at 1500 klb, with 10 steps. This results in a time step of 0.1 seconds during dwell.

In Forming Express, the dwell is activated by a non-zero dwell time and max load. Once the max load is reached, the simulation will dwell for the defined number of seconds with a step size of 0.1 seconds per step. If a power limit is defined, the max load will be set as the maximum load from the curve.



DEFORM 2D



Forming Express 2D

Under these settings, the press will run using speed-controlled movement until the maximum load is reached. At this time, the system will automatically switch to force-controlled movement for the defined dwell time.

Related Information

An Excel spreadsheet is provided to calculate an approximate power limit curve. Input force (ton) and speed (in/s) to obtain a power limit curve to paste into DEFORM.