Offshore structures under special loads including Fire resistance
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Module – 03
Fire Resistance
Lecture – 44
Blast Resistance II

Friends, we will continue with the discuss on Blast Resistance; is second lecture on the blast resistance on 44 in module 3, where will talk more details about how to estimate the blast loads for obtaining blast resistance features in a given offshore structure system.

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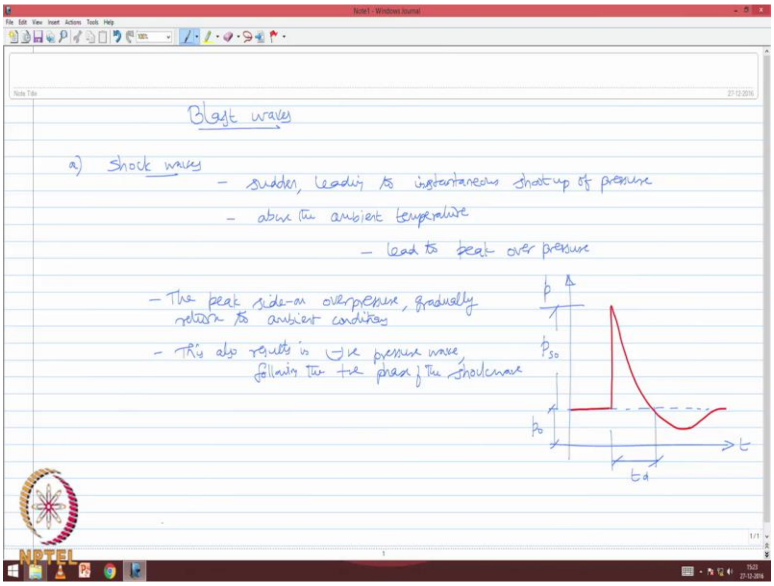

If look at the blast waves, there are different types of blast waves will start discussing one by one in detail and explain them what are the parameters that governed the definition of this kind of blast waves. The foremost one what we see here is the shock waves; shock waves are almost sudden leading to instantaneous shoot up of pressure. So, they are sudden increase in pressure above the ambient temperature and they will lead to what we technically called as peak over pressure, an say it try to plot time versus pressure and the plot has a peak rise then falls gradually and returns to value because this distance as td and this as p 0 and this value as p so. The peak side on over pressure gradually returns to 0 returns to ambient conditions, before returning this also results in negative pressure wave, following the positive phase of the shock wave.

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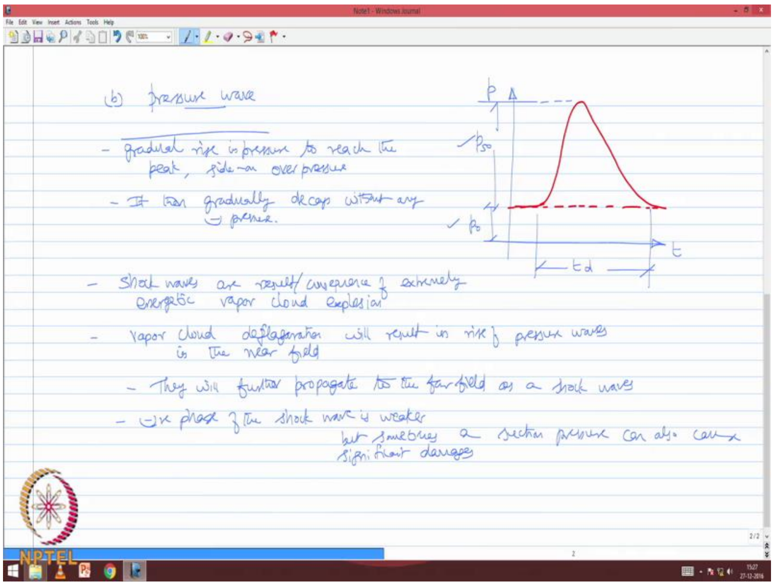

The next one is the pressure wave; typically plot of the pressure wave looks like this, try to plot time versus pressure is starts from p 0, which is the peak and comes to p 0, this value is p 0 and this value is p so. So, pressure wave has a gradual rise and pressure where as shock wave had instantaneous sudden rise in pressure, this is got the gradual rise in pressure to reach the peak side on pressure, side on over pressure it then gradually decays without any negative pressure.

So, as usual we note this time as td and this as p naught and this as p so. We all do agree that shock waves are result or consequence of extremely energetic vapor cloud explosion, a typical vapor cloud deflagration will result in rise of pressure waves in the near flied, they will further propagate to the far field as a shock wave. It is interesting note that the negative phase of the shock wave is weaker, but sometimes a section pressure can also cause significant damages.

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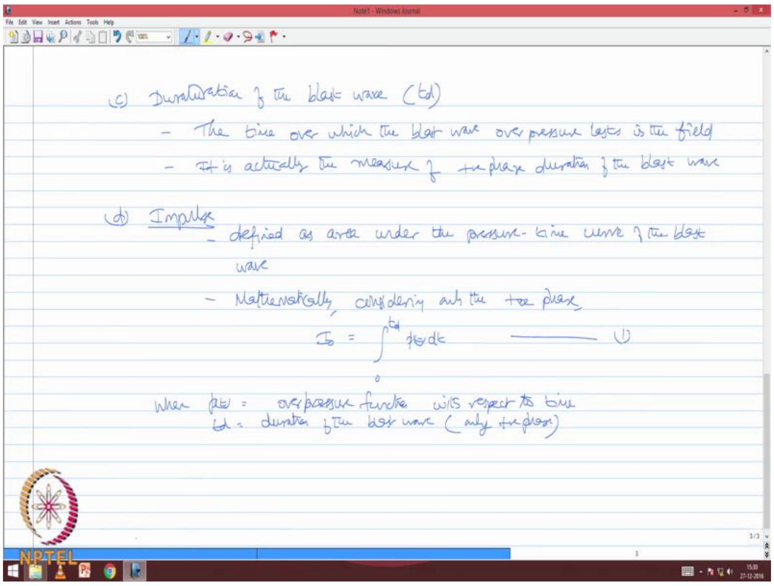

Now, let us talk about one important parameter which is duration of the blast wave, which we call as td, it is defined as the time over which the blast wave over pressure lost in the field. Essentially it is actually called it is actually the measure of positive phase duration of the blast wave carefully see it is only talking about the positive phase. The next parameter of interest and blaster design is impulse; impulse defined as area under the pressure time curve of the blast wave, mathematically considering only the positive phase i 0, which is the impulse is defined as 0 to td p t, dt, were pt is the over pressure function with respect to time and td is the duration of the blast wave only the positive phase.

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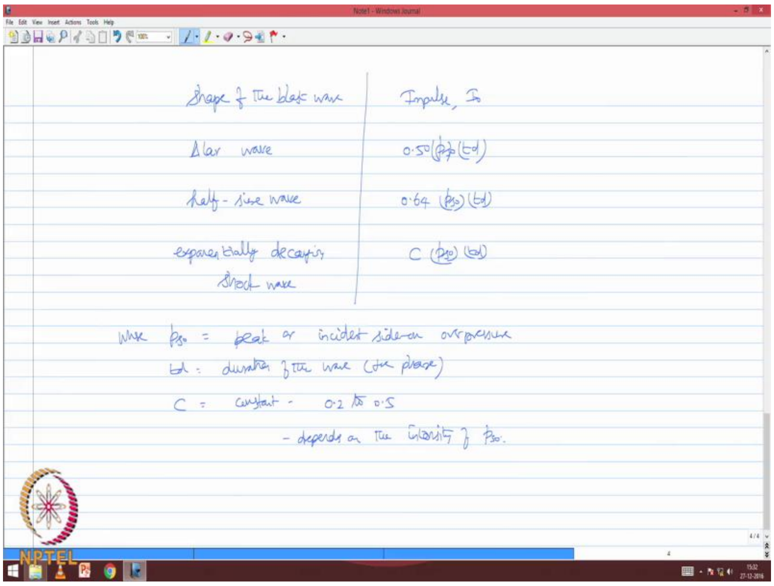

Ideally speaking depending upon the shape of the blast wave, one can find out the impulse I naught, if it is a triangular wave then it can be 0.50 p so td, if it is a half sine wave then it can be 0.64 p so td, if it is exponentially decaying shock wave then it could be C times p so into td, where p so is peak or incident side on over pressure, td duration of the wave only the positive phase, C is the constant where is from 0.2 to 0.5 and it depends on the intensity of p so.

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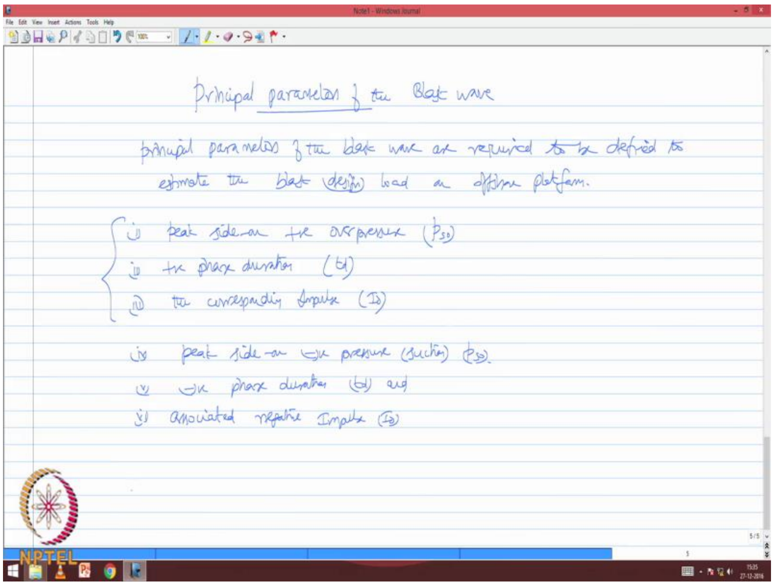

Let us look at what are the principle parameters of the blast wave. The principle parameters of the blast wave are required to be defined to estimate the blast load on a offshore platform. One is the peak side on positive over pressure, which I call p so; the next is positive phase duration, which is known as td and the corresponding impulse which is I naught. So, these are three parameters which are required to define the design blast wave that can act on the offshore platform. In addition may be also have peak side on negative pressure, which is section which is also p so, negative phase duration which is also called as td and associated negative impulse.

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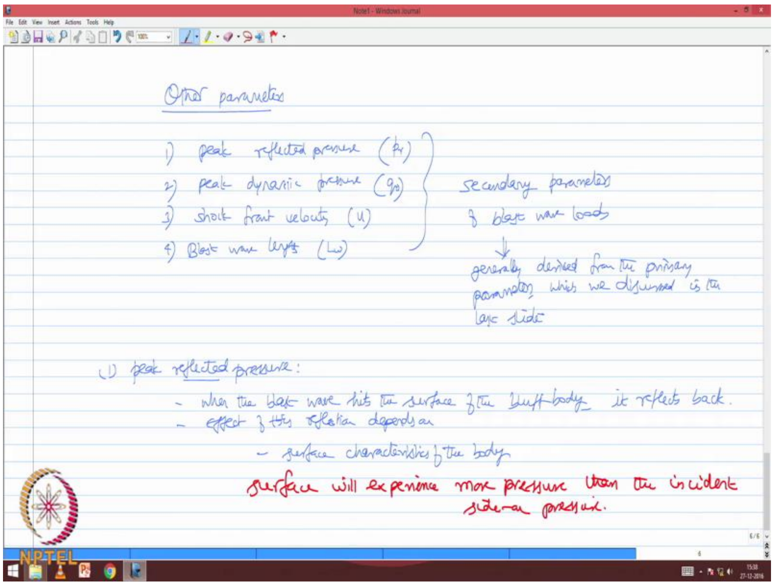

They other parameters are important like peak reflected pressure which is p r, peak dynamic pressure which is q 0, shock front velocity which is u, blast wave length which is Lw, these are called as secondary parameters of blast wave loads; this secondary parameters are generally derived from the primary parameters, which we saw in the last slide. Let us explain the secondary parameters more in detail; peak reflected pressure when the blast wave hits the surface of the bluff body, it reflects back. The effect of this reflection depends on the surface characteristics of the body is interesting to note that surface will experience more pressure than the incident side on value.

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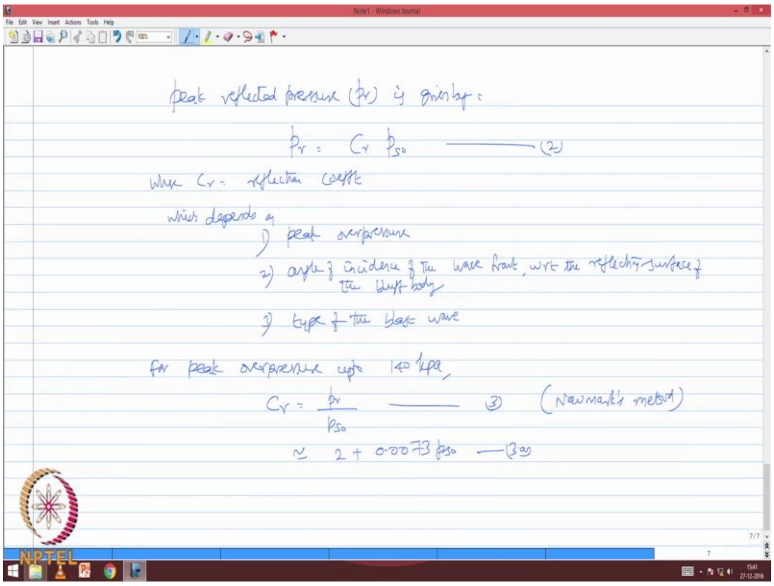

The peak reflected pressure p r is given by C r into p so, where C r is called reflection co efficient which depends on the peak over pressure angle of incidents of the wave front with respect to the reflecting surface of the bluff body. Thirdly it also depend upon type of the blast wave; for peak over pressure up to 140 kilo paschals, C r is given by p r by p so according to new marks method,0 which is also approximately equal to 2 plus 0.0073 p so.

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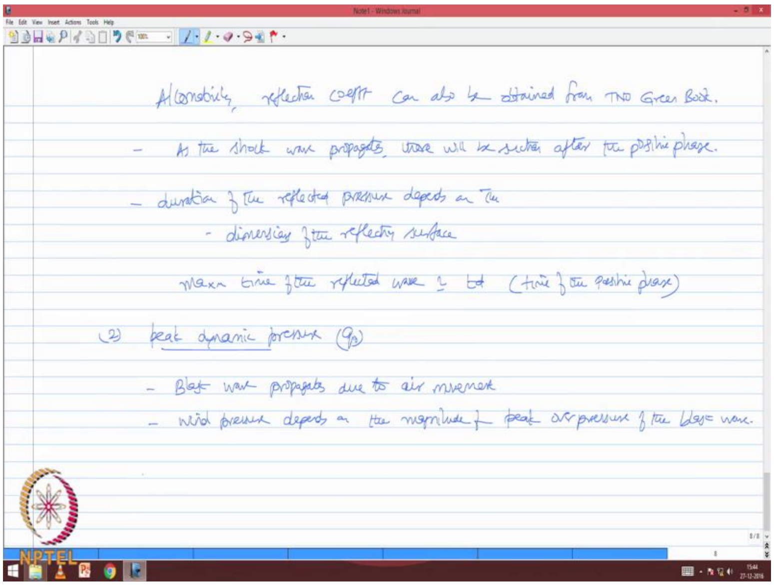

Alternatively, the reflection co efficient can also be obtained from the green book. We know that as the shock wave propagates, there will be section after the positive phase therefore, duration of the reflected pressure wave depends upon the dimensions of the reflecting surface. The maximum time of the reflected wave is approximate equal to the time of the positive phase. The second one what we are interested is the peak dynamic pressure, which is q naught; we know that blast wave propagates due to air moment and we also agree that wind pressure depends on the magnitude of peak over pressure of the blast wave.

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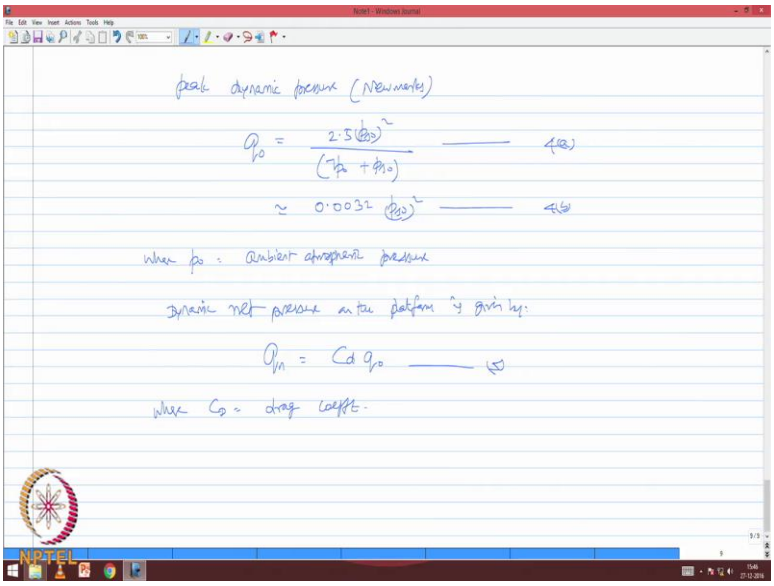

So, based on this one can compute peak dynamic pressure using the empirical equation suggested by New marks q 0 is 2.5 p so square divided by 7 p so 7 P o plus p so, which is approximately equal to 0.0032 of p so square, where p 0 is ambient atmospheric pressure, hence the dynamic net pressure on the platform is given by q n is equal to C d into q 0 where C d is called drag coefficient.

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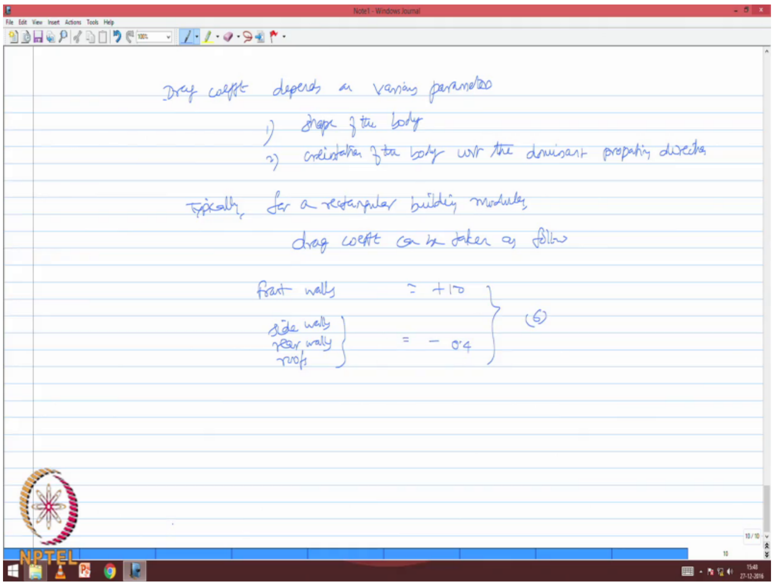

The drag coefficient depends on various parameters namely shape of the body, orientation of the body with respect to the dominant propagating direction, typically for a rectangular building modules, the drag co efficient can be taken as follows front walls we can say plus 1.0, side walls, rear walls, roofs can be taken as minus 0.4.

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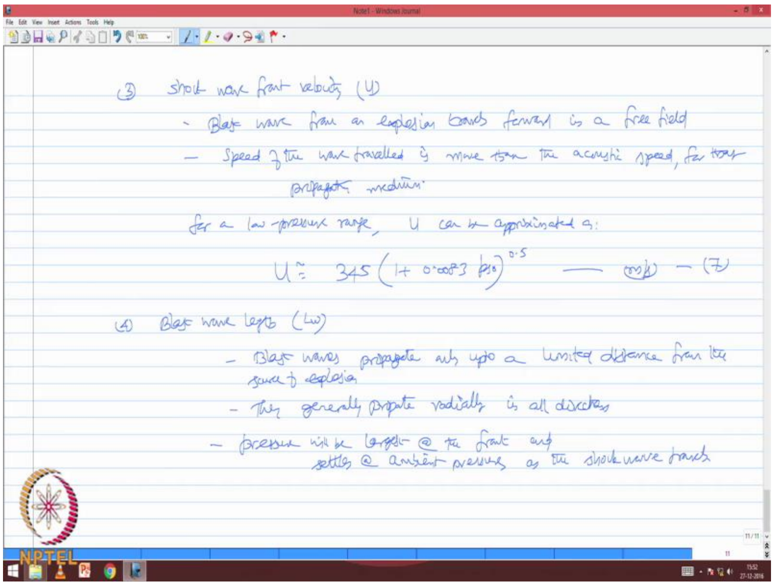

The third one is shock wave front velocity, which is U; blast wave from an explosion travels forward in a free field, the speed of the wave travelled is more than the acoustic speed for that propagating medium.

So, for a low pressure range this can be approximated as is equal to on approximately to 345, 1 plus 0.0083 p so is to the power of 0.5 and this will give me value in meter per second. The fourth parameter of interest is length of the blast wave indicated as Lw; blast waves propagate only up to a limited distance from the source of explosion and they generally propagate radially is all directions the typical values are pressure will be largest at the front and settles at ambient pressure as the shock wave travels.

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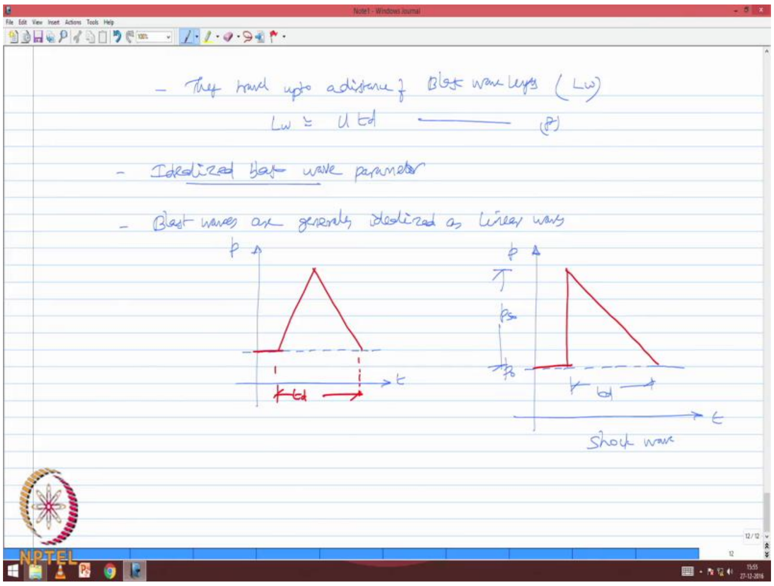

Generally they travel up to a distance of blast wave length which is Lw and Lw is approximately U times of td where U and td are already defined.

Lets now talk about idealized blast wave parameter; blast waves are generally idealized in linear waves, a typical figure looks like this, this distance we already know is marks td and this value is p 0 and this value is side over pressure p s0. So, this typical idealized form of the shock wave and typical idealized view of the pressure wave is given by. So, we know that this is td.

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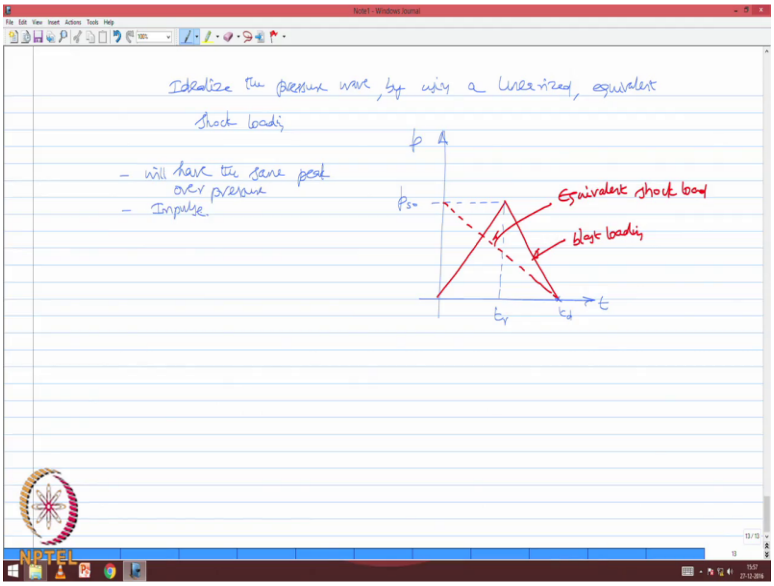

One can also idealized the pressure wave by using a linearized, equivalent shock loading. Let say we have plot of p verses time, a typical blast loading looks this way. So, this is the typical blast loading; a looking for equivalent shock loading, let say this value is p so and this value is t r, and this is any way td, I can draw an equivalent shock loading, this is my equivalent shock load. So, the equivalent shock load will have the same peak over pressure and same impulse.

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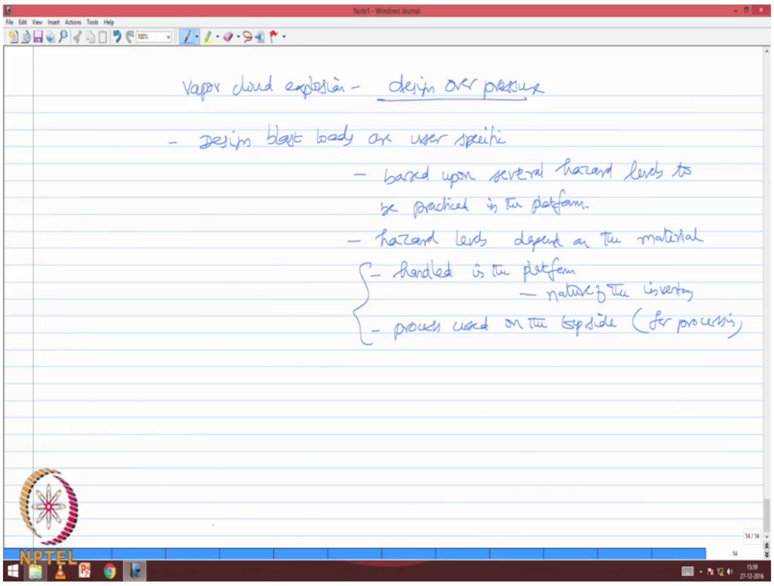

Let us now specifically pick up the case of vapor cloud explosion, which is the very common scenario of accidents in offshore top sit platforms and let us derived a design over pressure. We all agree the design blast loads are user specific, which are based upon several hazard levels to be practiced in the platform, these hazard levels depend on the material handled in the platform what we call nature of the inventory, and the process used on the top side for process for depends upon these two parameters.

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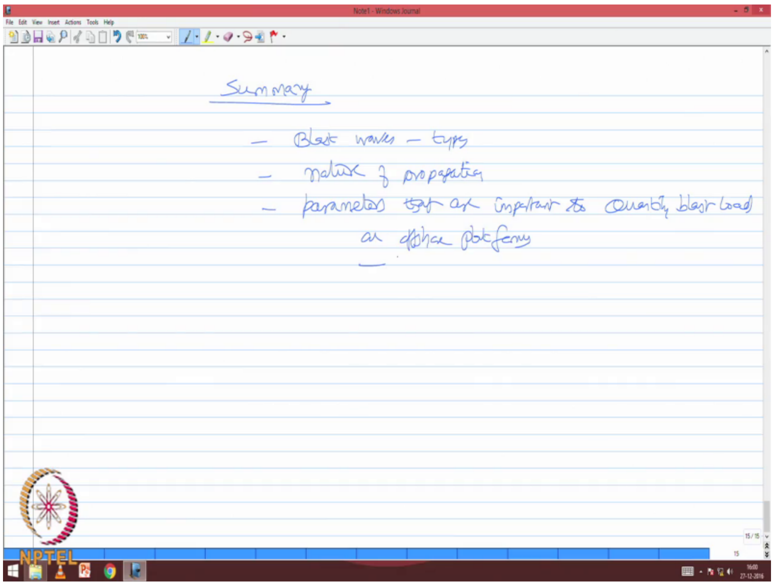

So, friends will discuss about the design over pressure procedure which arise from VCE in the next lecture, in this lecture we discussed about types of blast waves, we also discuss about the nature of propagation, we also discuss about parameters that are important to quantified the blast wave loads on offshore platforms.

Thank you very much.