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NUMERICAL MODELING OF THE RISKS OF OIL PLATFORMS

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ABSTRACT

(1) Background: The structural integrity of offshore platforms can be compromised by numerous environmental factors, including wind, waves, ocean currents, seismic activity, or biological accumulations (e.g., vegetation). These elements, acting in concert, generate complex dynamic stresses that must be considered both at the design stage of these structures and subsequently, when assessing their safe operating life.

(2) Methods: Based on the research of the international study and the local research study, the authors simulated the effects of the wind and wave equations of the Romanian Offshore Gas Platform Ana. In the context of the above, this paper will focus on describing a method for predicting horizontal displacements for fixed jacket platforms. These displacements are induced by the combined action of the environmental factors mentioned above, and their prediction will be achieved through artificial neural networks.

(3) Results: This study presents a new model of ANNs, enabling forecasts of the structural behaviour of a platform deck under various scenarios involving wind, waves, sea currents, and different water depths, and predictions that are particularly valuable in the engineering design process. We introduced in this paper a new Artificial Intelligent Models to prediction environments effects of the Romanian Gas Platform Ana.

(4) Conclusions: The design of any element of a fixed structure's analysis function to external forces is determined, and we will analyse exclusively the impact generated by waves, considering that the influence of sea currents is negligible in the specific context of this demonstration, applying the Morison equation.

Keywords: Morison equation, ANNs model, offshore gas platform, environment simulation, risk assessment

INTRODUCTION

The traditional approach, which involves manual estimation using mathematical calculation methods, proves to be highly complex and time-consuming. Moreover, the accuracy of the results obtained by such methods can be limited, given the dynamic and unpredictable nature of environmental factors. Offshore environment factors are values that fluctuate constantly (even from one hour to the next), and their directions of action can change significantly, depending on the season [1].

A fundamental principle in the engineering design of any element of a fixed structure is the need to rigorously consider all the stresses to which the component will be subjected during its service life [2].

As for external forces, the approximate distribution of those generated by the combined action of waves and currents is schematically presented in Figure 1, and the effects of vertical components of offshore structures (waves, currents) are described based on the experience of Ana Gas Offshore Platform Structure [3].

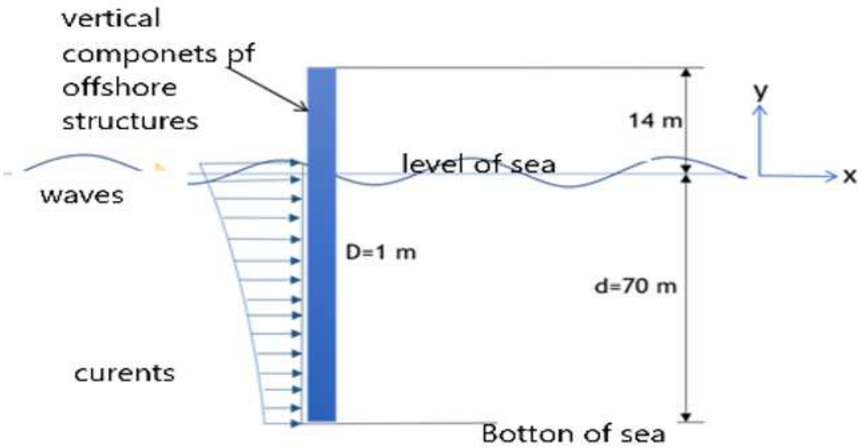

Figure 1. *Morison equation calculation of Ana offshore platform structure*

However, for the following calculation example, we will analyse exclusively the impact generated by waves, considering that the influence of sea currents is negligible in the specific context of this demonstration and the force is evaluated by identifying and summing its horizontal components [4], [5].

The foundation of this method is the equations developed primarily experimentally by Morison J.R., and his collaborators in 1950 and the results of their research were published in the article entitled "The force exerted by surface waves on piles" [6]. It is worth noting that the experimental measurements that formed the basis of these equations were conducted within the Fluid Mechanics Laboratory at the University of California, Berkeley [7], [8].

During these experimental investigations, Morison J.R. observed that the Reynolds number, calculated for the maximum velocity of water particles at the free surface of the fluid, presented a specific dynamics, ranging from the value of 2200 to 1110, and a decrease in this dimensionless number was also found as it advanced in depth along the vertical element, as well as a temporal variation [9],[10].

It is a generally accepted principle in fluid mechanics that, for flow through a pipe, the flow regime is classified as follows [11]:

a. laminar, when the Reynolds number (Re) is less than 2300;
b. transitional, for values of Re between 2300 and 4000;
c. turbulent, when Re exceeds 4000.

Consequently, the forces that the wave induces on the structural element are quantified by determining the following main components [12]:

a. the maximum value of the inertial force;
b. the maximum value of the frictional (driving) force.

Morison's equation is a semi-empirical engineering method, essential in the field of hydrodynamics, used to estimate the forces exerted by an oscillatory fluid – such as sea waves, and sometimes currents – on submerged structures [13],[14],[15].

This equation applies in particular to slender bodies, that is, to those structures whose diameter is considerably smaller than the wavelength of the incident wave, a situation in which the presence of the body does not significantly disturb the general wave field, and the fundamental idea behind Morison's equation is that the total hydrodynamic force acting on a segment of a structure can be considered as the sum of two distinct contributions, which usually do not reach their maximum values simultaneously [16].

In the first step need to analysis ***Inertia Force*** **(*or Mass Force*)**. This component of the total force is directly related to the acceleration of the fluid particles around the structure. It arises because the structure must impart an acceleration to the mass of fluid it displaces, plus an additional mass of fluid that is entrained in motion with the body (the "added mass" effect).

The magnitude of this force is proportional to [17]:

- The density of the fluid ρ.
- The volume of fluid displaced by the segment of the structure.
- The instantaneous acceleration of the fluid particles, perpendicular to the longitudinal axis of the element.

A coefficient of inertia, which is dimensionless and is determined experimentally. It adjusts the theoretical component to match actual observations.

In the second step of analysis need to determined a special force named ***Drag Force*** (or Forward Resistance Force).This component is associated with the relative velocity of the fluid relative to the structure. It results from the pressure differences created by the separation of the fluid boundary layer from the body surface and from the tangential stresses due to the fluid viscosity.

The magnitude of the drag force is proportional to [18]:

- The density of the fluid.
- A reference area, usually the frontal area of the structure segment exposed to the flow.
- The square of the instantaneous velocity of the fluid particles, perpendicular to the longitudinal axis. The mathematical terms $u|u|$ is used to ensure that the drag force always acts in the direction of the velocity.

A drag coefficient, which is also dimensionless and determined experimentally.

MATERIALS AND METHODS

In this paper we proposed a special models to determined the effects of environments to the Ana Offshore Gas Platforms, based to the ***Artificial neural networks*** (ANNs).

This models offer a promising alternative, demonstrating the ability to discern subtle patterns and structures in large data sets – patterns that are often not obvious through direct inspection – and to generate estimates based on them with an acceptable degree of accuracy [19].

We using a neural network to predict platform behaviour brings significant economic benefits in the design phase, because the performance of such a network is directly dependent on the quality and scale of the training process, which implies feeding it with the largest and most diverse volume of relevant input data.

Essentially, an artificial neural network emulates the principles of organization and functioning of the human brain and due to their ability to learn and adapt, similar to the brain, neural networks constitute a fundamental technology in the field of artificial intelligence (AI) and, implicitly, for machine learning algorithms.

For a better understanding of how ANNs support AI applications, a brief discussion of the concept of artificial intelligence is helpful and it is defined as "the ability of a system to correctly interpret external data, to learn from such data, and to use what it has learned to achieve its specific goals and tasks through flexible adaptation" [17]. In other words, there was a pressing need to develop systems capable of learning and accumulating knowledge in a way analogous to that of humans.

Because the model the Morison equation using AI, you need a dataset that connects the ***causes*** (fluid and structural properties) to the ***effect*** (the hydrodynamic force), and this relationship provide more strategy data to environment modeling, we dictated by numerous situations in which achieving a desired result would have involved processing input data of such extraordinary complexity that it would have exceeded human cognitive capabilities. However, computational systems, following an appropriate learning process and by applying combinations of algorithms and mathematical models, can successfully manage such challenges [20].

This model is applied to a specific vertical component of the platform, called "Ana" – consider, for example, one of the support pillars located at the corner of a horizontal section – and is based on a series of assumptions that will be explained as they arise.

RESULTS

In this paper we proposed:

a. A theoretical model based to the Morison Equation,
b. A experimental model based to the measurements of the structure response to effects of environment data,
c. An AI models to modeling Ana Platform to response to effects of environment data,

In particular study, Morison's equation provides a practical and widely accepted method to quantify the hydrodynamic loads on slender structures, combining physical principles with adjustments based on experimental observations.

In the following, we have built a calculation software program based on Morison's equation, applicable to the Ana platform [17].

Step 1. Calculate the ratio between the diameter of the analysed pillar and its length:

$$\frac{D}{L} = \frac{1}{100} = 0.01 \tag{1}$$

Considering that Morison's equation in the case of the Ana jacket is applicable (the value of the ratio $\frac{D}{L}$ is below the value of 0.20) [18].

Step 2. Calculation of the maximum inertia force:

The total force acting on the oil structures is given by the relationship:

$$F_t = F_{iv} + F_{fv} + F_{fcm} \tag{2}$$

where:

$F_{iv} = C_i \cdot \rho \cdot \dot{V} \cdot V_{vol}$ is the wave inertia force (occurs due to wave motion)

$F_{fv} = 0.5 \cdot \rho \cdot C_f \cdot A_p \cdot V \cdot |V|$ is the inertial force of the winds acting on the platform,

$F_{fcm} = 0.5 \cdot \rho \cdot C_f \cdot A_p \cdot V_c \cdot |V_c|$ is the frictional force due to ocean currents.

In the equations above V represents the instantaneous velocity of the water particle (which is measured as both a horizontal component u and a vertical component w), $\dot{V}$ is the instantaneous acceleration of the water particle (and in this case we have an acceleration measured in the horizontal direction of the wave, $\acute{u} = \frac{\partial u}{\partial t}$ and one in the vertical direction of the wave $w = \frac{\partial \omega}{\partial t}$.

To analyse the forces induced in the platform legs, Morison introduced the frontal area of the analysed structure into the calculation. A_p and its volume V_{vol} [19,20].

As is known, Morison's equations were determined experimentally and calculate the horizontal component of the inertial force using velocity and acceleration u and $\acute{u}$.

The Ana platform, which is analysed below, is located in the deep wave zone, $> \frac{L}{2}$, in this case the values of the velocity and acceleration of the particles hitting the platform horizontally are:

$$u = \frac{\pi H}{T} e^{ky} \cos(kx - \sigma t) \tag{3}$$

$$\dot{u} = \frac{du}{dt} = \frac{2\pi H}{T^2} e^{ky} \sin(kx - \sigma t) \tag{4}$$

It is very important to determine the horizontal inertia force applied to the entire length of the vertical element given by the relationship [20]:

$$F_i = \rho C_i \frac{\pi D^2}{4} \int_{-d}^{0} \frac{2\pi^2 H}{T^2} e^{ky} sin(kx - \sigma t) dy \tag{5}$$

Which can be rewritten, because $\frac{2\pi^2 H}{T^2} e^{ky}$ are largely invariant over time, so:

$$F_i = \rho C_i \frac{D^2}{4} \frac{2\pi^3 H}{T^2} e^{ky} \int_{-d}^{0} sin(kx - \sigma t) dy \tag{6}$$

In the equation above, $k = \frac{2\pi}{L}$ is the number of the wave hitting the platform.

Substituting with the data of the Ana platform:

$$F_i = 1017 \cdot 3.14^3 \cdot 0.5 \cdot \frac{1^2 \cdot 8}{10^2} \frac{1}{0.0628} \cdot (1 - e^{-4.397})\, sin(kx - \sigma t) \tag{7}$$

This force has a sinusoidal behaviour and therefore if $sin(kx - \sigma t) = 1$ then its value $F_i = 19.798\ kN$.

In the case of a wave of length 100 m, then the friction force of the horizontal component is:

$$F_f = 0.5 \cdot \rho \cdot C_f \cdot D \cdot A_p \cdot V \cdot |V| = 0.5 \cdot \rho \cdot C_f \cdot D \cdot \int_{-d}^{d} u \cdot |u| dy \quad (8)$$

$$F_f = 0.5 \cdot \rho \cdot C_f \cdot D \cdot \int_{-d}^{0} \frac{\pi \cdot H^2}{T} e^{2ky} \cos(ky - \sigma t) \cdot |\cos(ky - \sigma t)| dy \quad (9)$$

Since the wave number is 0.0628 rad/m, then the numerical value of the friction force is:

$$F_f = 0.5 \cdot 1017 \cdot 1.32 \cdot 1 \cdot (\frac{\pi \cdot 8}{10})^2 \cdot \frac{1}{2 \cdot 0.0628} \cdot (1 - \frac{1}{e^{0.0628 \cdot 70}} \cdot \cos(kx - \sigma t) \cdot |\cos(kx - \sigma t)| \quad (10)$$

So the total impact force of the waves on the Ana structure has the value:

$$F_T = F_i + F_f = 19.798 \cdot \sin(kx - \sigma t) + 32.299 \cdot \cos(kx - \sigma t) \cdot |\cos(kx - \sigma t)| \quad (11)$$

The value of the force given in kN and given that we can write it as $y = kx - \sigma t$ we will determine the derivative of the total force F_T in the condition $\frac{dF_T}{dy} = 0$

$$\frac{dF_T}{dy} = 19.789 \frac{d}{dy} \cdot \sin y + 33.299 \cdot cos^2 y \quad (12)$$

Also $\cdot\ x = \frac{2\pi}{L}$, $\sigma \cdot t = \frac{2\pi}{T}$ și $\frac{d \cos y}{dy} = -\sin y$, $\frac{d \sin y}{dy} = \cos y$

Get $\sin y = 0.4566$ și $y = \arcsin 0.4566 = 0.741\ rad = k \cdot x - \sigma \cdot t$

In the end $F_T = 19.978 \cdot \sin(0.741) + 33.299 \cdot cos^2\, 0.4741 = 33.46\ kN$

The force variation graph is given in the figure 2.

To determine the stresses of the offshore platform legs, we considered the use of the impact spectra of environmental factors on the platform legs, a calculation necessary to determine the dynamic loads.

In the spectral analysis of the Black Sea, we considered Morison's equation, modified by Penzien with the linearization term of the platform resistance and with the inertia and resistance coefficients considered constant (C_M = 1.5*;* C_D = 0.6).

The acceleration of water particles hitting the platform legs can be written in the form:

$$\ddot{a}(\tau) = \ddot{a}_t + f(\tau)(\ddot{a}_{t+\Delta t} - \ddot{a}_t) \quad (13)$$

Equation 13 can be written when the acceleration varies from the value t to the value $t + \Delta t$, where $\tau = t_i - t$ și $\tau = 0$ pentru $t_i = t$ și $\tau = \Delta t$ pentru $t_i = t + \Delta t$.

$$\dot{a}(\tau) = \dot{a}_t + \int_0^{\tau} \ddot{a}(\tau) = \dot{a}_t + \int_0^{\tau} (\ddot{a}_{t+\Delta t} - \ddot{a}_t) f(\tau)\, d\tau \quad (14)$$

$$a_{t+\Delta t} = a_t + \dot{a}_t \Delta t + ((\frac{1}{2} - \beta)\ddot{a}_t + \beta \ddot{a}_{t+\Delta t})\Delta t^2 \quad (15)$$

and $g(\tau) = \int_0^{\tau} f(\tau) d\tau$ și $\gamma \Delta t = \int_0^{\Delta t} f(\tau) d\tau$

Where $\tau = \Delta t$ then $\beta = \frac{1}{\Delta t^2} \int_0^{\Delta t} g(\tau) d\tau$

The equations above represent the acceleration, velocity, and displacement of water particles at the value $t + \Delta t$.

$$M\ddot{a}_{t+\Delta t} + C\dot{a}_{t+\Delta t} + k a_{t+\Delta t} = F_{t+\Delta t} \quad (16)$$

The equation of motion of the particles hitting the platform is of the form:

$$\left(k + \frac{1}{\beta \Delta t^2} M + \frac{\gamma}{\beta \Delta t} C\right) a_{t+\Delta t} = F_{t+\Delta t} + M\left(\frac{1}{\beta \Delta t^2} a_t + \frac{1}{\beta \Delta t^2} \dot{a}_t + \left(\frac{1}{2\beta} - 1\right) \ddot{a}_t\right) + C(\frac{\gamma}{\beta \Delta t} a_t + \left(\frac{\gamma}{2\beta} - 1\right) \dot{a}_t + \left(\frac{\gamma}{2\beta} - 1\right) \Delta t \ddot{a}_t) \quad (17)$$

By solving equation 17, the displacement values for the time value $t+\Delta t$ are obtained, then the velocities and accelerations at a previous time t. The usual values of the terms β, γ are 0.26 and 0.5 (figures 3, 4, 5, 6).

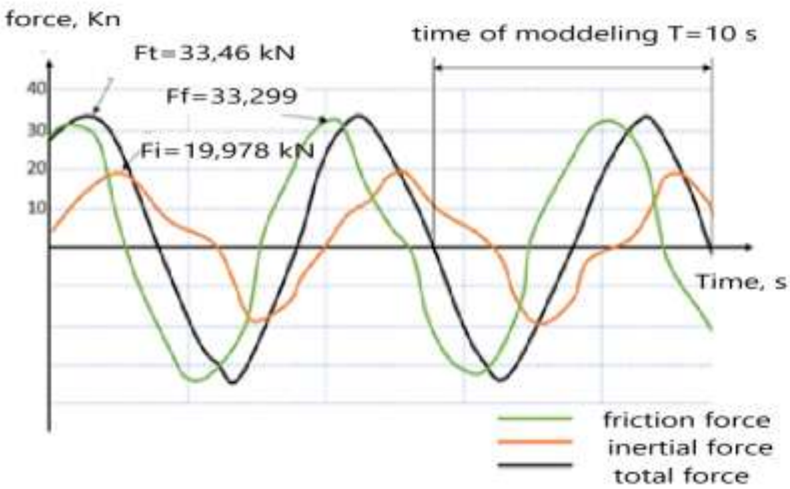

Figure 2. *Effects of forces to the Ana Platform*

In second study we proposed to analysed the marine corrosion zone (at the splash line and at the water-mud line) and determined the stress states at the joints subjected to marine factors (leg effort value in the main current area $E1$ and leg effort value in the secondary current area $E2$) (table 1, 2, 3, 4).

This models it is based to the experimental study, research of Ana Gas Platform (figure 3 and figure 4). Data of this measurements is presenting in figures 5, 6, 7 and 8.

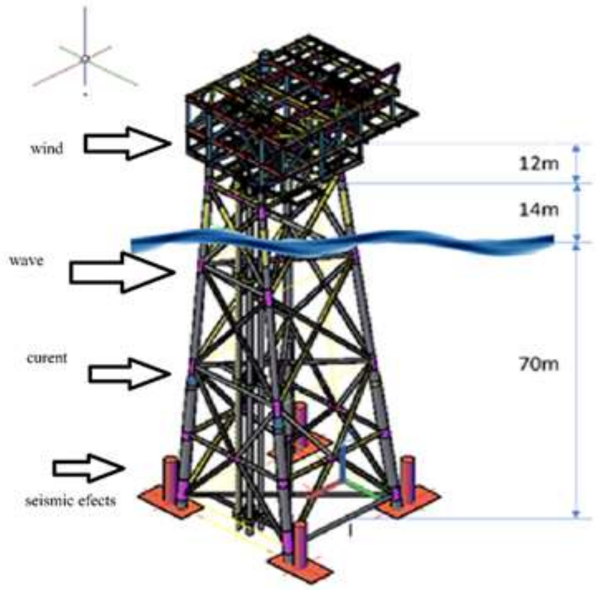

Figure 3. *Offshore Ana structure*

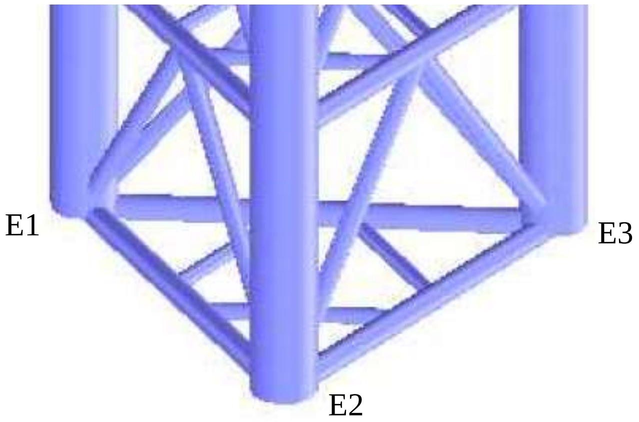

Figure 4. *Risk analysis of stress states at the joints*

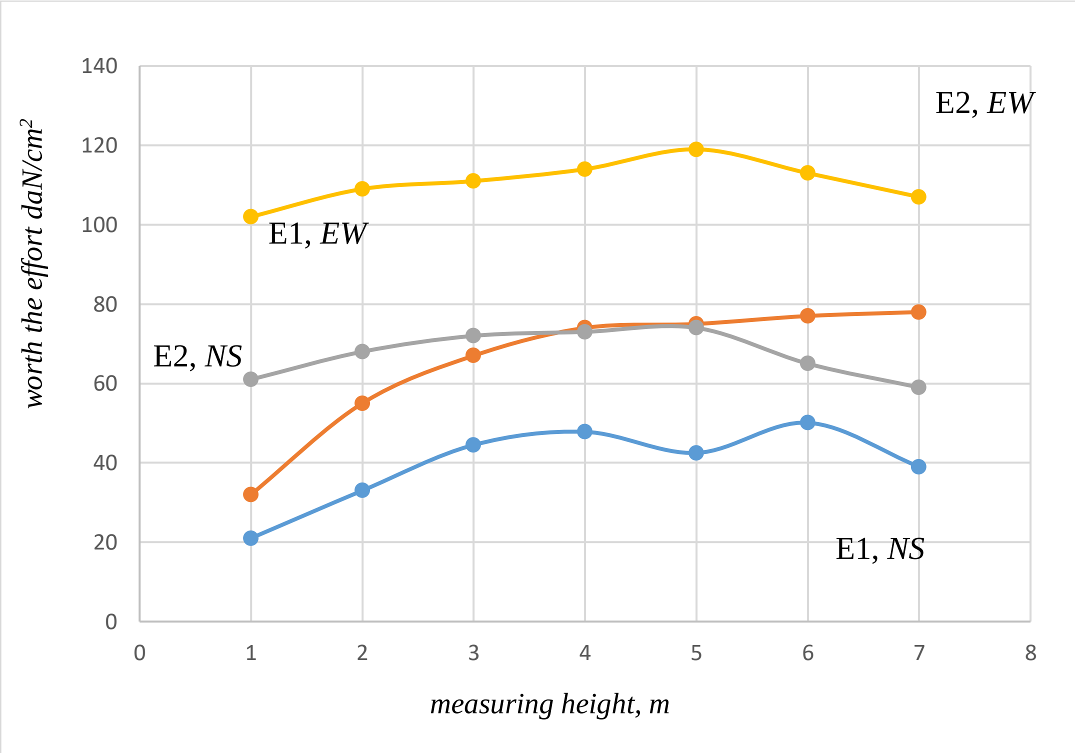

Figure 5. *Variation of stress in pillars E1 and E2 at wind direction N-S and E-W*

Table 1. *Variation equations of shear stress (impact) as a function of height above sea level*

Equation	***The value of the shear stress (shock) y of the platform at the height above sea level x***	R^2
Effort value, daN/cm^2 (EV), *E2*	$y = 0.0653x^6 – 1.4458x^5 + 12.34x^4 – 51.271x^3 + 107.09x^2 – 99.783x + 135$	1
Effort value, daN/cm^2 (EV), *E1*	$y = 0.0722x^6 – 1.65x^5 + 14.764x^4 – 65.667x^3 + 150.16x^2 – 158.68x + 122$	1
Effort value, daN/cm^2 (NS), *E2*	$y = -0.0444x^6 + 1.0583x^5 – 9.9444x^4 + 47.208x^3 – 122.01x^2 + 177.73x - 62$	1

Effort value, daN/cm² (NS), *E1*	$y = -0.1244x^6 + 2.735x^5 - 23.299x^4 + 97.483x^3 - 211.38x^2 + 236.28x - 80.70$	1
Effort value, daN/cm² (NW-SE), *E1*	$y = -0.0681x^6 + 1.7208x^5 - 16.993x^4 + 83.729x^3 - 221.44x^2 + 312.05x - 92$	1
Effort value, daN/cm² (NW-SE), *E2*	$y = 0.0111x^6 - 0.125x^5 - 0.3472x^4 + 9.7083x^3 - 46.164x^2 + 86.917x - 1$	1

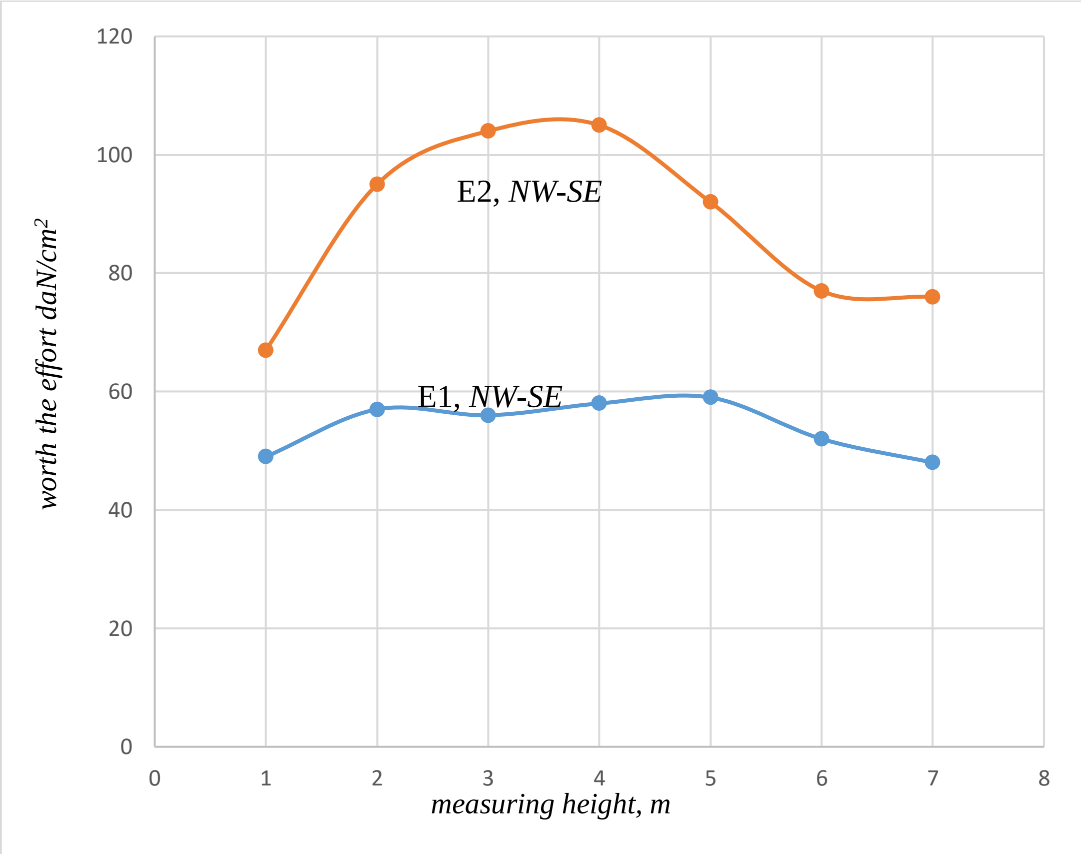

Figure 6. *Variation of stress in pillars E1 and E2 at wind direction NW-SE*

Table 2. *Shear stress variation values (impact) depending on height above sea level*

H (m), measurement relative to sea level	***Effort value, daN/cm² (NS), E1***	***Effort value, daN/cm² (NS), E2***	***Effort value, daN/cm² (EV), E1***	***Effort value, daN/cm² (EV), E2***	***Effort value, daN/cm² (NW-SE), E1***	***Effort value, daN/cm² (NW-SE), E2***
1	21	32	61	102	49	67
2	33	55	68	109	57	95
3	44.5	67	72	111	56	104
4	47.8	74	73	114	58	105
5	42.5	75	74	119	59	92
6	50.1	77	65	113	52	77
7	39	78	59	107	48	76

On the N-S direction, maximum values of the stress field are observed at a height of 6 m, i.e. at the splash zone. Element 2 will be hit harder on the East-West direction, the maximum value being at 5 m, i.e. at the meeting of the waves with the wind. The stress on the East-West direction is over 38% lower than on the East-West direction.

Table 3*. Equations of variation of shear stress (impact) as a function of depth from sea level*

Equation	***The value of the shear stress (shock) y of the platform as a function of the depth at sea level x***	R^2
effort value, daN/cm² (NS), *E*1	$y = -1E-07x^6 + 3E-05x^5 - 0.0028x^4 + 0.1372x^3 - 3.5169x^2 + 42.45x - 195$	1
effort value, daN/cm² (NS), *E*2	$y = 8E-09x^6 - 2E-06x^5 + 0.0001x^4 - 0.0053x^3 + 0.1362x^2 - 3.6533x - 15$	1
effort value, daN/cm² (EV), *E*1	$y = -7E-08x^6 + 2E-05x^5 - 0.0015x^4 + 0.0729x^3 - 1.838x^2 + 22.757x - 173$	1
effort value, daN/cm² (EV), *E*2	$y = 4E-08x^6 - 1E-05x^5 + 0.0011x^4 - 0.0533x^3 + 1.3247x^2 - 15.805x - 28$	1
effort value, daN/cm² (NW-SE), *E*1	$y = -6E-08x^6 + 1E-05x^5 - 0.0011x^4 + 0.0426x^3 - 0.7463x^2 + 3.5983x - 64$	1
effort value, daN/cm² (NW-SE), *E*2	$y = -1E-07x^5 + 6E-05x^4 - 0.0076x^3 + 0.3571x^2 - 7.8338x + 16.571$	1

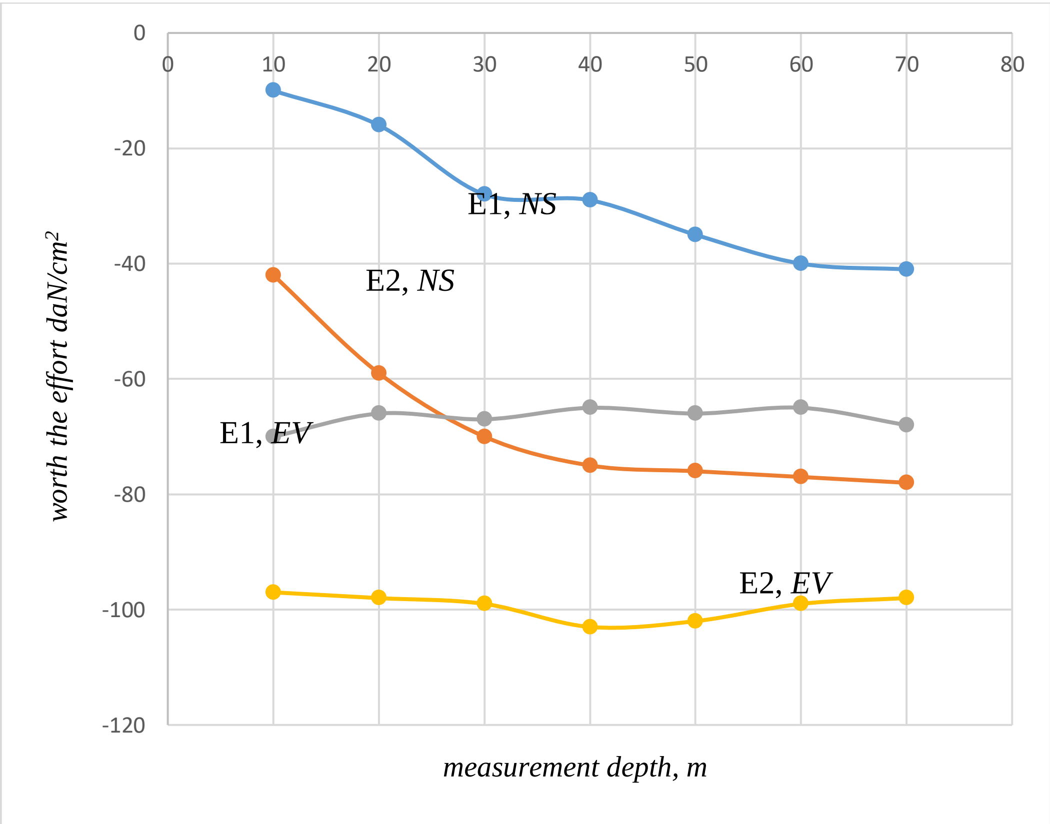

Figure 7. *Variation of stress in pillars E1 and E2 in the direction of currents N-S and E-V*

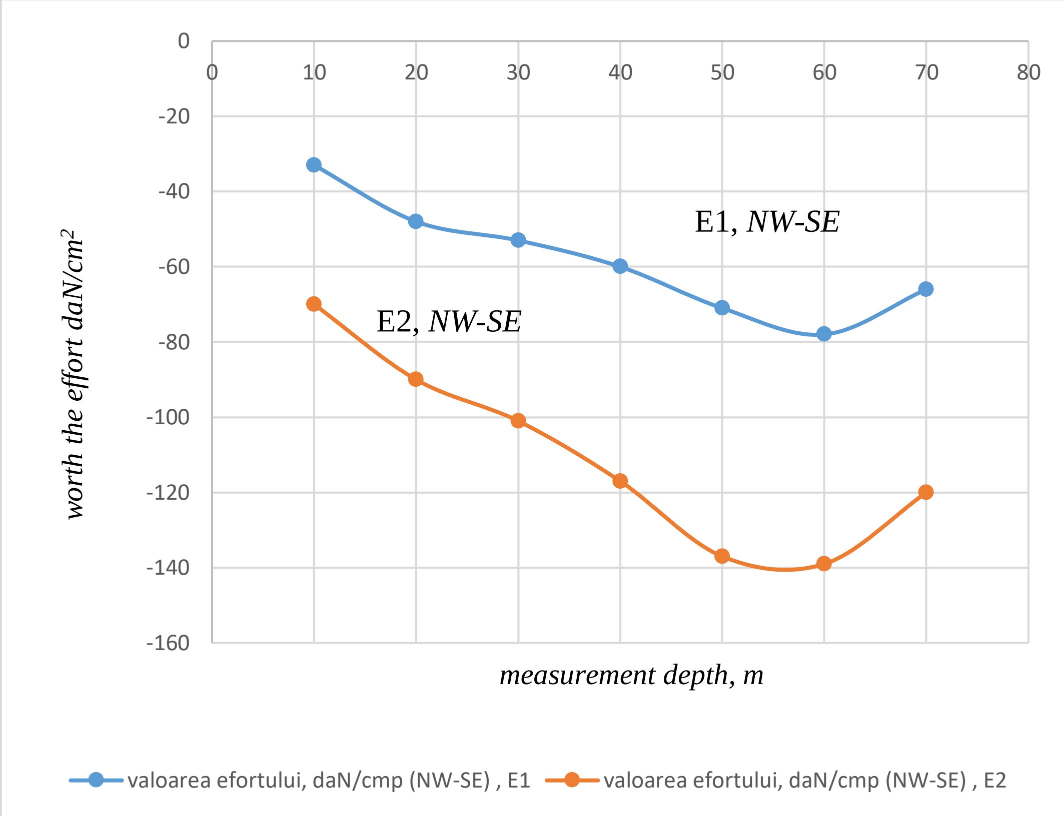

Figure 8. *Variation of stress in pillars E1 and E2 in the direction of NW-SE currents*

Table 4*. Shear stress variation values (impact) as a function of depth from sea level*

H (m), wave height	***effort value, daN/cm²(NS), E1***	***effort value, daN/cm²(NS), E2***	***effort value, daN/cm²(EV), E1***	***effort value, daN/cm²(EV), E2***	***effort value, daN/cm²(NW-SE), E1***	***effort value, daN/cm²(NW-SE), E2***
10	-10	-42	-70	-97	-33	-70
20	-16	-59	-66	-98	-48	-90
30	-28	-70	-67	-99	-53	-101
40	-29	-75	-65	-103	-60	-117
50	-35	-76	-66	-102	-71	-137
60	-40	-77	-65	-99	-78	-139
70	-41	-78	-68	-98	-66	-120

In final methods were measured friction forces, inertial force and total force (figure 9).
Equation of friction forces is:

$$y = -1E\text{-}05x^6 + 0.0016x^5 - 0.0741x^4 + 1.5203x^3 - 13.458x^2 + 35.402x + 30.108 \quad (18)$$

with $R^2 = 0.9972$.
Equation of inertial forces is:

$$y = 5E\text{-}06x^6 - 0.0005x^5 + 0.0171x^4 - 0.2175x^3 + 0.305x^2 + 6.3657x - 1.7582 \quad (19)$$

with $R^2 = 0.8246$.

Equation of total forces is:

$$y = -9\text{E-}06x^6 + 0.0011x^5 - 0.0569x^4 + 1.3028x^3 - 13.153x^2 + 41.768x + 28.349 \quad (20)$$

with $R^2 = 0.9382$.

In equation 18, 19 and 20, x is times (s) and y is total forces, friction forces and inertial forces (kN).

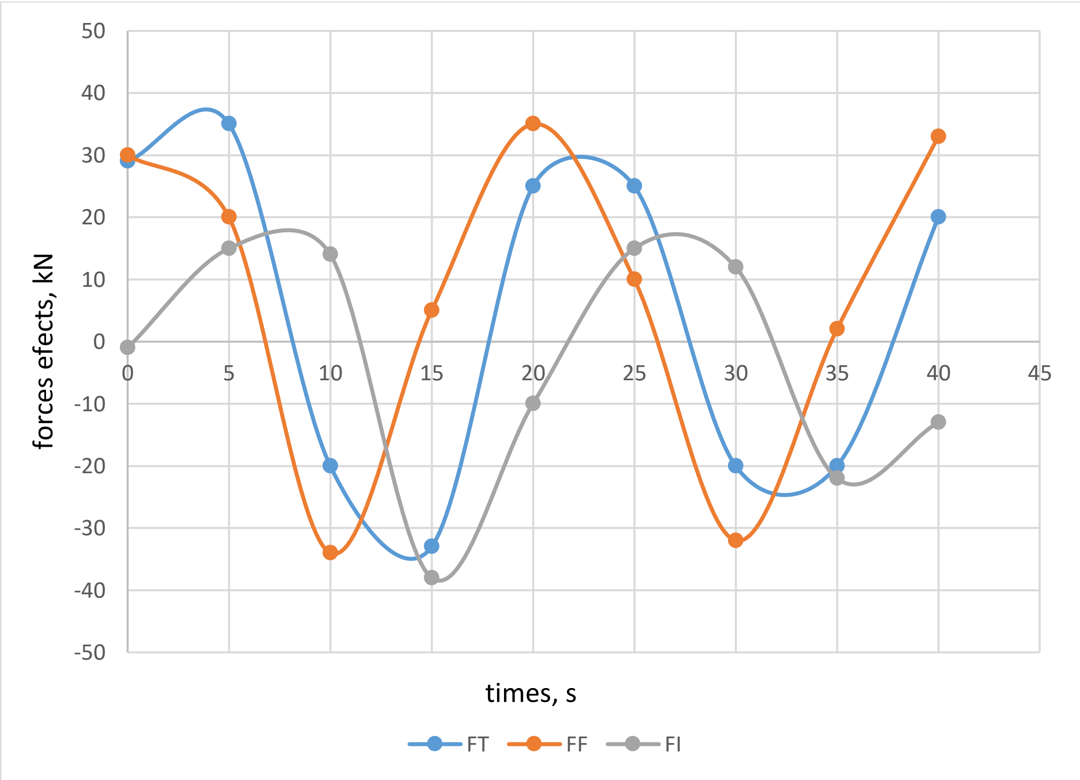

Figure 9. *Variation of forces to wave of Ana Gas Platform*

In figures 10, 11 and 12, we presenting AI models function to equation models.

CONCLUSIONS

In this study we analysis the Morison Equation and Polynomial Equation. The ***Morison Equation*** is like a ***recipe***. It tells you *why* you get a certain force by explaining the ingredients: a certain amount of drag (related to velocity) mixed with a certain amount of inertia (related to acceleration). It explains the underlying process.

Our ***Polynomial Equation*** is like a highly detailed ***drawing of the final cake***. It can describe the shape and appearance of the final result perfectly, but it tells you nothing about the ingredients (flour, sugar, etc.) or the recipe used to make it.

The Morison equation need to respects the Empirical Coefficients. It is crucial to emphasize that empirical coefficients are not universal physical constants but are empirical coefficients.

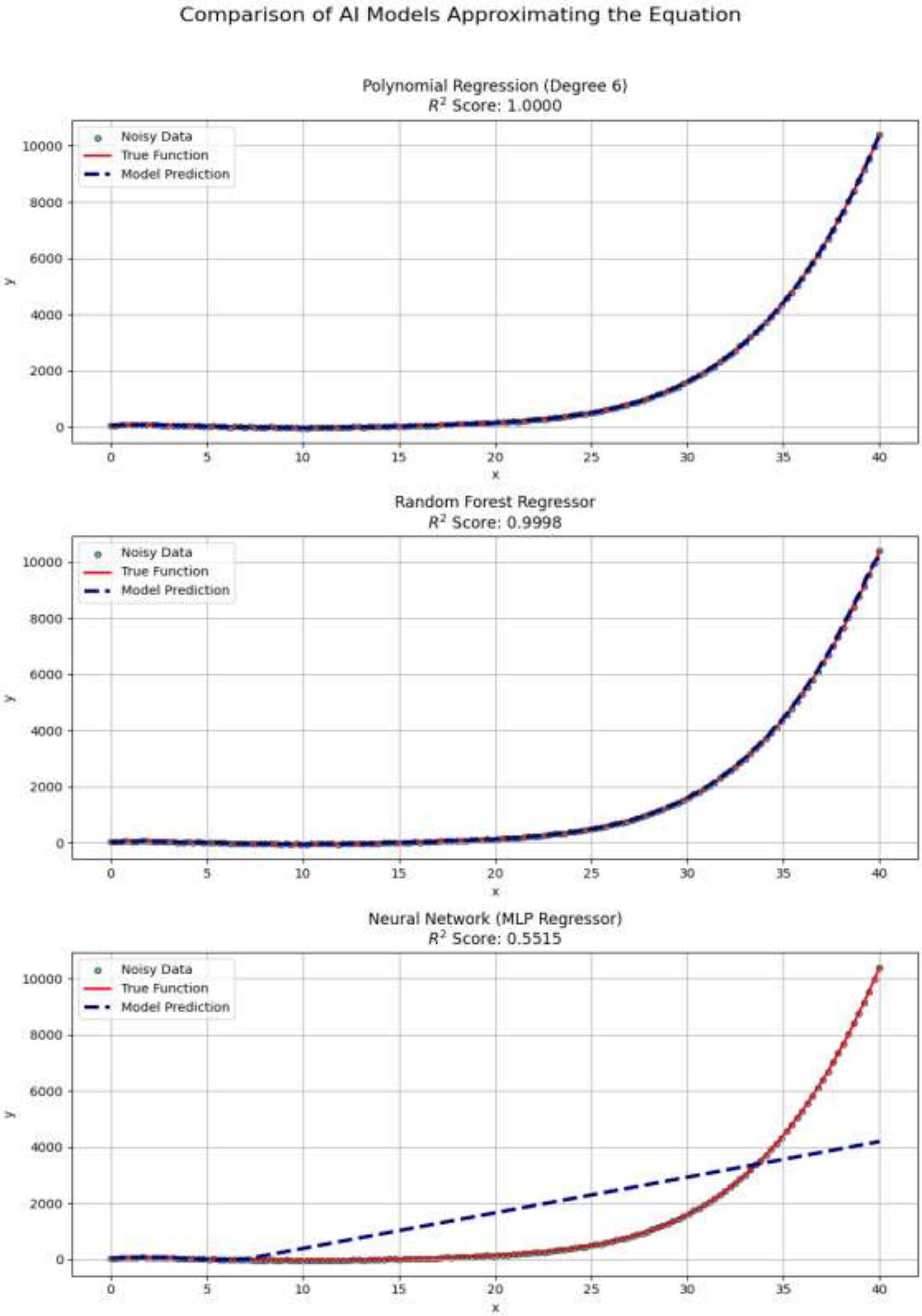

Figure 10. *Model prediction in AI function to equation of friction forces*

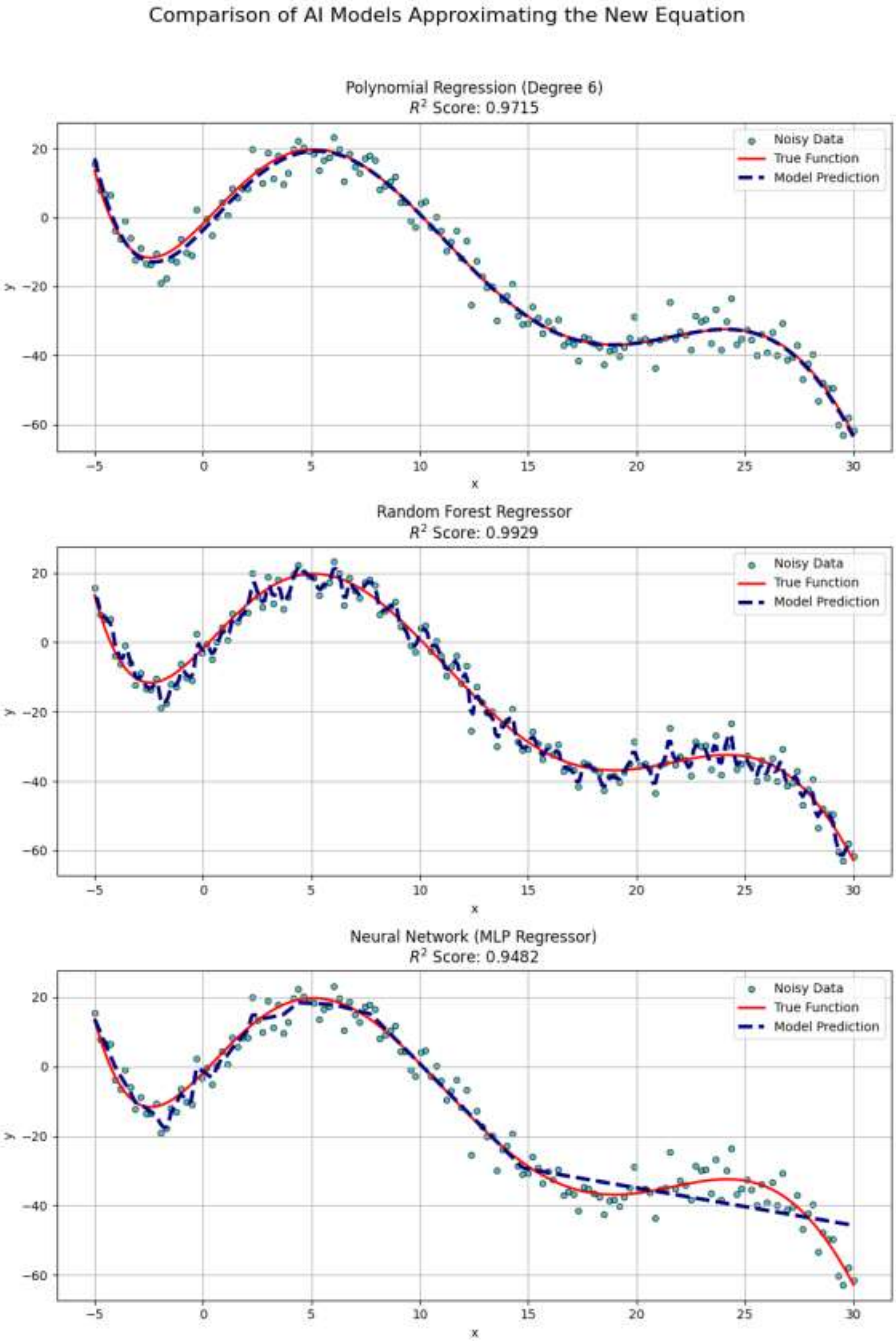

Figure 11. *Model prediction in AI function to equation of inertial forces*

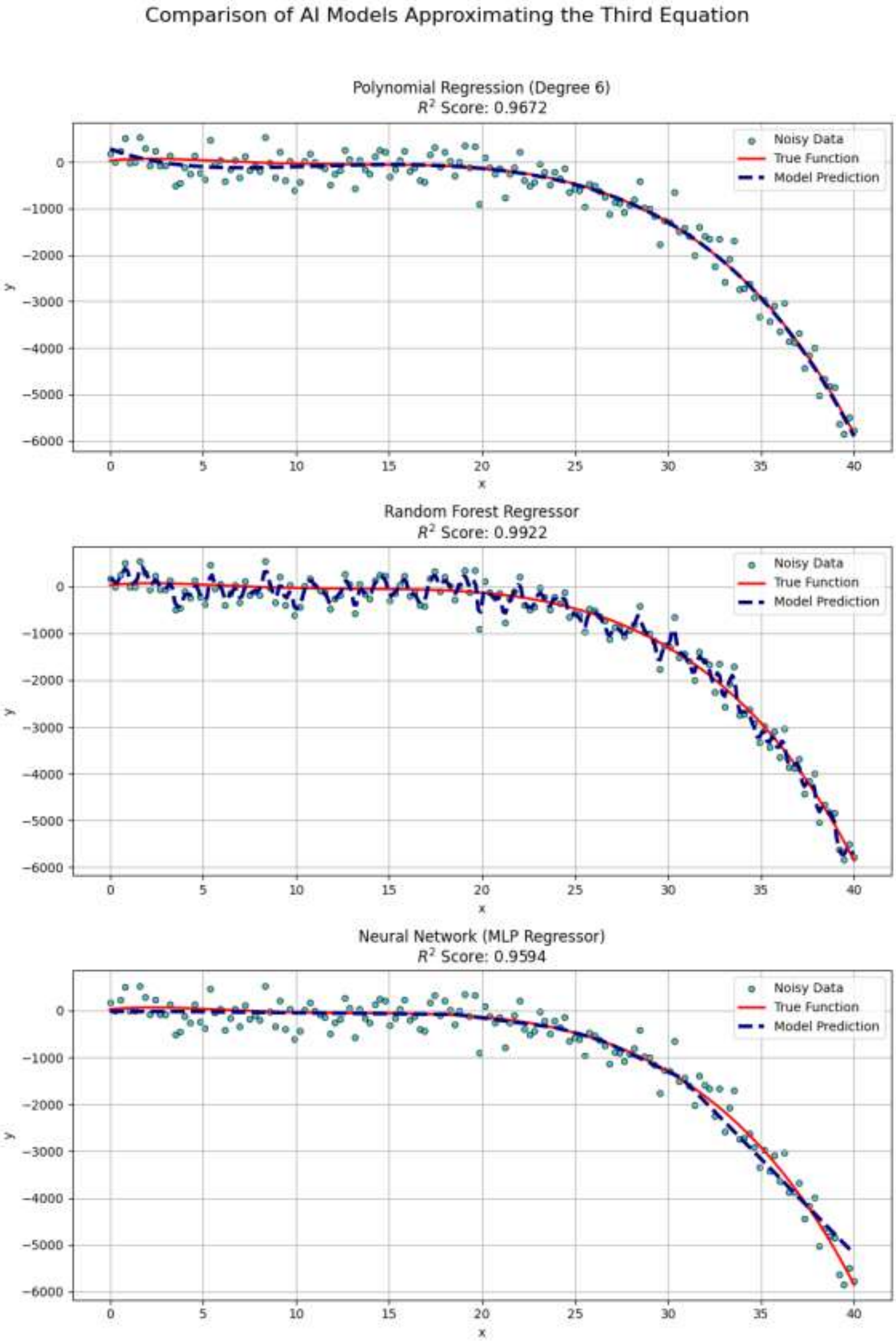

Figure 12. *Model prediction in AI function to equation of total forces*

Their values depend on several factors, including:

- Reynolds number (Re): Characterizes the ratio of inertial to viscous forces in the fluid.
- Keulegan-Carpenter number (KC): Describes the ratio of the amplitude of fluid motion to the diameter of the structure, indicating the relative importance of driving forces to inertial forces in an oscillation cycle.
- The roughness of the surface of the structure.
- The shape of the cross-section of the element.

Therefore, the correct choice of these coefficients, based on experimental data relevant to the flow conditions and specific structural characteristics, is vital for the accuracy of force estimates.

But limitations of Morison's equation is a basic tool in coastal and offshore engineering, being used for the preliminary and final design of piers, pipelines, structural members of offshore platforms, etc.

Its main limitation is that it does not take into account the effects of wave diffraction, which become significant when the diameter of the structure is comparable to or larger than the wavelength (usually when D/L0.2). In such cases, diffraction-based theories are used.

In short, the Morison equation is a model based on physics, while your polynomial is an empirical curve fit that an AI model generated. They are two completely different ways of describing the same phenomenon.

Offshore structures, unique metal constructions due to their operational complexity and manufacturing technology, are individually designed to adapt to a series of critical factors:

a. meteorological and geopolitical conditions specific to the location.
b. geological and geochemical characteristics of the exploited deposit.
c. structural parameters of the site, such as water depth, sea currents and seabed stability.
d. technical and economic requirements imposed by the exploitation of resources.
e. the level of training of operational personnel.
f. conditions imposed by the existing economic and service area, including maritime transport routes, fishing areas and the economic interests of the state.

Risk assessment and management require a thorough understanding of the risk factors and mechanisms of facility degradation, which can affect the safety of personnel, assets and environmental protection.

In the offshore industry, the concept of asset integrity is closely linked to the economic evaluation and monitoring of the state of degradation of facilities. In Romania, a method is used to establish the percentage required for the rehabilitation of production structures, in the context of recognizing deductible expenses. In addition, the implementation of the European Directive on the safety of offshore platforms has led to the adoption of a control model in Romania as well.

This model, although useful for assessing the current state of facilities, does not provide insight into future risk factors or the long-term behaviour of offshore structures.

It is important to emphasize that no facility can be considered 100% safe in operation. Even with rigorous safety measures, there is always the possibility of incidents that may compromise the integrity and stability of the platform, affect the environment or endanger personnel.

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