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Türkçe E-postalarda Spam Tespiti için Makine Öğrenme Yöntemlerinin ve Dil Modellerinin Analizi

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Öz

Son zamanlarda teknolojinin ve sosyal ağların gelişmesiyle çevrimiçi karşılıklı etkileşim, herhangi konuda fikirlerini paylaşma oldukça önem kazanmıştır. Bu etkileşimlerin olumlu yanı olsa da olumsuz yanı da oldukça fazladır. Sosyal ağlarda kullanıcıların bilgilerini elde edip kullanıcıları taklit etmek güvenlik açısından büyük bir problemdir. Böylelikle kullanıcılar üzerinden dolandırıcılık vs. yapılabilmektedir. Kullanıcıları taklit edebilmek için en yaygın yol spam mesajların, e-postaların, vs. atılmasıdır. Güvenlik probleminin üstesinden gelmek için spam filtreleme, spam tespiti yöntemi geliştirme gibi işlemler uygulanmaktadır. Bu çalışmada Türkçe e-postalarda spam içeren e-postaların tespiti için Rastgele Orman, Lojistik Regresyon, Naive Bayes, Yapay Sinir Ağları makine öğrenme yöntemleri ve BERT, ELECTRA, ALBERT, DistilBERT dil modelleri analiz edilmiştir. Böylece dil modellerinin Türkçe için spam e-postaları sınıflandırmadaki etkisi gösterilmek istenmiştir. Deneysel çalışmaların sonucunda, spam e-postaları sınıflandırmada tüm dil modelleri makine öğrenme yöntemlerine göre daha başarılı olmuştur. Makine öğrenme yöntemlerinden yapay sinir ağları %90.15 doğruluk değeri elde ederken, en başarılı dil modelleri %94.08 doğruluk değeri ile BERT ve ELECTRA olmuştur.

Anahtar Kelimeler: Siber Güvenlik, Spam Tespiti, Dil Modeli, Makine Öğrenmesi, Doğal Dil İşleme, Metin Sınıflandırma.

Analysis of Machine Learning Methods and Language Models for Spam Detection in Turkish Emails

Abstract

Recently, with the development of technology and social networks, online interaction, sharing ideas on any subject has gained importance. While there are positive aspects to these interactions, there are also many negative aspects. Obtaining users' information and impersonating users in social networks is a big problem in terms of security. Thus, fraud etc. can be done by under cover of users. The most common way to impersonate users is by sending spam messages, emails, etc. In order to overcome the security problem, processes such as spam filtering and spam detection method development are applied. In this study, Random Forest, Logistic Regression, Naive Bayes, Artificial Neural Networks machine learning methods and BERT, ELECTRA, ALBERT, DistilBERT language models were analyzed to detect e-mails containing spam in Turkish e-mails. Thus, it is aimed to show the effect of language models in classifying spam e-mails for Turkish. As a result of experimental studies, all language models were more successful than machine learning methods in classifying spam emails. While artificial neural networks from machine learning methods achieved 90.15% accuracy, the most successful language models were BERT and ELECTRA with 94.08% accuracy.

Keywords: Cyber Security, Spam Detection, Language Model, Machine Learning, Natural Language Processing, Text Classification.

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1. Giriş

Teknolojinin yaşamamıza girmesiyle beraber akıllı cep telefonu, bilgisayar gibi birçok teknolojik cihaz günlük hayatta kullanılmaktadır. İnsanların birbiri ile etkileşime geçmesini sağlayan bu gelişmeden dolayı birçok sosyal ağ ortaya çıkmaktadır. Kişilerin birbirine e-posta ve mesaj göndermesi, sosyal medyada paylaşımlara yorumlar yapılması, kullanıcının etkileşim alması gibi süreçler sosyal ağlarda mevcuttur.

Sosyal veya profesyonel bağlantılar, etkileşimler, büyüyen iş itibarı, kamuoyu görüşlerini bilmek, haberler, çevrimiçi öğrenme, afet yönetimi, sağlık hizmetleri, öneri sistemleri sosyal ağların temel uygulamalarıdır. Ancak kullanıcılar, kişisel bilgilerini ara sıra bu sosyal ağlarda bilmeden de olsa yabancılara paylaşabilmektedir. Bu da güvenlik açısından sorun oluşturmaktadır. Spam gönderenler, botlar, bilgisayar korsanları, siber suçlular ve üçüncü taraf şirketler gibi kötü niyetli kullanıcılar, dolandırıcılık gibi sorun çıkaran faaliyetleri gerçekleştirmek için bu kullanıcıların bilgilerden yararlanmaktadır. Spam gönderenler ayrıca insanların güvenini kullanarak reklam, kimlik avı, casusluk, kadına yönelik şiddet, siber zorbalık gibi yasa dışı faaliyetlerde bulunabilmektedir. Genel olarak spam gönderenler, spam yaymak için meşru hesaplar yerine sahte/kopyalanan hesaplar, otomatik botlar vs. kullanmaktadır (Rao vd., 2021). Böylece spam gönderenler kendilerini güvene almaktadır. Spam gönderme mesaj veya e-posta yoluyla, yorum yapılma vs. gibi olaylarla yapılabilir. Yorum ile iletilen spamlar, tüketicinin güveninde kayba neden olduğundan işletmeleri de olumsuz etkilemektedir. Örneğin, BBC ve New York Times, "spam yorumların Web'de yaygın bir sorun haline geldiğini ve yakın zamanda bir fotoğraf şirketinin yüzlerce karalayıcı tüketici spam yorumuna maruz kaldığını" belirtmektedir (Crawford vd., 2015).

Spam mesajlar veya e-postalar, kaçınılması veya ortadan kaldırılması gereken bir konudur. Çünkü bu tür spam e-postalar, oluşturulan zararlı olaylarla genel e-postaları etkilemektedir. Bu tür spam e-postaların tespit edilmesi, yasa dışı faaliyetler sorunundan kaçınmak için oldukça önemlidir. Spam e-postaları filtreleme için kara liste, beyaz liste, içerik tabanlı veri filtresi gibi metodolojiler yer almaktadır. Ancak, bunlar tamamen başarılı bir metodoloji olmamaktadır. E-posta kara liste mekanizması, çok sayıda spam e-posta kimliğini saklayarak kullanıcılara mesajların bu saklanan e-posta kimliklerinden gelip gelmediğini kontrol etmektedir. İçerik tabanlı veri filtresinde ise şüpheli IP adreslerinden gelen mesajları engelleyen ve mevcut sisteme makul bir şekilde güvenlik sağlayan IP tabanlı filtreleme bulunmaktadır. Beyaz listeye alınan e-postalar ise bilinen kimlik e-postalarıdır. Bu liste ile kullanıcıya bilinen posta kimliklerini engelleme, gelecek e-postalardan korumayı sağlamaktadır (Ismail vd., 2022).

Spam e-postalarının tespit edilebilmesi için birçok İngilizce dilinde çalışma bulunmaktadır. Bu çalışmada Türkçe açısından literatüre katkı sağlamak için Türkçe spam e-postalarını sınıflandırma için analiz uygulanmaktadır. Analiz aşamasında makine öğrenme yöntemlerinin yanı sıra günümüzde oldukça sık kullanılan dil modelleri (DM) de tercih edilmektedir. Böylece makine öğrenme yöntemleri ile DM arasında Türkçe dili için karşılaştırma yapılması da amaçlanmaktadır.

Çalışmanın başlıca katkıları şunlardır:

- Türkçe dili için spam tespiti analiziyle literatüre katkı sağlamaktadır.
- Dil modellerinin Türkçe için kullanıldığı çalışma sayısı oldukça azdır. Bundan dolayı dil modelleri ile analiz önem taşımaktadır.
- Makine öğrenme yöntemleri ile dil modellerinin başarısı kıyaslanarak dil modellerinin Türkçe dili için etkisi gösterilmektedir.

Çalışmanın akışı incelendiğinde ikinci başlıkta Türkçe spam tespiti için ilgili çalışmalar anlatılmaktadır. Materyal ve Yöntem başlığı altında ise kullanılan veri seti, uygulanan ön işlemler, makine öğrenme yöntemleri ve dil modelleri kısaca açıklanmaktadır. Dördüncü başlık içeriğinde ise ön işlem analizi, makine öğrenme yöntemleri ve dil modellerinin analizi gerçekleştirilmektedir. Tartışma bölümünde ise makine öğrenme ve dil modellerinin spam tespitine etkisi açıklanmaktadır. Son başlıkta ise sonuçlara ve gelecek çalışmalara değinilmektedir.

2. İlgili Çalışmalar

Spam tespitinde Türkçe içinde belli çalışmalar yapılmıştır. Bu çalışmalar genel olarak makine öğrenme ve derin öğrenme yöntemlerinin kullanımına dayalıdır. Deniz vd. (2019) Türkçe spam tespitinde e-postaların sayısallaştırılması için öznelik çıkarımında Doc2Vec kütüphanesinin algoritmalarını kullanmışlardır. Ardından sınıflandırma algoritmaları ile Doc2Vec'in başarısını ölçmüşlerdir. Eryılmaz vd. (2020) Keras derin öğrenme kütüphanesi ile Türkçe spam verileri analiz etmişlerdir. Uzun kısa süreli bellek (LSTM) yöntemi ile analizin başarılı olduğunu göstermişlerdir. Şimsek ve Aydemir (2022), yeni bir Türkçe spam e-posta veri seti oluşturmuşlar ve Weka programındaki algoritmalar kullanılarak Türkçe spam veya normal e-postaların sınıflandırılmasını analiz etmişlerdir. Karasoy ve Ballı (2022) makine öğrenmesi ve derin öğrenme yöntemleri kullanarak içerik tabanlı SMS sınıflandırması uygulamışlardır. Elde edilen özelliklere ek Word2Vec ile çıkarılan ayrı özellikler ile yöntemlerin başarılarını analiz etmişlerdir. Dedetürk ve Atay (2020) yapay arı kolonisi algoritmasını bir lojistik regresyon sınıflandırma modeliyle birleştiren yeni bir spam tespit yöntemi önermişlerdir. Türkçe e-posta veri seti dahil üç veri seti üzerinde bu yöntemi analiz etmişlerdir. Önerilen yöntemi destek vektör makinesi, lojistik regresyon ve Naive Bayes algoritmaları ile karşılaştırmışlar ve yöntemleri ile daha iyi sonuç elde etmişlerdir. Isik vd. (2020) Karşılıklı Bilgi ve Ağırlıklı Karşılıklı Bilgi özellik seçme yöntemlerini kullanarak farklı derin öğrenme yöntemlerini Türkçe e-posta spam tespiti için analiz etmişlerdir. Özellik seçim işleminden sonra, kelime çantası yöntemi ile özellik vektörleri elde etmişlerdir. Ardından, Yapay Sınır Ağı (YSA), LSTM ve Çift Yönlü LSTM yöntemleri kullanılarak sistemin performansını ölçmüşlerdir. Ekici ve Takcı (2021), diğer dillerde sıkça kullanılan Word2Vec ve Terim Frekansı-Ters Terim Frekansı (TF-IDF) yöntemlerini Türkçe spam tespiti için karşılaştırmışlar ve başarıyı artırmışlardır.

Türkçe dili için dil modelleri genellikle duygu analizi (Acikalin vd. (2020), Guven (2021a), Sigirci vd. (2020)) alanında, metin sınıflandırmada (Çelikten ve Bulut (2021), Şahin ve Diri (2021)) kullanılmıştır.

3. Materyal ve Metotlar

Çalışmada kullanılan veri seti, uygulanan ön işlemler, uygulanan yöntemler bu kısımda açıklanmaktadır. Uygulanan makine öğrenme yöntemleri ve dil modelleri analiz için ayrı olarak kullanılmaktadır.

2.1. Veri Seti

Kaggle platformunda yüklü olan Türkçe e-posta spam veri seti[†] analiz için kullanılmaktadır. Veri seti 502 normal (ham) mailden, 517 ise spam mailden oluşmaktadır. 20 kişiye gelen normal ve spam maillerden veri seti elde edilmiştir (Şimsek ve Aydemir, 2022). Veri setine ait kelime bulutu Şekil 1'de gösterilmiştir. Veri setinin, eğitim ve test olarak kullanımı açıkça belirtilmediği için karşılaştırma amaçlı kullanılamamıştır.



Şekil 1. Veri setine ait kelime bulutu

2.2. Ön İşlemler

Analiz öncesinde veri seti üzerinde belli ön işlemler uygulanmaktadır. Ön işlemlerin uygulanması sırayla gerçekleştirilmektedir:

- E-posta küçük harfe dönüştürülmektedir.
- Metin içindeki email ve web adresleri düzenli ifadeler (RegEx) ile tespit edilerek sırasıyla “email, website” olarak güncellenmiştir. Bu işlem ile farklı adreslerin aynı yapıda olmasını sağlamak amaçlanmıştır.
- E-posta içindeki sayısal ifadeler ve noktalama işaretleri silinmektedir.
- E-postadaki tüm metin için Zeyrek[‡] kütüphanesi aracılığıyla kök alma (lemmatization) işlemi uygulanmıştır. Böylece aynı anlama gelen farklı yapıdaki kelimeler aynı yapıya dönüştürülmüştür.
- Kök alma işlemi sonrası e-posta içinde etkisiz kelimeler silinmiştir. Bu işlemin sonucunda analize etki etmeyen kelimeler silinerek veri hacmi azalmıştır.

Ön işlemler sonrasında veri seti güncel haliyle kaydedilerek analiz aşamasında kullanılmıştır. Ön işlemlere ait bir örnek Tablo 1'de verilmiştir.

2.3. Makine Öğrenme Yöntemleri

Çalışmada makine öğrenme yöntemleri olarak Rastgele Orman (RO), Naive Bayes (NB), Lojistik Regresyon (LR) ve Yapay Sinir Ağları (YSA) kullanılmaktadır. Etkisiz kelime temiz-

Tablo 1. Makine öğrenme yöntemlerinin başarısı

Ön İşlemler	Metnin Değişimi
Mailin ilk hali	Ödemen İade Edildi kitapsec.com web sitesinde 16/02/2022 22:00 tarihinde gerçekleştirmiş olduğun 39.39 TRY tutarındaki işleminin iadesi izyico tarafından başarıyla tamamlanmıştır. İade işlemleri, kredi kartları ile yapılan ...
Küçük harfe dönüştürme + Email ve web adresi düzenleme	ödemen iade edildi website web sitesinde 16/02/2022 22:00 tarihinde gerçekleştirmiş olduğun 39.39 try tutarındaki işleminin iadesi izyico tarafından başarıyla tamamlanmıştır. iade işlemleri, kredi kartları ile yapılan ...
Sayısal ifade ve noktalama işaretleri silme	ödemen iade edildi website web sitesinde tarihinde gerçekleştirmiş olduğun try tutarındaki işleminin iadesi izyico tarafından başarıyla tamamlanmıştır iade işlemleri kredi kartları ile yapılan ...
Kök alma işlemi	ödemek iade edildi website web site tarihî gerçek olmak try tutar işlem iade izyico tarafından başar tamam iade işlem ile kredi kart yapılanmak ...
Etkisiz kelimelerin silinmesi	ödemek iade edildi website web site tarihî gerçek olmak try tutar işlem iade izyico tarafından başar tamam iade işlem kredi kart yapılanmak ...
Mailin son hali	ödemek iade edildi website web site tarihî gerçek olmak try tutar işlem iade izyico tarafından başar tamam iade işlem kredi kart yapılanmak ...

leme, noktalama işaretleri kaldırma gibi ön işlemler sonrasında Terim Frekansı-Ters Terim Frekansı (TF-IDF) yöntemi ile veri setinin özellikleri çıkarılmaktadır. TF-IDF ile çıkarılan özellikler, makine öğrenme yöntemlerinin eğitimi aşamasında k-çapraz doğrulama tekniği ile kullanılmaktadır. Teknikteki k değeri 5 olarak belirlenmiştir. Böylece veri seti 5 kümeye ayrılarak her aşamada farklı 4'lü küme eğitim, kalan tek küme ise test olarak eğitime verilmektedir. Sonuçlar bu 5'li varyasyona göre aşağıdaki makine öğrenme yöntemleri için elde edilmektedir:

- **RO:** Karar ağacı yapısını kullanan bir topluluk öğrenmesi yöntemidir. Çok sayıda karar ağacı üretilip bir modele dahil edilen her bir değerlendiricinin önemini belirlemektedir (Probst ve Boulesteix, 2017).
- **NB:** Olasılıksal bir makine öğrenme yöntemidir. Sınıfa verilen özelliklerin birbirinden bağımsız olduğu varsayarak bir sınıf için yeni olan örneğin olasılığını hesaplamaktadır (Chen vd., 2020).
- **LR:** İki veya daha fazla sınıf için ayırım yapabilmeyi sağlayan model oluşturmada kullanılmaktadır. Girdinin doğrusal fonksiyonu kullanılarak belirlenen sayıda sınıfların olasılıklarını modellemektedir (Chen vd., 2018).

[†] <https://www.kaggle.com/datasets/emrahaydemir/turkish-mail-dataset-normalspam>

[‡] <https://zeyrek.readthedocs.io/en/latest/#>

- **YSA:** Sinir ağları insanların beyin yapısından etkilenerek oluşturulmuştur. Girdi, gizli ve çıktı katmanlarından oluşmaktadır. Modelin hesaplanmasında değişken ağırlık çarpanları, toplam fonksiyonu, tanımlama (aktivasyon) fonksiyonu kullanılmaktadır (Taşar vd., 2018).

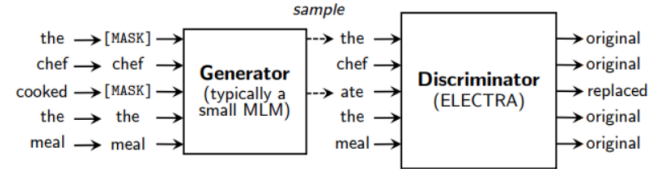
2.4. Dil Modelleri

DM, kelime tahmini, sınıflandırma gibi görevler için metinlerin gövdelerini analiz etmektedir. Metinlerin gövdelerine ait kelime dizilerini girdi olarak kullanarak görev için olasılık dağılımı hesaplanmaktadır (Güven, 2021b). DM, tek yönlü ve çift yönlü olarak iki modele ayrılmaktadır. Tek yönlü DM, girdi dizisi için diziyi çarpanlarına ayırıp bu diziyi bir olasılık atamaktadır. Çift yönlü DM için ise kelimenin konumu ile kelimenin sol ve sağ bağlamını da analiz etmektedir (Petroni vd., 2019). Çalışmada BERT, ELECTRA, ALBERT ve DistilBERT DM'leri kullanılmaktadır.

BERT: Transformer temelli çift yönlü kodlayıcı gösterimi olarak tanımlanmaktadır. Kelimenin sadece tek bir yönüne odaklanılmayarak sol ve sağ bağlamını incelemektedir. BERT modeli maskelenmiş dil modeli adı verilen yapıyı eğitim aşamasında kullanılmaktadır. Bu yapıda girişteki bazı belirteçler rastgele seçilerek maskelenmektedir, model ise bu maskelenen belirteçleri bağlama göre doğru tahmin etmeyi hedeflemektedir (Devlin vd., 2018).

2019). Çalışmada analiz için DistilBERT-TR** ön eğitilmiş modeli kullanılmaktadır.

ELECTRA: BERT modeline göre daha az hesaplama uygulayarak önceden eğitmek için kullanılmaktadır. Modelin amacı "gerçek" olan belirtecin "sahte" belirteç ile değiştirilip değiştirilmediğini tespit etmektir (Clark vd., 2020). Şekil 3'te ELECTRA modelinin yapısı gösterilmiştir. Şekil incelendiğinde "cooked" kelimesi maskelenmiştir ve küçük MLM aracılığıyla tahmin edilen kelime "ate" olmuştur. Bu kelimenin değiştirildiğini ise ELECTRA modeli "replaced" olarak tespit etmiştir.



Şekil 3. ELECTRA modelinin yapısı

ELECTRA modelinin, BERT modelinin maskelenmiş dil modellemesi yapısına göre, hesaplama açısından daha verimli olduğu gösterilmiştir (Clark vd., 2020). Çalışmada spam e-postaları sınıflandırma görevi için ELECTRA-TR†† ön eğitilmiş modeli kullanılmaktadır.

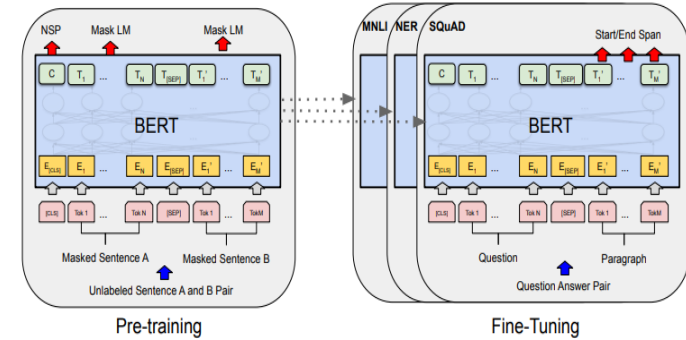
ALBERT: BERT modelinde bellek limiti ve iletişim ek yükünü sorunu eğitim aşamasında sorun oluşturmaktadır. Bundan dolayı BERT'e göre daha az parametreye sahip ALBERT modeli geliştirilmiştir. Geliştirme aşamasından iki tane parametre azaltma (çarpanlara ayırarak gömme, katmanlar arası parametre paylaşımı) tekniği uygulanmıştır. Bu iki teknikle beraber ALBERT için parametre sayısı oldukça azaltılmaktadır (Lan vd., 2019). Böylece model daha az parametre ile hızlı eğitilebilmektedir. Çalışmada ALBERT-TR‡‡ ön eğitilmiş modeli kullanılarak analiz işlemi gerçekleştirilmektedir.

3. Deneysel Çalışmalar

Çalışmanın ilk aşamasında veri seti üzerine ön işlemler uygulanmıştır. Uygulanan ön işlemler sonucunda veri setinin yapısı, hacmi değişmiştir. Bu ön işlemler arasında email ve website adreslerinin belli formatta yazılması, kelimelerin kökünün alınması işlemleri veri setinin yapısını değiştirirken, etkisiz kelimelerin silinmesi işlemi veri hacmini azaltmaktadır. Tablo 2'de veri seti üzerindeki kelime sayısının ön işlem sonrası değişimi gösterilmiştir. Tablodaki veriler incelendiğinde, ön işlem sonrası kelime sayısında düşüş gözlemlenmiştir. Bu düşüş veri hacmi için toplam kelime sayısında yaklaşık %25 iken, eşsiz (unique) kelime sayısında ise yaklaşık %64 olmuştur. Eşsiz kelime sayısında aşırı düşüşün nedeni kelimelerin kökünün alınması ile kelimelerin aynı biçime dönüştürülmesidir.

Tablo 2. Makine öğrenme yöntemlerinin başarıları

İşlem		Kelime Sayısı
	Toplam	66870



Şekil 2. BERT modelinin işleyişi

Şekil 2'de BERT modelinin işleyişi gösterilmiştir. BERT modeli ön eğitim ve ince ayar olmak üzere iki aşamadan oluşmaktadır. Ön eğitim (pre-training) aşamasında, model farklı ön eğitim görevleri için etiketlenmemiş veriler kullanılarak eğitilmektedir. İnce ayar (fine-tuning) aşamasında ise önceden eğitilmiş parametreler ile başlatılan modelde tüm parametreler seçilen göreve göre etiketli veriler ile uyarlanmaktadır (Devlin vd., 2018). BERT modeli, sınıflandırma, görüntü işleme, boşluk doldurma gibi birçok görevde kullanılabilir. Bunun için eğitilmiş ve kullanılabilir birçok ön-eğitilmiş DM mevcuttur. Türkçe içinde ön-eğitilmiş BERT-TR§ modeli kullanılarak bu çalışmada analiz gerçekleştirilmektedir.

DistilBERT: BERT modelinin farklı bir versiyonu olarak önerilmiş bir modeldir. BERT modelinden farklı olarak eğitim öncesi bilgi ayrıştırma işleminden yararlanarak BERT'e göre boyutu daha küçük ve daha hızlı DM elde edilmiştir (Sanh vd.,

§ <https://huggingface.co/dbmdz/bert-base-turkish-uncased>

** <https://huggingface.co/dbmdz/distilbert-base-turkish-cased>

†† <https://huggingface.co/dbmdz/electra-base-turkish-cased-discriminator>

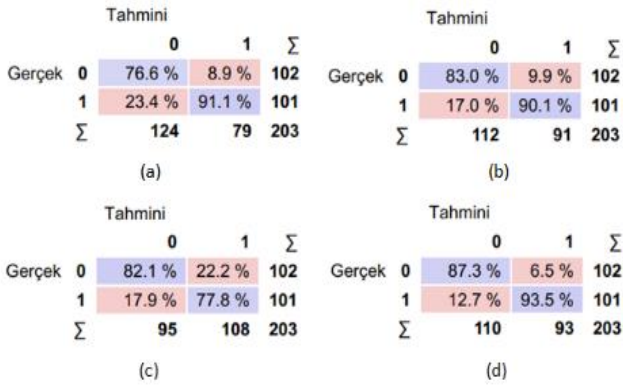
‡‡ <https://huggingface.co/loodos/albert-base-turkish-uncased>

Ön İşlem Olmadan	Eşsiz	19162
Ön İşlem Sonrası	Toplam	50112
	Eşsiz	6892

Çalışmada eğitim ve geçerleme olarak ayrılan veri setlerinden, eğitim seti makine öğrenme yöntemleriyle eğitilerek geçerleme seti ile test edilmiştir. Türkçe spam e-postaların tespitinde kullanılan makine öğrenme yöntemlerine ait sonuçlar Tablo 3'te gösterilmiştir. Sonuçlar incelendiğinde en başarılı makine öğrenme yöntemi doğruluk ve F1-ölçüm değerleri için YSA olmuştur. Ayrıca yöntemlerin ayrı ayrı etiketler için analizlerini içeren karışıklık matrisi Şekil 4'te verilmiştir. Makine öğrenme yöntemleri arasında RO hariç diğer yöntemler 1 numaralı (spam) etikete sahip verileri daha doğru sınıflandırmıştır. RO ise 0 numaralı (ham) etikete sahip verileri daha başarılı sınıflandırmıştır.

Tablo 3. Makine öğrenme yöntemlerinin başarısı

Yöntem	Eğitim Süresi(sn)	Doğruluk (%)	F1-Ölçüm (%)
RO	6.90	79.80	79.78
YSA	9.76	90.15	90.13
NB	13.78	86.21	86.17
LR	37.96	82.27	82.05



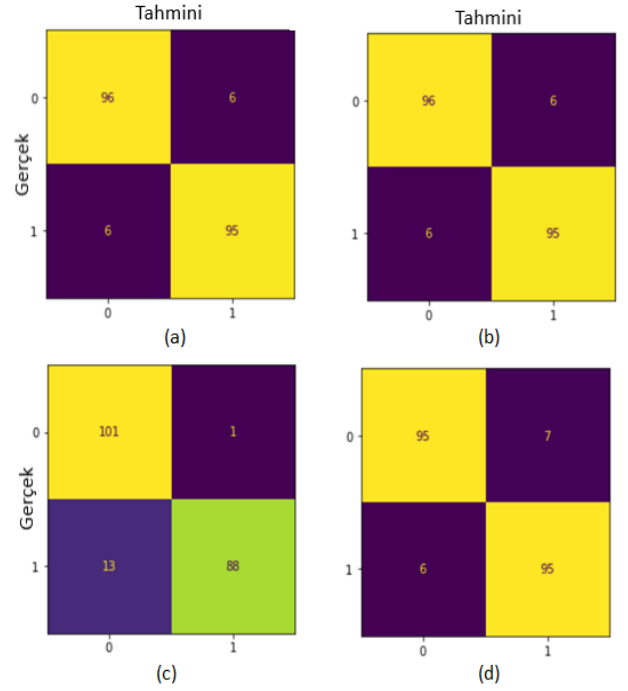
Şekil 4. Makine öğrenme yöntemlerinin karışıklık matrisleri (a) LR (b) NB (c) RO (d) YSA

İkinci aşamada aynı eğitim ve geçerleme seti ile DM'nin analizi gerçekleştirilmiştir. Türkçe için ön-eğitilmiş BERT-TR, ALBERT-TR, ELECTRA-TR, DistilBERT-TR modelleri için analiz sonuçları Tablo 4'te verilmiştir. Tablodaki veriler incelendiğinde BERT-TR ve ELECTRA-TR modelleri en başarılı DM olmuştur. Ayrıca DM için hangi etiketleri daha doğru yanıtladığına dair karışıklık matrisi Şekil 5'te gösterilmiştir. Şekil 5'teki sonuçlar gösteriyor ki ALBERT-TR modeli haricinde tüm modeller her iki etiketi de dengeli şekilde doğru sınıflandırmıştır. Ancak ALBERT-TR modeli 0 etiketini (ham), 1 etiketine (spam) göre daha doğru tahmin etmiştir.

Tablo 4. Türkçe spam e-postaların tespiti için dil modellerinin başarısı

Yöntem	Doğruluk (%)	F1-Ölçüm (%)
BERT-TR	94.08	94.0
ALBERT-TR	93.10	93.55
ELECTRA-TR	94.08	94.0

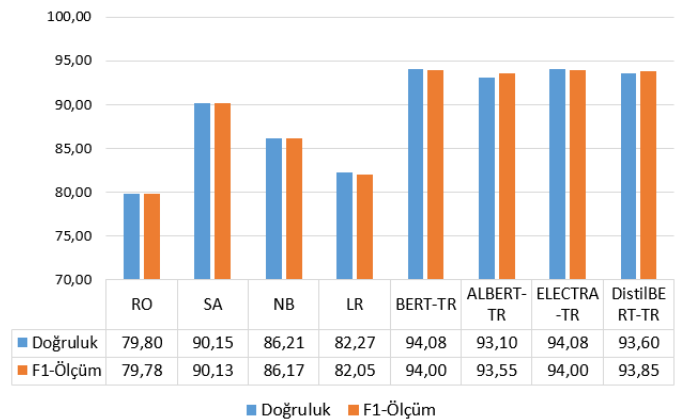
DistilBERT-TR	93.60	94.0
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Şekil 5. Dil modellerinin karışıklık matrisleri (a) BERT-TR (b) ELECTRA-TR (c) ALBERT-TR (d) DistilBERT-TR

4. Tartışma

Türkçe dili ile alakalı çalışmalar az olduğu ve makine öğrenmesi yöntemlerine ek olarak DM'nin Türkçe spam e-posta sınıflandırmada etkisinin gösterilmesi için bu çalışma uygulanmıştır. Veri seti ilk olarak çok fazla sayıda çalışmada kullanılan makine öğrenme yöntemleri ile analiz edilmiştir. Analizler sonucunda makine öğrenme yöntemlerinde YSA %90.15'lik doğruluk değeri elde etmiştir. Bu analize ek olarak, DM'nin Türkçe spam e-posta sınıflandırmadaki başarısı analiz edilmiştir. Aynı yapıdaki veri seti (eğitim, geçerleme) ile önceden belirtilen ön-eğitilmiş DM analizde kullanılmıştır. DM, derin öğrenme ve anlamsal yapı içermesinin katkısıyla spam e-postaları sınıflandırmada makine öğrenme yöntemlerine göre %3 ile %4 arasında doğruluk değeri artışı sağlamıştır. Makine öğrenme yöntemlerinin ve DM'nin doğruluk değerleri ve F1-ölçüm değerleri Şekil 6'da verilmiştir. Grafik incelendiğinde tüm DM, makine öğrenme yöntemlerinden daha iyi sonuç vermiştir. Makine öğrenme yöntemleri arasında YSA en iyi doğruluk değeri elde ederken, dil modelleri arasında BERT-TR ve ELECTRA-TR



Şekil 6. Tüm makine öğrenme yöntemleri ve dil modellerinin analiz sonuçları

modelleri %94.08 doğruluk elde ederek en başarılı sonuçları vermiştir. Bu açıdan bakıldığında, çalışma Türkçe spam tespiti için DM'nin olumlu etkisini göstermede öncülük etmektedir.

5. Sonuç ve Gelecek Çalışmalar

Spam tespiti, email, twitter gibi sosyal ağlarda kullanıcıların kandırılmasını ve suçlara karıştırılmasını önlemek için büyük önem taşımaktadır. İngilizce dilinde bu konuyla ilgili birçok çalışma bulunmaktadır. Bu çalışmada Türkçe spam e-postaların tespiti için makine öğrenme yöntemleri ve DM kullanılarak başarıları analiz edilmiştir. Türkçe spam e-postaların tespiti için DM içeren çalışma olmadığı için DM, Türkçe literatüre katkı sağlama açısından tercih edilmiştir. Böylece DM makine öğrenme yöntemleri ile karşılaştırılmış ve DM'nin sınıflandırmadaki etkisi gösterilmiştir. Ayrıca makine öğrenme yöntemleri ve DM'nin başarıya etkisi karşılaştırılmıştır. Deneysel çalışmaların sonucunda tüm DM, makine öğrenme yöntemlerinden daha iyi doğruluk değeri vermiştir.

Gelecek çalışmalarda duygu analizi, haber sınıflandırma, içneleme tespiti gibi farklı sınıflandırma görevleri için Türkçe dilinde dil modelleri ile çalışmalar yapılması ve Türkçe literatüre katkı sağlanması hedeflenmektedir.

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Solar Radiation Forecasts and a Tiny House PV Off-Grid System

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Abstract

In this article, which is discussed at a time when initiatives towards renewable energy sources are increasing and reducing fossil fuel consumption; the factors that need to be examined for the installation of an off-grid solar panel system were examined and in line with the data obtained, a system was designed for a tiny-house. Off-grid system with 10KWh power consumption with optimum irradiance data has been found how many square meters of PV system will be needed to operate it. How to meet the stable 10KWh need for the worst month, the amount of battery capacity required has been examined. A system inventory has been allocated.. A provenciet of Pamukkale in Turkey, with latitude of 37.89°, was chosen for the solar panel installation; It is aimed to meet all the electricity needs of the house, which was built in a forest area 8 km away from the mains, with the solar panel system to be installed. From theory to practice with an academic approach as well as solar energy sector jargon; in this article, includes a two-way study. A solar panel system was installed in line with the data obtained and the 7600Wh value that the house to be built would need, and 29 batteries integrated into the system was sized for cases where the system could not provide sufficient energy through the sun with a 1% probability. Thus, the design of the optimum "Solar Energy System" desired for a certain location and compatible estimation calculations will be able to provide examples of this study.

Keywords:Solar Insolation, Solar Radiation, Solar Angle Calculations, PV system, Solar Energy Off-Grid System.

Güneş Radyasyonu Tahminleri ve Şebekeden Bağımsız PV'li Kır Evi

Öz

Yenilenebilir enerji kaynaklarına yönelik girişimlerin arttığı ve fosil yakıt tüketimini azalttığı bir dönemde ele alınan bu yazıda; Şebekeden bağımsız güneş paneli sistemi kurulumu için incelenmesi gereken faktörler incelenmiş ve elde edilen veriler doğrultusunda güneş paneli sistemi ile küçük bir ev için sistem tasarlanmıştır. Optimum ışınım verileri ile 10KWh güç tüketimine sahip şebeke dışı sistem, onu çalıştırmak için kaç metrekairelik bir PV sistemine ihtiyaç duyulacağı bulunmuştur. En kötü ayda sabit 10KWh ihtiyacının nasıl karşılanacağı, gerekli akü kapasitesi miktarı incelenmiştir. Bir sistem envanter tahsisi yapılmıştır. Güneş paneli kurulumu için Türkiye'de Pamukkale'nin 37.89° enlemlili bir ilçesi seçilmiştir; Şebekeye 8 km uzaklıkta ormanlık alana inşa edilen evin kurulacak güneş paneli sistemi ile tüm elektrik ihtiyacının karşılanması hedefleniyor. Güneş enerjisi sektörü jargonunun yanı sıra akademik bir yaklaşımla teoriden pratiğe; Bu yazıda iki yönlü bir çalışma yer almaktadır. Elde edilen veriler ve yapılacak evin ihtiyaç duyacağı 7600Wh değer için güneş paneli sistemi kurulmuş ve sistemin yeterli enerjiyi sağlayamadığı durumlar için sisteme entegre 29 adet batarya %1 olasılıkla boyutlandırılmıştır. Böylece bu çalışmanın, belirli bir lokasyon için istenilen optimum "Güneş Enerjisi Sistemi"nin tasarlanması ve uyumlu tahmin hesapları örnek sunabilecektir.

Anahtar Kelimeler: Güneş Işığı, Güneş Radyasyonu, Güneş Açısı Hesapları, PV sistemi, Güneş Enerjisi Şebekeden Bağımsız Sistem.

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1. Introduction

As it is known, in 2021, there is a need for decarbonization in energy-intensive sectors and an acceleration in energy transformation strategies regarding fossil fuel use, especially at the global level. It is also observed that the global energy transformation; This can be achieved through the creation of appropriate policies, financial models, and the development of cutting-edge technologies. Further investment in low-carbon energy technologies and the development of smart electricity grids will help equip what is being done with green systems. Thanks to the combination of storage and green hydrogen technologies by increasing the capacity of renewable energy sources, it seems possible to accelerate the aforementioned energy transformation and bring the costs of these technologies to public dimensions within 5-10 years. The renewable energy systems, which are specially designed according to the installation site and usage load, contribute to sustainable energy consumption with environmental friendly and low waste outputs [1-5, 14- 16].

An important factor in the design of PV systems is the angle of inclination created by the ground where the PV panel is located, the angle between the ground and the panel. The most suitable tilt angle, which is of great importance in terms of the amount of radiation absorbed, is determined according to the latitude angle of that region. Of course, it will be necessary to take into account seasonal factors in the angle of slope, and this allows to get rid of the burden of seasonal factors such as rain and snow, and thus to obtain efficiency [6-10].

In this study, collecting meteorological data in Pamukkale's coordinate according to the defined conditions and establishing a PV panel system that is suitable for the climatology of the region and that will meet the energy needs provides resource management and will environmentalist contribution.

For this, the situation of the region has been analyzed primarily by using data blocks that have been measured for many years. Then, the solar radiation received by the region in certain periods has been calculated. The best and worst months of the year determined. Besides, temperature, surface angle etc. factors have also been considered in the installation of this system.

1. Materials and Method

Before starting to design, it is necessary to determine in which situations a system will be designed to be used. Then it is necessary to compile and analyze the necessary information. In this study, due diligence will be made for a tiny house. Data will

be calculated based on the fact that this house has been installed for a little longer than a few days. The designed system will be carried out in line with the possible and electricity use-based needs of the house where were natural wonder travertine region, located in Pamukkale provenciet of city of Denizli in Turkey [17].

In light of all the above mentioned considerations, after collecting and evaluating all the information, tiny-house has been designed the PV off-grid system. Furthermore, in this study, via PVGIS, a part of calculates the performance of PV systems that are not connected to the electricity grid but instead rely on battery storage to supply energy when the sun is not shining [13].

Energy Need: To estimate the electricity need of the tiny house, a list of items that need daily electricity consumption is created. The electricity consumption of these items is investigated and the total daily consumption is calculated.

Energy Sources and Devices: It should be ensured that sufficient energy source is used for the independent system. After the energy requirement has been calculated, a list is created to identify suitable devices for the energy required. At this stage, the performance, cost and ease of installation of the devices can be evaluated. Solar panels may be insufficient due to a temporary system and high energy usage requirement. In addition, the use of generators is also essential.

2.1. Location Information

Pamukkale in Denizli-Turkey, which was included in the World Heritage List by UNESCO in 1988, is a natural wonder location with its travertines. In this area, there is the ancient city of Hierapolis. It is a location that is visited by many tourists who love nature and landscapes and is tried to be protected.

Pamukkale, a visual feast created by thermal waters in Turkey's Aegean Region, Büyük Menderes basin, with a series of earthquakes 400 thousand years ago, is a rare place in the world where the picturesque travertine was formed over thousands of years [17].



Figure1. Location of Pamukkale, Türkiye on the map [18]

Table 1. Data for Pamukkale Provencie in Turkey

Location Data	Consumption Data
City: Denizli Provencie: Pamukkale Location: Denizli, Turkey Coordinate: DMS 37° 55' 26" N, 29° 7' 24" E (Decimal: 37.923889, 29.123333) Elevation Above Sea Level: 251.712 m Installation Type: Off-Grid Azimuth: -20 TiltedAngle:20 PV technology: CrystallineSilicon PV Panel: 330Wp/PERC-MONO Half-Cut (60 pcs)	Daily: 10 KWh Monthly: 300 KWh

2.2. Meteorological Information

Pamukkale region has climate condidations that summers are hot-dry-clear, and winters are cold-rainy-partly cloudy. The temperature normally varies between 6°C and 27°C throughout the year, rarely below -3°C in winter session and above 39°C in summer session [19-21].

Much of the meteorological data is from NASA's Prediction of WorldwideEnergy Resource (POWER) Data obtained from the Data Access Viewer Enhanced (DAVe) project. In addition, data were obtained from the General Directorate of Meteorology, PhotovoltaicGeographical Information System (PVGIS) and WeatherSpark [19-22].

2.3. Calculations

In order to size the solar panel to be installed in the Pamukkale region and to get the desired efficiency throughout the year, the hourly and daily Watt (W) values per square meter from the sun to the desired location were first obtained theoretically. For this, first of all, the declination angle, which is the declination angle, was calculated by Equation 1.

$$\delta \approx \text{sgn}(L) \delta_0 \sin ([284 + n] 365 \times 360 \circ) \quad (1)$$

Zenith angles of the days with known declination angles were also calculated in the 'solar noon' (w=0) by Equation (2) and illustrated to the table in the result section of this paper.

$$\cos(\theta Z) = \sin(\delta) \sin(|L|) + \cos(\delta) \cos(|L|) \cos(\omega) \quad (2)$$

How many degrees our panel should have for the worst month was calculated with the python code written using the Equation3.

$$\tan(\beta_{opt}) = \frac{B_{ter} \tan(\theta_z)}{B_{ter} + \frac{1}{2}D(0) - \frac{1}{2}\rho[B(0)+D(0)]} \quad (3)$$

In the light of all these data, the hourly horizontal flux values reaching the earth on average are presented as a graphic that shows a character suitable for the effect of the Zenith angles calculated in the "solarnoon" due to the declination angles of the moons.

Once the appropriate tilt angle has been found for each day of the year, the most logical option to choose a fixed tilt angle is to choose the worst month of the year. Because, the system will be need to optimize the sunlight that comes in that month the most. Thus, 47°, which is the average value of the inclination angles inthe worst month, namely in December and January, was chosen as the inclination angle of our panel. The Optimal tilt angle calculation formula is given by the Equation 4 which includes latitude of Φ in northern hemisphere.

$$\beta = 1.3793 + \Phi(1.2011 + \Phi(-0.014404 + \Phi 0.000080509)) \quad (4)$$

With a separate discussion, it is also predicted that the optimum solar panel angle is 47.89°, with the Latitude+10 degree approach, for winter use only in Denizli/Pamukkale.

On the other hand, for the tiny house, an inventory of electrical appliances was created by taking into account the different working areas and durations of the existing electrical appliances, and the total daily needed Wh was calculated as shown in table 2 in the result section of this paper. The Total Required Power equals to Quantity multiple by Unit-hour Watt with product Hours.

While sizing the battery, the solar panel system to be installed is designed to meet the electricity needs of the house to be built for 3 days, assuming that the desired electrical energy cannot be obtained with a 1% probability throughout the year (cloudy days, etc.).In other words, the energy produced in 3 days of the year cannot meet the energy demanded to be used from daily solar energy at the rate of $3/365 \cong 1\%$ per year, according to the household inventory. Batery size has been calculated by Equation 5.

$$Q = \frac{\text{Total Wh/d used by appliances} \times \text{Days of usage}}{0,85 \times 0,6 \times \text{nomnal battery voltage}} \quad (5)$$

The main considered parameters for the battery capacity calculated in Ah are; daily energy need, the number of days the system will be fed only by the battery, the losses in the battery, the DoD value and the battery voltage (V). When these values are 9500Wh, 3, 0.85, 0.6 and 24, respectively, it is concluded with Equation 5 that the battery capacity should be 2328 Ah.

3. Results and Discussion

3.1. Calculation Results

Analysis of typical meteorological datasets for Pamukkale location as mentioned above was fair. Horizontal flux values were extracted for all months. The PV system has been sized to provide the necessary energy for every hour & day & month of the year. The optimum tilt angle of the panel was determined according to the worst month of the year. The daily values of the total horizontal flux were calculated and the standard deviation of the values of the months, namely 28, 30 and 31, was also found. An inventory of all electrical workers in the house was

made. Load profile was determined for all days and months of the year. PV panel size and load loss probability were taken into account. The power of the PV panel was so adjusted according to the home inventory that there was a 1% chance of draining the battery. For 3 days of the year, the battery of the panel was not enough, so 3/365 had a probability of running out of battery at a rate of approximately 1/100.

The outputs obtained as a result of all these calculations will be presented in this section. In this context, first of all, Zenith angles for days with known computational declination angles are calculated as shown in the Table 2. The tiny house electric appliances evaluations are illustrated in the Table 3.

Table 2. Data for Pamukkale Provençie in Turkey

Month	δ (°)	θ_z (°)	Midday
Jan	-21,28	59,17	15
Feb	-13,6	51,49	45
Mar	-2,46	40,35	75
Apr	8,48	29,41	105
May	18,76	19,13	135
Jun	23,26	14,63	165
Jul	21,69	16,2	195
Aug	14,47	23,42	225
Sep	3,48	34,41	255
Oct	-8,41	46,3	285
Nov	-18,1	56	315
Dec	-23,1	61	345

Table 3. Tiny House Eelectrical Inventory in Pamukkale Provençie in Turkey

Apliances	Wh	Usage hours	Total Wh
Refrigerator	1000W	24	2400
TV	75W	2	150
Airconditioner	950W	5	4750
Laptop	50W	5	250
WifiRouter	10W	5	50
			7600Wh

When the average hourly horizontal flux data in the Figure 2 is multiplied by the average day length of each month, the daily average irradiance value per square meter is obtained.

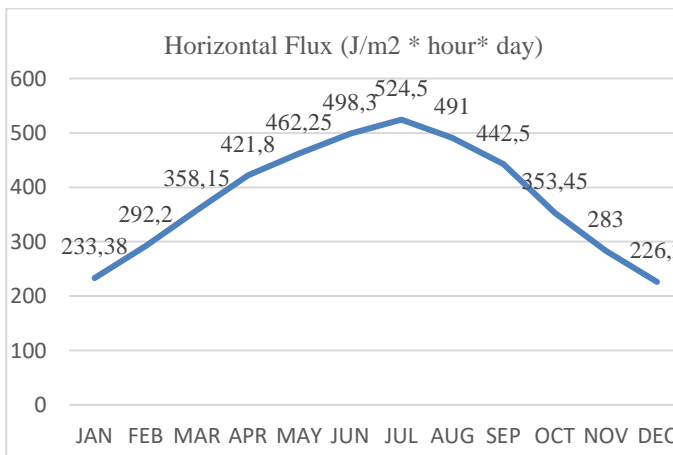


Figure 2. The hourly horizontal flux values reaching the earth on average

3.2 Other Online Sources Results

As mentioned above parts, the data sets are from NASA's Prediction of WorldwideEnergy Resource (POWER), the General Directorate of Meteorology, and PhotovoltaicGeographical Information System (PVGIS) and also WeatherSpark. The coldest month in Pamukkale is January; the average low temperature in this month is 2°C while the high temperature is around 12°C [20-24].

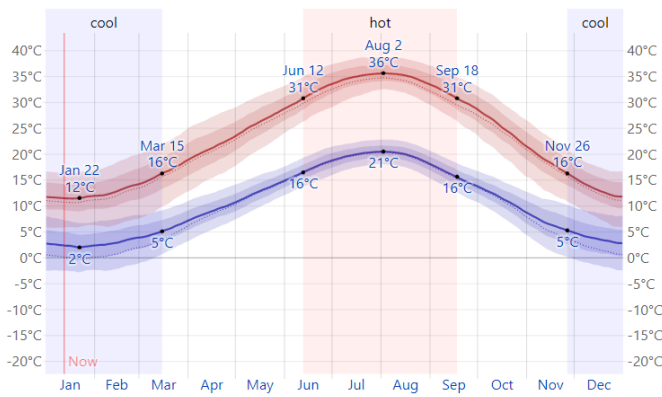


Figure 3. Average High (red line) and Low (blue line) Temperature in Pamukkale. The thin dotted lines are the corresponding average perceived temperatures [24]

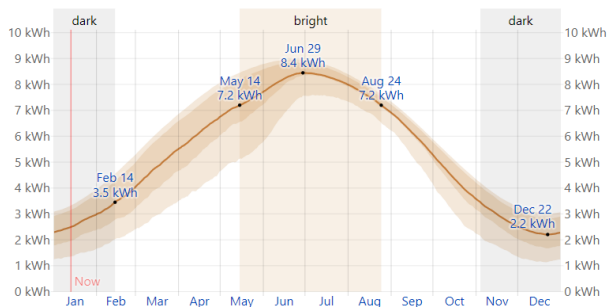


Figure 4. Average Daily Incident Shortwave Solar Energy in Pamukkale from Online Evaluation [24]

Figure 3 and Figure 4 show that the hot season in Pamukkale is about 3 months with a daily average high temperature above 31°C; On the other hand, it is seen that the cold season lasts for 4 months and the daily average temperature is the lowest 2°C and the highest 12°C.

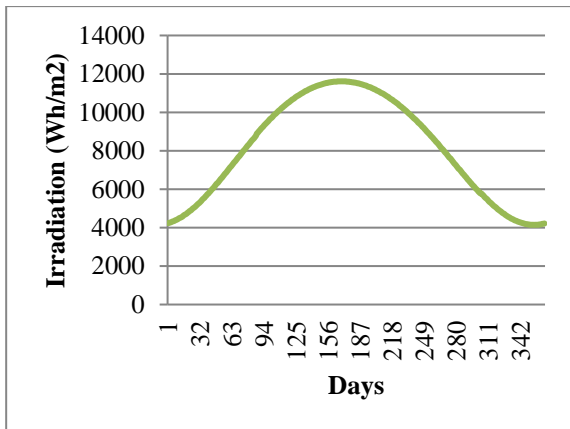


Figure 5. The variation of average solar radiation by days (for clear skies)[22].

The radiation distribution graph for Pamukkale, which was created using the datasets obtained from NASA, is given in figure 5. Efficiency estimation of solar power generation with data from PVGIS-5 is shown in figure 6.

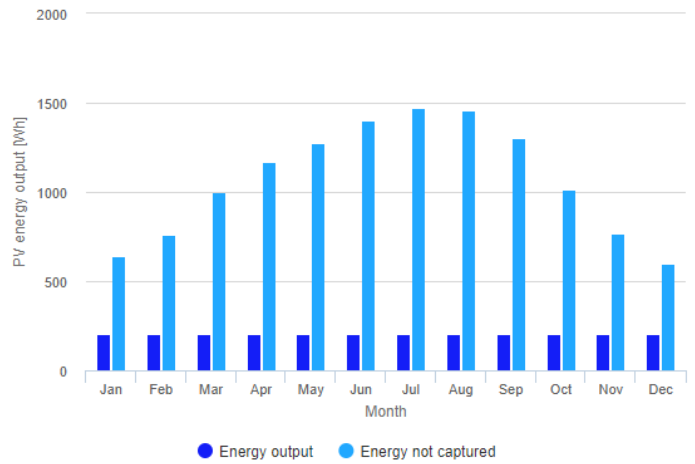


Figure 6. Power production estimate for off-grid PV system via PV-GIS[23]

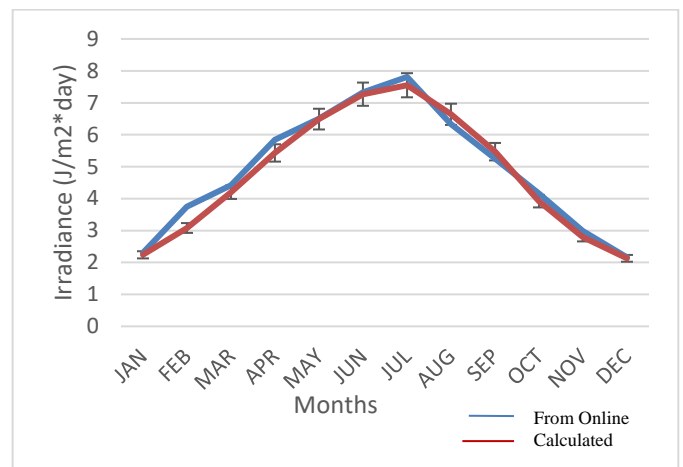


Figure 7. Comparison of the variation of average solar radiation by month (for the whole sky)

The compliance behavior between the obtained data sets and the calculated data was examined and presented in Figure 7. While the deviation of the data is consistent, slight deviations of the calculation results from the online values have been observed, but these deviations are negligible.

4. Conclusions and Recommendations

It seems that Pamukkale, which is in the northern hemisphere, has the maximum clearness index in June and the least in December and January. This correlates with the reaching radiation and effective irradiance.

In this study, Python programming language was used for calculations.

When making calculations:

- Transferring libraries to be used in calculations,
- Functions that calculate monthly-daily averages using the GHI and Clearsky GHI data in the data sets,
- Graphs to show the amount of radiation reaching from the sun created.

As a result, based on the meteorological data, it is determined that the month with low solar radiation is December and January for the PV panel of the tiny house in Pamukkale. It has been determined, and from the horizontal flux data, the

optimum panel angle is about 47 degrees. The clearness index has been determined that it decreases to around 5% in winter months. Also, taking into account the 1% risk of battery loss, in December and January it has been calculated and determined that the required panel tilt angle for the tiny house will be approximately 47 degrees.

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Developing and Evaluating an Artificial Intelligence Model for Malicious URL Detection

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Abstract

Today, the increased use of the internet has become important in our lives and new communication technologies, social networks, e-commerce, online banking, and among other applications have a significant impact on the promotion and growth of business. In our study, we aimed to work with a large dataset and to achieve the best results in detecting malicious URL addresses using an artificial intelligence model. A 7-layer RNN model was used in the study, and two similar national and international datasets were combined and merged to create a big new dataset consisting of 579,112 URL addresses. Then, this new data set is divided into training and test sets. The first data set was trained at the model and then the second data set was processed test. When this data set was processed in our model, we achieved a success rate of over 91%. This rate is a very good result of detecting malicious url addresses. Your contribution with this work is significant in developing more effective methods for detecting harmful sites as internet usage increases, parallel use of artificial intelligence models makes detection of such sites more effective and potentially assist users in protecting from various types of cyber-attacks is targeted.

Keywords: Malicious URL, Cyber Security, Artificial Intelligence, RNN Model, Accuracy

Kötücül URL Tespitinde Yapay Zekâ Modeli Geliştirme ve Değerlendirilmesi

Öz

Günümüzde internetin her geçen yıl kullanımının artmasıyla hayatımızda çok önemli bir hale gelmiş ve yeni iletişim teknolojileri, sosyal ağlar, e-ticaret, çevrimiçi bankacılık dâhil olmak üzere birçok uygulamada işlerin teşvik edilmesinde ve büyütülmesinde önemli bir etkiye sahiptir. Yaptığımız çalışmada, kullandığımız yapay zekâ modeli ile zararlı URL adreslerini tespitinde büyük bir veri seti ile çalışılması ve en iyi sonucu elde etmek hedeflenmiştir. Çalışmada 7 katmanlı RNN modeli kullanılmış, modelde çalıştırmak üzere ulusal ve uluslararası birbirine benzer iki adet veri seti birleştirilmiş, 579.112 adet URL adresinden oluşan devasa bir yeni veri seti oluşturulmuştur. Daha sonra bu yeni veri seti eğitim ve test setlerine ayrılmıştır. İlk olarak veri setimiz modelde eğitilmiş ve ardından ikinci veri seti test edilmiştir. Bu veri seti modelimizde işlendiğinde %91'in üzerinde bir başarı oranı elde edilmiştir. Bu oran zararlı url adreslerini tespit etmesinde çok iyi bir sonuçtur. Bu çalışmamızla, internet kullanımını arttıkça zararlı sitelerin tespiti için daha etkin yöntemlerin geliştirilmesine önemli katkı sağlamakta, yapay zeka modellerinin paralel kullanımı bu tür sitelerin tespitini daha kolay hale getirmekte olup ve potansiyel olarak kullanıcıların çeşitli siber saldırı türlerinden korunmalarına yardımcı olması hedeflenmektedir.

Anahtar Kelimeler: Kötücül URL, Siber Güvenlik, Yapay Zekâ, RNN, Doğruluk

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1. Introduction

The use of the internet has become increasingly widespread and important in our lives. New communication tools and social networks have increased the use of the internet. [1]. In particular, the Covid-19 pandemic that swept the world in December 2020 further accelerated the process of internet use and widespread use, and the number of users roaming the internet has increased exponentially [2]. It is estimated that by 2022, the global number of internet users will approach 5 billion, with 2 billion websites. Banks, educational institutions, universities, businesses, and academic and scientific studies are all open to internet use and data sharing of all kinds. As the internet has become so widely used and indispensable in our lives, secure internet use has come to the forefront. As the number of users and websites on the internet has increased, cybercriminals have started to use website addresses, or URLs, for attacks. This malicious use of URLs is a major threat to cybersecurity and is referred to as "malicious URL." The rate of malicious URLs has increased significantly in recent years, the use of artificial intelligence-machine learning techniques has become increasingly important in detecting and preventing these attacks [3].

Chen et al. processed a dataset consisting of 200,000 URLs, including 100,000 normal URLs and 100,000 Malicious URLs, using the YOLO algorithm on an artificial neural network [4]. The features extracted were used to evaluate malicious URLs by a bidirectional LSTM recurrent neural network algorithm, and it was claimed that a success rate of 90% was achieved [5]. Ahammad et al. investigated lexical and domain-based features using random forests with a dataset of 35,300 URLs, comparing Decision Tree, Light GBM, Logistic Regression, and Support Vector Machine. They found that the Light GBM algorithm had the best result, with a success rate of 86% [6].

Kumar et al. designed a static feature-based Kaya using a dataset of 350,000 URLs, claiming a success rate of 90% [7]. Bharadwaj et al. claimed to have reached a success rate of 89% using a GloVe-based YSA model on 227,909 URLs [8]. Vecile et al. claimed a 79% accuracy rate using machine learning (LSTM) models on a dataset of 68,908 URLs [9]. Zahao et al. processed 300,000 URLs using their own detection algorithms, achieving a success rate of 90% [10]. Paydey et al. claimed a success rate of 85% using a machine learning-based deep learning model on a dataset of 20,000 URLs [11].

In this study, the following contributions have been made to the solution of the problem of detecting malicious URL addresses:

- A 7-layered deep neural network RNN model has been designed using features obtained from URL address information and with the necessary optimization processes.
- According to the studies in the literature review, a wider and universal data set is used and the availability and performance of the model is verified through the trained data set.
- It has been shown that the model used has a higher Accuracy rate than other models.

In the second section of our study, the working environment and the method used are discussed. In the third section, the URL structure, the data set used in the study, the Model Architecture, and the training of the model. In the fourth section, testing of the model, evaluation metrics, and comparison of the method are carried out. In the fifth section, the results obtained are evaluated.

2. Experimental Environment

2.1. Working Environment

In this study; an i5-7300U 2.60 GHz processor and 8 GB memory computer was use for the implementation. The Windows 10 Pro operating system was installed on the computer used and a wired internet connection was provided. Python was used as the programming language and colab.research.google.com was used as an internet-based platform.

2.2. Method Used

The training and testing of the data set used was carried out. It is showing the procedures of the study carried out figure 1. The data set section, where the data sets are combined, the processing section where the data is mixed, the model section where the RNN model is created, tokenizer, and epoch are made and artificial neural network section where the training is carried out and the results are obtained, are formed.

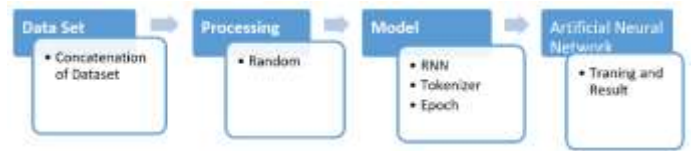


Figure - 1 URL Processing Diagram

PROPOSED SYSTEM

2.3. URL Structure

URL (Uniform Resource Locator) is the 'address' of any data such as a file or web page on the internet. It addresses specifies the source of the data. URLs consist of 4 parts [12]. These parts is showing at the figure 2.

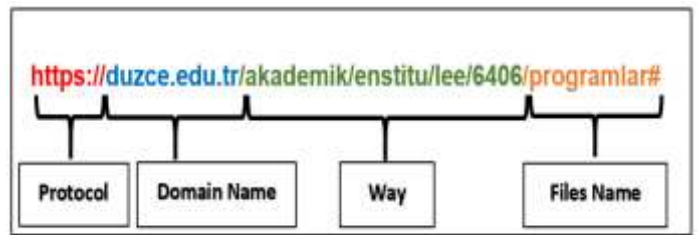


Figure - 2 URL Structure

URL addresses consist of four main parts; the first part is the protocol section and the connection type is determined. The "S" is for the security protocol. The second part is the domain name of the URL address. In the third part, the link path of the file within the URL address is shown. In the example, the link path in the file path within the institute subfolder in the academic main folder is specified. The fourth part is the name of the file.

2.4. Data Set Structure

The performance of the data set is largely dependent on the size of data set and the fact that it's a more comprehensive international data. Great care was taken in preparing our real data set.

Table - 1 URL Data Set Number

URL Data Set	Category	Number of URLs
CC0: Public Domain License	Mixed	411,247
SOME	Malicious	167,865
Total		579,112

Malicious URL: % 37 Good URL: % 63

Looking at Table 1, you can understand number the URLs and rates of malicious URLs. When preparing our final data set, a total of 579,112 URLs were used, including 411,247 URLs distributed by Kaggle under the CC0 Public Domain License [13] and 167,865 malicious URLs distributed by the National Cyber Intervention Center (SOME) [14] in the malicious links section on September 12, 2022. Thus, a large national and international data set was reached. Since the information in both data sets is the same and has the same purpose, they were combined as a single data set. The with new data set, is intended to create a wider and transparent data set with 37% malicious URL addresses and 63% non-malicious URL addresses.

2.5. Model Architecture

We completed the training of our data set by inserting it into a 7-layered RNN model and tried to reach the real accuracy value by processing our test data through the trained RNN model.

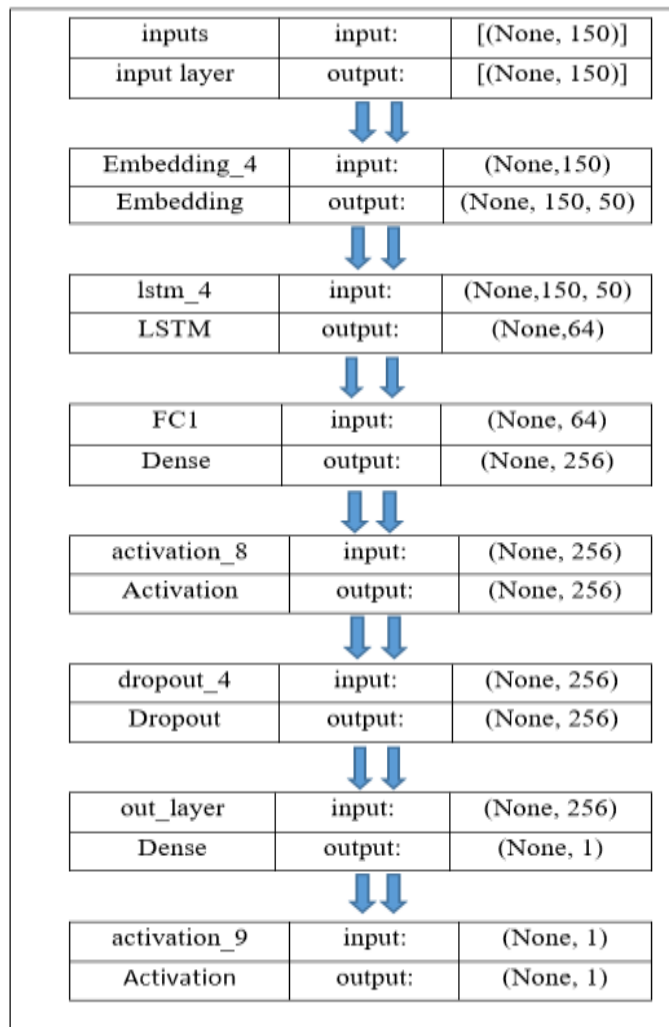


Figure - 3 Model Flow

Let's briefly describe the flow of our 7-layered RNN model. In the model creation, an embedding layer that can generate a maximum of 150 characters and a maximum of 50 words, a LSTM layer that generates a 1x64-dimensional feature vector, which enables deeper learning and reduces errors, and a 256-node output layer were used [15]. The relu function was used as the activation function in the output layer because I used multi-class data. Then, the binary_crossentropy was used as the loss function, the Adam algorithm as the optimization algorithm, and the accuracy as the metric. The test success was measured by repeating 10 epochs in the model.

2.6. Model Training

The data sets from two different sources were combined. In this study, the RNN model of artificial intelligence method was applied in Python. The newly prepared data set was defined in the system, the URL addresses were mixed, and then they were divided into training and test sets. These URL addresses allocated 20% of them (115,822) to the training set and 80% to the test set. In this way, the data sets were more accurately trained and the most accurate result was tried to be obtained.

3. Results and Discussion

3.1. Model Testing

The test model was created with consisting of 463,289 URLs and predictions were made. Accuracy was calculated and seen that a result of over 91%. This rate is proof that the used model has high sensitivity and accuracy.

3.2. Evaluation Metrics

Precision, sensitivity, accuracy, and f score metrics were used for evaluate performance of the model.

	Malicious URL	Good URL
Estimated Malicious URL	True Positive (TP)	False Positive (FP)
Estimated Good URL	False Negative (FN)	True Negative (TN)

Figure - 4 Accuracy Table

True Positive (TP) and True Negative (TN) are area where model is correctly predicted while False Positive (FP) and False Negative (FN) are area where model is incorrectly predicted. These parts show at the figure 4.

- True Positive (TP): Malicious URL correctly predicted,
 - True Negative (TN): Normal URL correctly predicted,
 - False Positive (FP): Normal URL incorrectly predicted,
 - False Negative (FN): Malicious URL incorrectly predicted.
- **Accuracy:** It is the ratio of the number of malicious URLs correctly predicted to total number of URLs. The calculation formula is as follows [16].

$$\text{Accuracy} = \frac{TP + TN}{TP + FP + TN + FN} \quad (1)$$

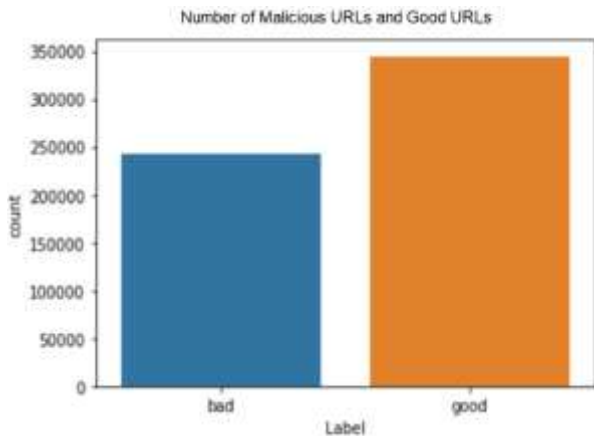


Image -1 Success rate of accuracy

Image 1 show the number of malicious-normal URLs and rate of accuracy.

- **Precision:** It is a metric that expresses what percentage of positive predictions are made for the situations that need to be predicted positively. The calculation formula is as follows [17].

$$\text{Precision} = \frac{TP}{TP + FP} \quad (2)$$

- **Recall:** It is the ratio of the number of malicious URLs correctly predicted to number of normal URLs incorrectly predicted. The calculation formula is as follows [16].

$$\text{Recall} = \frac{TP}{TP + FN} \quad (3)$$

- **F Score** It is a value used to evaluate precision and sensitivity values together. It is the harmonic mean of the two values. The calculation formula is as follows [17].

$$\text{F Score} = \frac{2 \times (\text{Precision} \times \text{Recall})}{\text{Precision} + \text{Recall}} \quad (4)$$

A high accuracy value shows that the model has a successful classification ability for all types of URLs in general. A high sensitivity value indicates that the identification is as successful for the relevant type. A high precision value guarantees that the high accuracy value is obtained for the relevant type. A high f score value shows that the system's stability in classification results for all types is as high [16].

3.3. Comparison with Other Articles

In other articles that have been reviewed in the literature review, data sets ranging from 35,000 to 300,000 have been used, and machine learning models (decision tree, Gbm, logistic regression, etc.) and artificial neural network models (Yolo, Lstm, Glove-based, etc.) have been used to achieve success rates between 19% and 90%.

In this study, a more accurate and performance-oriented data set was targeted by using more URL addresses (579,112) and a 7-layer RNN model was used to achieve success rates above 91%.

4. Conclusion

The use of the internet has become increasingly widespread and important every year. The widespread is use of the internet and cyber criminals is used of internet website addresses, or

URLs, by as targets for attacks. Therefore have caused the need for early detection of bad URLs to be very important.

In this study, two separate data sets with the same features, obtained from [13] and [14] were combined to create a large new data set of 579,112 URLs. The RNN model was processed in 7 layers, with 20% of the created data set used for training and 80% used for testing. The highest accuracy rate of 91% was obtained as a result of the performance analysis performed.

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The Effect of Lead Oxide on the Change in Gamma Ray Protection Parameters of Bismuth Oxide

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Abstract

The aim of this study is to investigate the gamma ray radiation absorption properties of bismuth oxide (Bi_2O_3), and determine the effect of lead oxide (PbO) additive in the shielding of Bi_2O_3 . For this reason, the radiation absorption parameters such as mass attenuation coefficient (MAC), linear attenuation coefficient (LAC), half value layer (HVL), tenth value layer (TVL) and mean free path (mfp) were calculated theoretically for the Bi_2O_3 , PbO, and 50% Bi_2O_3 -50%PbO. The all parameters results were obtained by using the GATE/Geant4 (Geant4 Application for Tomographic Emission) simulation code in energy range 511 keV, 662 keV, 1173 keV, 1274 keV, and 1332 keV. Also, the gamma ray protection parameters were calculated by using the XCOM program in the energy range from 1 keV to 1 GeV. Thus, the simulated the GATE/Geant4 results were tested for correctness using the XCOM program. On the other hand, theoretically were calculated values of all parameters of the shielding materials were compared with each other. These results indicate that the GATE/Geant4 results were in good agreement with the XCOM results.

Keywords: XCOM, GATE, Bi_2O_3 , PbO, Radiation Shielding

Bizmut Oksit'in Gama Işını Koruma Parametrelerindeki Değişime Kurşun Oksit Etkisi

Öz

Bu çalışmanın amacı, bizmut oksidin (Bi_2O_3) gama ışını radyasyonu absorpsiyon özelliklerini araştırmak ve kurşun oksit (PbO) katkısının Bi_2O_3 'ün kalkanlanmasındaki etkisini belirlemektir. Bu nedenle Bi_2O_3 için kütle zayıflama katsayısı (MAC), doğrusal zayıflama katsayısı (LAC), yarı değer katmanı (HVL), onuncu değer katmanı (TVL) ve ortalama serbest yol (mfp) gibi radyasyon absorpsiyon parametreleri teorik olarak hesaplanmıştır. , PbO ve %50 Bi_2O_3 -%50 PbO. Tüm parametre sonuçları, 511 keV, 662 keV, 1173 keV, 1274 keV ve 1332 keV enerji aralığında GATE/Geant4 (Geant4 Application for Tomographic Emission) simülasyon kodu kullanılarak elde edilmiştir. Ayrıca XCOM programı kullanılarak 1 keV ile 1 GeV enerji aralığında gama ışını koruma parametreleri hesaplanmıştır. Böylece, simüle edilmiş GATE/Geant4 sonuçlarının doğruluğu XCOM programı kullanılarak test edildi. Diğer yandan ekranlama malzemelerinin tüm parametrelerinin teorik olarak hesaplanan değerleri birbirleri ile karşılaştırılmıştır. Bu sonuçlar, GATE/Geant4 sonuçlarının XCOM sonuçlarıyla iyi bir uyum içinde olduğunu göstermektedir.

Anahtar Kelimeler: XCOM, GATE, Bi_2O_3 , PbO, Radyasyon zırhlama

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1. Introduction

The interaction of high-energy photons with matter is significant for use in radiation medicine, agriculture, engineering, nuclear applications and space technology. With the development of suitable protective materials to reduce the increase in radiation dose alongside in developed the technology, it is possible that living beings are affected as little as possible by radiation [1, 2]. The most effective way of protection from radiation is to put a protective material between the radiation source and the living thing. Because the importance of shielding in radiation protection is known, studies where different shielding materials are developed are important studies in the nuclear field. Over the last years, efforts to find new shielding materials to replace Pb' in terms of cost and easy usability, a heavy metal, have increased. A wide variety of materials designed for use as radiation shields exist in the literature [3-11].

Glasses are one of the appropriate materials that may be used for radiation shielding because of its high transparency to visible light, it has relatively high densities, it can be formed in great volumes and controllable properties with changing compositions [12, 13]. In order to understand the structural, mechanical, optical, physical and chemical properties of glasses, both theoretical and experimental studies are carried out by researchers [14-18].

Bismuth Oxide has applications in the electronics, glass and ceramics industries. In electronics, capacitors, pressure sensitive resistors and solid electrolytes, it is used in the ceramic industry to increase the preferability of ceramic materials, and to increase the refractive index of glass when added to glass [19, 22].

For this reason, in this study, the gamma radiation absorption properties of bismuth oxide (Bi_2O_3), and determine the effect of lead oxide (PbO) additive in the shielding of Bi_2O_3 .

2. Material and Method

The GATE simulation is an open access software program that performs Monte Carlo calculations for use in areas such as nuclear physics, radiology, and radiotherapy. The XCOM software, on the other hand, can calculate total attenuation cross section, total mass attenuation coefficient data, and partial cross-sections data for the different elements, compounds and mixtures in the photon energy range of 1keV-100GeV using the web infrastructure [23-25].

2.1. Radiation Absorption Parameters

The attenuation coefficient (μ and μ_m) of any material is defined from the exponential attenuation rule known as Beer-Lambert:

$$I = I_0 e^{-\mu x}$$

$$\mu_m = \mu/\rho$$

where I_0 and I are incident and attenuated photon intensities, μ (cm^{-1}) and μ_m (cm^2/g) are linear and mass attenuation coefficients, x (cm) is sample thickness, and ρ is density (g/cm^3) respectively.

HVL is the used to reduce the radiation intensities by one half and TVL is used to reduce the radiation intensities that one tenth.

$$\text{HVL} = (\ln 2/\mu)$$

$$\text{TVL} = (\ln 10/\mu)$$

MFP is the average distance between two consecutive interactions.

$$\text{MFP} = (1/\mu)$$

3. Results and Discussion

This study, the GATE simulation program and XCOM software were used to contribute to the literature and to investigate additional radiation absorbing materials. The linear attenuation coefficient and the half value layer of the Bi_2O_3 , PbO, and 50% Bi_2O_3 -50%PbO samples have been calculated. Obtained values are given comparatively (Fig. 1 and Fig. 2).

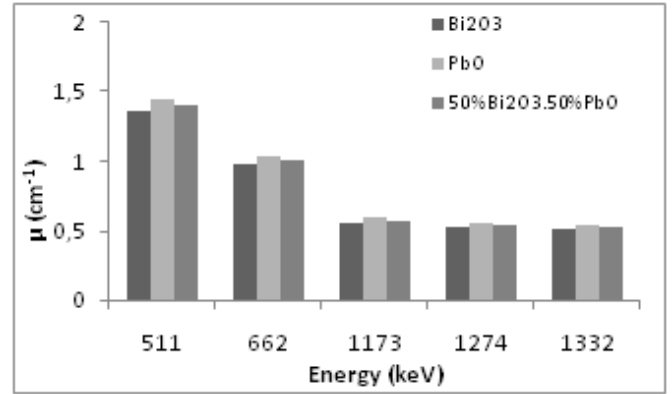


Fig. 1 LAC for samples

Fig 1 has demonstrated that the concentration of PbO added to Bi_2O_3 causes an increase in linear attenuation coefficients of 50% Bi_2O_3 -50%PbO. Also, the linear absorption coefficient of uptake appears to diminish as the energy increases.

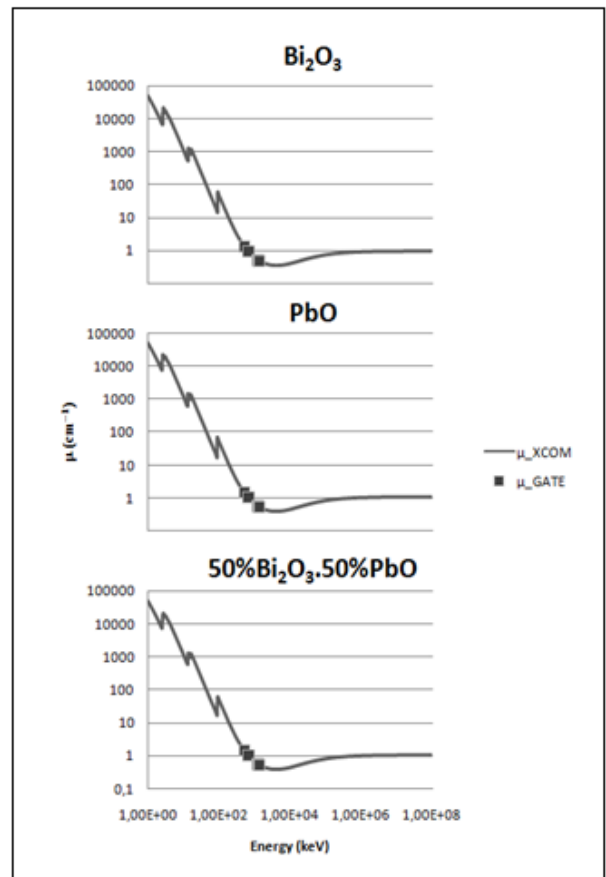


Fig. 2 The GATE values compared with the XCOM values for linear attenuation coefficient

Fig. 2 has demonstrated that the calculated XCOM and GATE values of LAC were compatible with each other.

The calculated HVL values at 0.001 MeV and 10 MeV energy range are shown in Fig. 3.

Fig .3 has demonstrated that the concentration of PbO added to Bi₂O₃ causes an decrease in HVL values of 50% Bi₂O₃.50%PbO.

In addition, calculated using the LAC values calculated with the XCOM program HVL, TVL and MFP values are shown in Table 1.

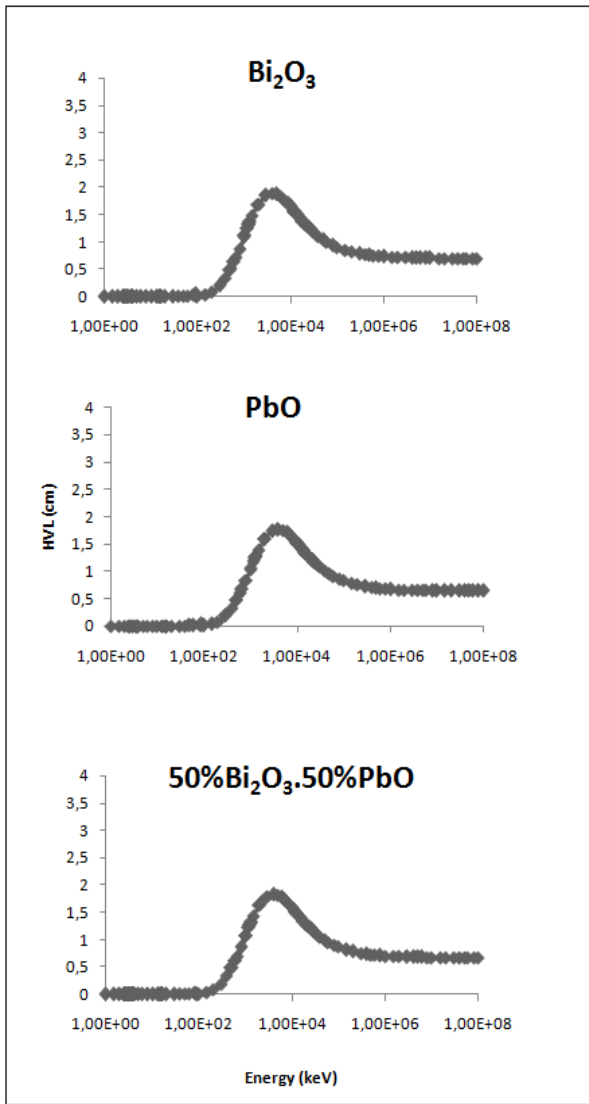


Table 1. HVL, TVL and MFP values

Energy (keV)	Bi ₂ O ₃			PbO			%50 Bi ₂ O ₃ -%50 PbO		
	HVL	TVL	MFP	HVL	TVL	MFP	HVL	TVL	MFP
511	0,510	1,6954	0,736	0,481	1,598	0,694	0,496	1,648	0,716
662	0,715	2,3757	1,0318	0,675	2,241	0,973	0,696	2,311	1,04
1173	1,252	4,1588	1,806	1,181	3,926	1,705	1,218	4,045	1,757
1274	1,332	4,4248	1,922	1,258	4,178	1,814	1,296	4,304	1,870
1332	1,374	4,5629	1,982	1,297	4,308	1,871	1,336	4,438	1,928

4. Conclusions and Recommendations

Although there are many studies in the literature comparing the results obtained with the XCOM data, there are limited studies investigating the properties of shielding materials using the Geant4-based GATE simulation.

For this reason, in this study, it was compared with simulated GATE values calculated XCOM values.

5. Acknowledge

In this study, which was conducted to determine the gamma radiation absorption properties of bismuth oxide (Bi_2O_3) and the effect of lead oxide (PbO) additive on the shielding of Bi_2O_3 , observed that the GATE simulation program data were compatible with the XCOM data, and Bi_2O_3 absorption values were also determined to increase by the 50% contribution of PbO .

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Manisa İli Mahalle (Köy) Yolları İçin Kaplama Performanslarının İncelenmesi ve Karşılaştırılması

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Öz

Bu çalışmada, Manisa ilinde yapılması planlanan mahalle (köy) yolları için farklı kaplama türleri ele alınmış ve yol yapımı için ayrılan kamu bütçesinin en efektif şekilde kullanılabilmesi için öneriler sunulmuştur. İlk olarak Manisa'da mahalleleri birbirine bağlayan örnek bir yol güzergahı seçilmiştir. Belirlenen yol güzergahı, Alaşehir ve Salihli ilçelerini birbirine bağlayan, D585 kontrol kesim numaralı karayoluna paralel olan mahalle yoludur. Ele alınan bu güzergahta, her bir kaplama türü için kesit tayini yapılmıştır. Belirlenen kesitlerin kalınlıkları, temel tabakaları dahil olmak üzere, sathi kaplama, bitümlü sıcak kaplama ve silindirle sıkıştırılmış beton kaplama olmak üzere hesaplanmıştır. Kesit tayininin ardından, her bir kaplama türü için kurum fiyatlarıyla m² başına maliyet çalışması yapılmıştır. Maliyet çalışması sonucunda, 1 m² sathi kaplama yapımı için gerekli tutar 250,46 TL, bitümlü sıcak kaplama için 280,60 TL ve silindirle sıkıştırılmış beton kaplama için 363,32 TL'dir. Ayrıca çalışmada, kaplama türlerine ait mekanistik analiz yapılmış ve tasarlanan kesitlerin 11,5 ton/dingil yük altındaki davranışları incelenmiştir. Belirlenen kesitler, bir sonlu elemanlar paket programı olan ANSYS'de modellenmiştir. Kaplamaların mekanistik analizi sonucunda, sathi kaplamalarda 0,42 mm, Bitümlü sıcak karışım kaplamada 0,15 mm ve rijit kaplamada 0,017 mm deformasyon olduğu gözlemlenmiştir. Yapılan çalışma sonucunda, Manisa İlinde bulunan mahalle (köy) yollarında yapılacak en uygun kaplama türünün sathi kaplama olduğu ortaya çıkmıştır.

Anahtar Kelimeler: Mahalle Yolları, Kaplama Performansı, Mekanistik Analiz, ANSYS, Maliyet Analizi

Investigation and Comparison of Pavement Performances for Manisa Province Local Roads

Abstract

In this study, different types of pavements for the roads planned to be built in Manisa province are discussed and suggestions are presented for the most effective use of the public budget allocated for road construction. First, a sample road route connecting the neighborhoods in Manisa was selected. The determined road route is the neighborhood road that connects Alaşehir and Salihli districts, parallel to the highway with control section number D585. In the route considered as an example, a cross-section determination was made for each pavement type. The thickness of the determined sections, including the foundation layers, was found for surface coating, bituminous hot mix coating, and roller-compacted concrete coating. After the section determination, a cost per m² study was carried out for each type of coating with the institution's prices. As a result of the cost study, the required amount for the construction of 1 m² surface coating is 250.46 TL, 280.60 TL for hot bituminous coating and 363.32 TL for roller compacted concrete coating. In addition, a mechanistic analysis of pavement types was carried out and the behavior of the designed sections under 11,5 tons/axle load was investigated. The determined sections were modeled in ANSYS, a finite element package program. As a result of the mechanistic analysis of the pavement types, it was observed that 0.42 mm deformation occurred in surface coatings, 0.15 mm deformation in bituminous hot mix coating and 0.017 mm deformation in the rigid coating. As a result of the study, it has been revealed that the most appropriate pavement type to be made on the neighborhood (village) roads in Manisa is surface coating.

Keywords: Neighborhood roads, Pavement Performance, Mechanistic Analysis, ANSYS, Cost Analysis

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1. Giriş

Dünyada özellikle sanayi devriminden sonra insanların hayatında yolcu ve yük taşımacılığı büyük önem kazanmıştır. Gerek yük taşımacılığı gerekse seyahat amaçlı kullanılan en yaygın ulaşım türü karayoludur. Bu durum Türkiye özelinde değerlendirildiğinde de aynı sonuçla karşılaşmaktadır. Ülkemizde yolcu taşımacılığının %97'si, yük taşımacılığının ise %89'u karayolları üzerinden yapılmaktadır (Çetin vd., 2011).

Ülkemizde, devlet ve il yollarında hâkim kaplama türünün, bağlayıcısı bitüm olan esnek kaplamalardan oluştuğu görülmektedir. Esnek kaplamaların yaklaşık %42'sini asfalt betonu oluşturmakta, %58'ini sathi kaplama oluşturmaktadır (KGM, 2021). Bunun yanında günümüzde, esnek kaplamaya alternatif olarak sunulan rijit kaplamaların da uygulandığı bilinmektedir. Rijit kaplama, tekil olarak bağlayıcılığı bulunmayan, nemli ortamda kalsiyum hidroksitle reaksiyona girmek suretiyle bağlayıcılık kazanan ve içeriğindeki malzemelerin hidratasyonu ile agregaları birbirine bağlayan Portland çimentosunun agregayla uygun oranlarda karıştırılmasıyla oluşturulan plak yol kaplamasıdır (Geçkil & Tanyıldızı, 2019).

Bu çalışmada Manisa ilinde yer alan ve mahalleleri birbirine bağlayan çeşitli üstyapı tipine sahip yol kaplamalarının yatırım maliyeti ve performans kriterleri karşılaştırıp, Manisa ili özelinde mahalle yolları için gerekli nitelikleri taşıyan en uygun üstyapı kaplama tipinin belirlenmesi hedeflenmiştir.

Esnek üstyapı kaplamalarında kesit tayininde; sathi kaplamalar için Karayolları Genel Müdürlüğü tarafından yayımlanan Esnek Üstyapı Projelendirme Rehberi, diğer bir esnek üstyapı türü olan bitümlü sıcak kaplama için American Association of State Highway and Transportation Officials (AASHTO-93) abakları kullanılmıştır. Rijit kaplama tasarımı için ise American Concrete Institute (ACI) tarafından yayımlanan tasarım tablosu kullanılmıştır.

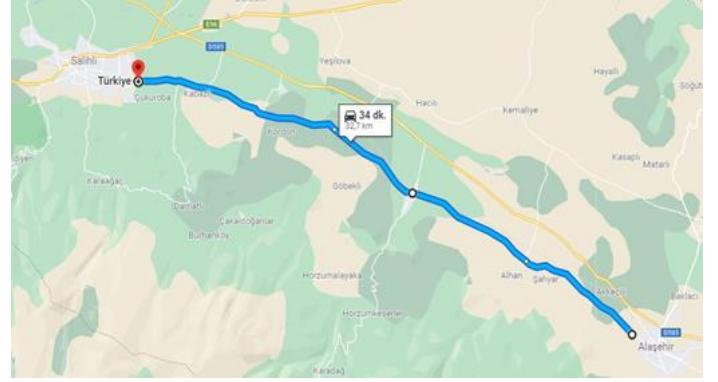
Tasarımı yapılan yol kesitlerinin maliyet analizleri için her yıl yayımlanan kurum pozları yardımıyla malzeme ve işçilik dahil yapım tutarı 1 m² için bulunmuştur.

Son olarak, bir sonlu elemanlar hesap programı olan ANSYS'de üç boyutlu katı model oluşturulmuş ve Karayolları Trafik Yönetmeliği'nde belirtilen, tek dingilli araçlar için dikkate alınan 11,50 ton yüklemeye ile analiz yapılmıştır.

2. Materyal ve Metot

2.1. Kesit Hesapları

Tasarımda kullanılacak trafik verileri, Alaşehir İlçesi ile Salihli İlçesini bağlayan mahalle yolundan alınmıştır ve bu yol Karayolları Genel Müdürlüğü sorumluluk sahasında bulunan D585 kontrol kesim numaralı karayoluna paralel konumdadır.



Şekil 1. D585 kontrol kesim numaralı karayolu

Dikkate alınan yol ile ilgili 2019 yılına her bir taşıt grubu için yıllık ortalama günlük trafik (YOGT) verileri Tablo 1'de gösterilmiştir. Belirlenen yolun servis ömrü 20 yıl olarak değerlendirilmiştir. Ayrıca trafik artış katsayısı treyler ve kamyon için %4, otobüs, orta yüklü ticari taşıt ve otomobil için %5 alınmıştır.

Tablo 1. YOGT verileri

Taşıt Grubu	Geçen Araç Sayısı
Treyler	3
Kamyon	74
Otobüs	3
Orta Yüklü Ticari Taşıt	542
Otomobil	1018

Elde edilen ve kabul edilen veriler ışığında yolun trafiğe açılmasından 20 sene sonra her bir taşıt için oluşacak trafik sayısı (T_{2039}) formül (1) yardımıyla bulunmuştur.

$$t_t = t_0 \times (1+r)^t \quad (1)$$

Buradan yola çıkarak her bir taşıt tipi için ortalama proje trafiği formül (2) kullanılarak hesaplanmıştır.

$$t_p = 0,4343 \times (t_t - t_0) / \log(t_t / t_0) \quad (2)$$

Ardından hesap şeridine düşen ortalama günlük standart dingil yükü tekrerrür sayısı (T_p), formül (3) yardımıyla bulunmuştur. Hesaba katılacak taşıt eşdeğerlik faktörleri Esnek Üstyapı Projelendirme Rehberi'nden alınmıştır. Son olarak toplam standart dingil yükü tekrerrür sayısı formül (4) yardımıyla hesaplanmıştır.

$$T_p = t_p / i \times TEF \quad (3)$$

$$T_{8,2} = T_p \times 365 \times t \quad (4)$$

Kaplama kesit hesaplarında kullanılmak üzere taban CBR değeri 12 olarak kabul edilmiştir.

Tablo 2. Trafik verileri hesap tablosu

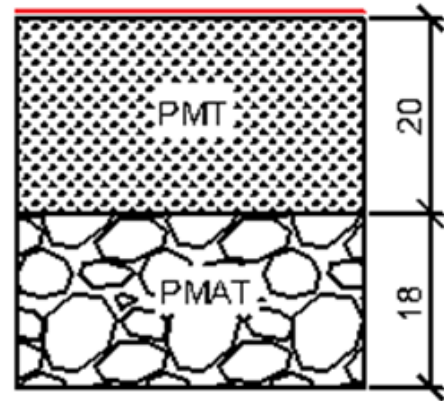
Proje Yılı:	20				
	Trafik Artış Katsayısı	T ₂₀₃₉	t _p	TEF	T _p
Treyler	4	7	5	4,1	8
Kamyon	4	162	112	2,9	147
Otobüs	5	8	5	3,2	7
Orta Yüklü Ticari Taşıt	5	1438	918	0,6	248
Otomobil	5	2701	1725	0,0006	0
$\sum T_p$					411
$T_{8,2}$					2.998.682,38

2.1.1. Sathi Kaplama Kesit Hesapları

Sathi kaplama kesit tayini yapabilmek için ilk olarak taban esneklik modülünün bulunması gerekmektedir. Bunun için, tasarımda göz önüne alınan yolun taban zeminine ait CBR değerlerinin 1500 ile çarpılmasıyla esneklik modülünün (MR) yaklaşık değeri formül (5) ile PSI cinsinden bulunmuştur (Geçkil & Tanyıldızı, 2019). Projede dikkate alınan esneklik modülü;

$$MR=1500 \times 12=18.000 \text{ PSI} \quad (5)$$

Elde edilen trafik değerleri ve taban esneklik modülü yardımıyla, Şekil 2’de yer alan abak yardımıyla belirlenen kesit özellikleri, çift kat sathi kaplama, 20 cm plent-miks temel ve 18 cm plent-miks alt temeldir.

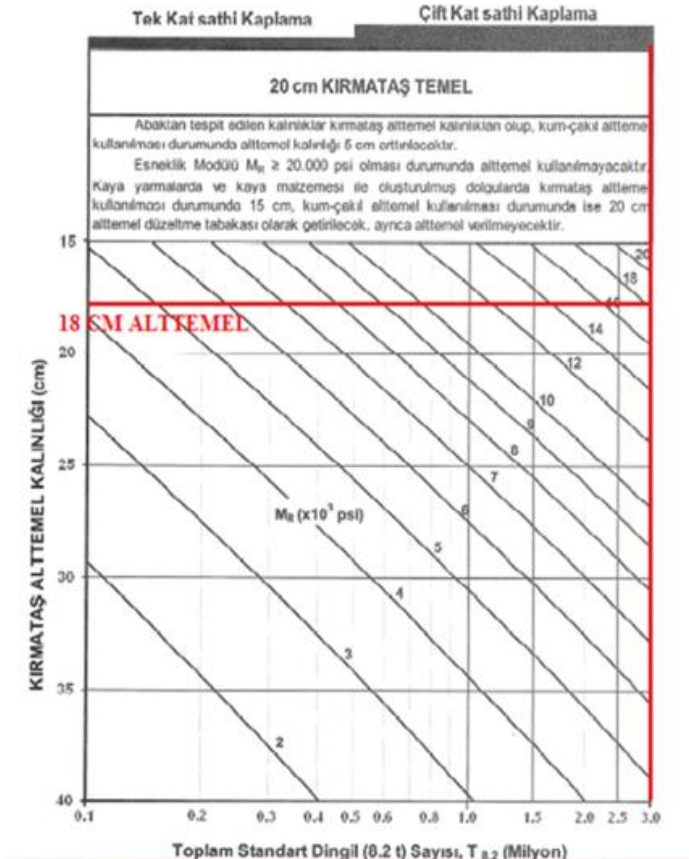


Şekil 3. Sathi kaplama kesiti

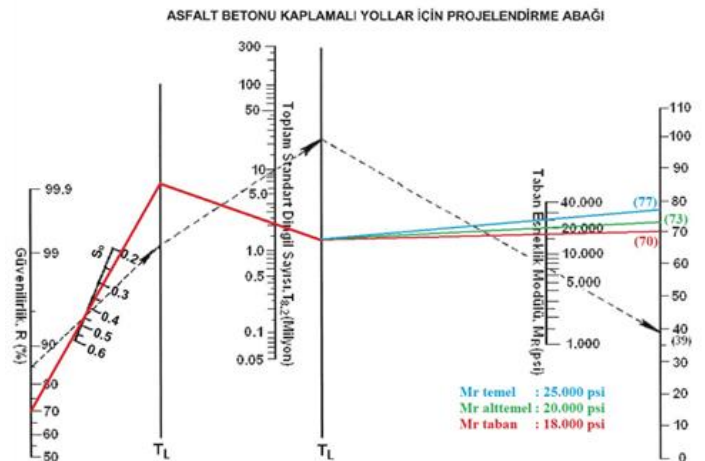
2.1.2. Bitümlü Sıcak Kaplama Kesit Hesapları

Bitümlü sıcak kaplama (BSK) kesit tasarımında, temel esneklik modülü 25.000 psi ve alttemel esneklik modülü 20.000 psi olarak belirlenmiştir. Toplam standart sapma değeri 0,45 seçilmiştir. Güvenilirlik değeri il yolları için 70 olarak belirlenmiştir. Servis yeteneği kaybı değerlendirildiğinde, ilk servis yeteneği 4,2, son servis yeteneği 2 olarak alınmıştır. Buradan servis yeteneği kaybı 2,2 olarak elde edilmiştir.

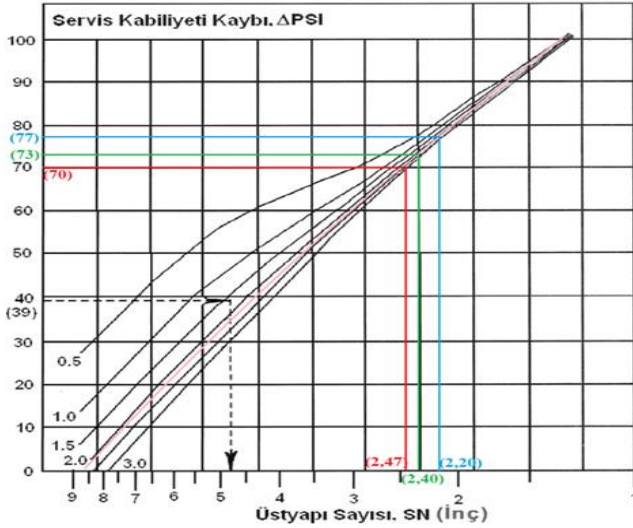
Belirlenen veriler ışığında, AASHTO-93 yol tasarım yönteminde sunulan abaklar yardımıyla üstyapı sayıları (SN) bulunmuştur.



Şekil 2. Sathi kaplama tabaka kalınlıkları hesabı



Şekil 4. BSK için projelendirme abağı-1



Şekil 5. BSK için projelendirme abağı-2

Şekil 4'ün devamı olan ve Şekil 5'te gösterilen abaktan elde edilen üstyapı sayıları (SN) aşağıda belirtilmiştir.

- Temel için SN : 2,20
- Alttemel için SN : 2,40
- Taban için SN : 2,47

Abakların kullanımdan sonra elde edilen SN sayılarının kontrolü sağlanmalıdır. Bu kontrolü yapmak ve tabaka kalınlıklarını bulmak için, Esnek Üstyapı Projelendirme Rehberi'nden izafi mukavemet katsayısı bulunmuştur.

İlk olarak, bitümlü tabaka için seçilen katsayı (a_1) binder tabakası için 0,40 olarak alınmıştır. Ardından plent-miks tabakası için seçilen katsayı (a_2) 0,15 olarak elde edilmiştir. Son olarak, kırmataş alttemel tabakası için (a_3) 0,13 alınmıştır.

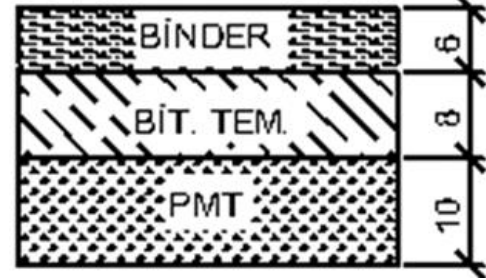
Hesaplamalarda kullanılacak drenaj katsayıları yine Esnek Üstyapı Projelendirme Rehberi'nden alınmış, iyi derecelendirilmiş (GW) çakıllı tabakalar için (m_2) 1 seçilmiştir. Alttemel kalınlık kontrolü için ise (m_3) 0,95 alınmıştır.

Bu verilerden yola çıkarak, tabaka kalınlıkları aşağıda hesaplanmıştır.

- $D_1^* > SN_1 / a_1$
 $D_1^* = 2,2 / 0,4 = 5,5$ inç $\cong 14$ cm
 (8 cm bitümlü temel, 6 cm binder)
 $SN_1^* = a_1 D_1^* = 0,4 (14 / 2,54) = 2,20$ inç $\cong 2,2$ inç
 (Tasarım uygundur.)
- $D_2^* = SN_2 - SN_1^* / a_2 \cdot m_2$
 $D_2^* = (2,4 - 2,20) / (0,15 \times 1) = 1,33$ inç $\cong 3,38$ cm
 (Temel tabakası 10 cm seçildi. 3,94 inç)
 $SN_2^* = a_2 D_2^* \cdot m_2 = 0,15 \times 3,94 \times 1 = 0,59$
 $SN_1^* + SN_2^* \geq SN_2$
 $2,20 + 0,59 = 2,79 \geq 2,4$
 (Tasarım uygundur.)

- $D_3^* = SN_3 - (SN_2^* + SN_1^*) / a_3 \cdot m_3$
 $D_3^* = [2,47 - 2,79] / 0,13 \times 0,95 = -2,59$ inç
 (Alttemele ihtiyaç yoktur.)

Yapılan kontrollerden yola çıkarak, belirlenen kaplama kesiti Şekil 6'da gösterilmiştir.



Şekil 6. BSK kesiti

2.1.3. Rijit Kaplama Kesit Hesapları

Çalışmanın bu bölümünde, üstyapı tasarımında silindire sıkıştırılmış beton yol kaplaması ele alınmıştır. Beton yol uygulamalarında kaplama kalınlığının tayini; tekrarlı trafik yüklerinden dolayı yol kaplamasına etkiyen yüklere, beton dayanımına ve zemin sınıfının parametrelerine bağlıdır.

Rijit kaplama kesit tayini için pratik bir yöntem aranmış ve sonuç olarak Amerikan Beton Enstitüsü (American Concrete Institute-ACI) tarafından hazırlanan, "Caddeler ve Yerel Yollardaki Derzli Beton Kaplamalarının Tasarım Rehberi'nden" faydalanılmıştır.

Özkan vd., 2019, yapmış oldukları çalışmalarında Alaşehir ve Salihli ilçelerini birbirine bağlayan, D585 karayoluna alternatif ve bu bildirinin konusu olan yolda rijit kaplama tasarımı yapmışlardır. Bahse konu çalışmada, tasarım yapılan yolda zemin yataklama katsayısı 27,80 mpa olarak tespit edilmiştir. Silindire sıkıştırılmış beton yol kaplaması için C30/37 beton sınıfı kullanılması öngörülmüştür. Ayrıca, yol kaplama maliyet analizlerinde, yayımlanan kurum pozlarının alt analizinde de yine C30/37 sınıfı beton dikkate alınmıştır.

Kaplama yapılacak beton malzemesinin eğilme dayanımı, ACI318-95 standardında yer alan formüller yardımıyla hesaplanmıştır. Bu formül, eğilmede çekme dayanımını (F_{ctf}) yansıttığından, yol kaplamasında kullanılan beton davranışına daha yakındır. Formül (6)'da C30/37 sınıfı için basınç dayanımı (f_c) 30 mPa olarak kabul edilmiştir. Buradan hareketle, tasarımda kullanılacak MOR değeri 3,45 mpa olarak bulunmuştur. Bu değer tasarım abağında bulunmadığından, MOR değeri için 3,8 mpa alınmıştır.

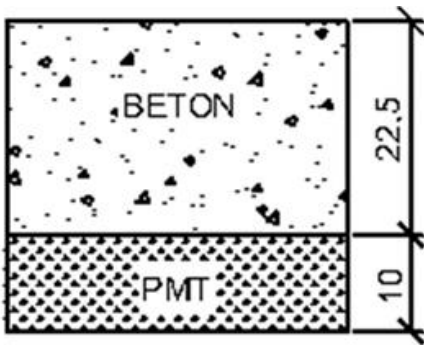
$$F_{ctf} = 0,63 \sqrt{f_c} \quad (6)$$

Tez kapsamında yapılacak olan rijit kaplama tasarımı için gerekli yıllık ortalama günlük kamyon trafiği sayısı (ADTT) Tablo 2'den 411 olarak alınmıştır. Ancak, tasarımda güvenli yönde kalmak için abakta ADTT 500 olarak dikkate alınmıştır.

k = 27 MPa/m	MOR MPa						Traffic classification	
	3.4	3.8	4.1	4.5	4.8			
	175	175	175	175	175	ADTT = 3	ADTT = 10	ADTT = 20
	200	200	200	200	200	ADTT = 50	ADTT = 50	ADTT = 100
	225	200	200	200	200	ADTT = 100	ADTT = 100	ADTT = 500
	225	225	225	225	225	ADTT = 500	ADTT = 400	ADTT = 800
	275	250	250	250	250	ADTT = 1500	ADTT = 300	ADTT = 700
	275	275	275	275	275	ADTT = 400	ADTT = 400	ADTT = 800
	275	275	275	275	275	ADTT = 800	ADTT = 800	ADTT = 800
	275	275	275	275	275	ADTT = 1500	ADTT = 1500	ADTT = 1500
	275	275	275	275	275	ADTT = 300	ADTT = 300	ADTT = 300
	275	275	275	275	275	ADTT = 700	ADTT = 700	ADTT = 700
	275	275	275	275	275	ADTT = 400	ADTT = 400	ADTT = 400
	275	275	275	275	275	ADTT = 800	ADTT = 800	ADTT = 800

Şekil 7. Rijit kaplama tabaka kalınlıkları hesabı

Nihai olarak, dikkate alınan veriler ışığında yapım tekniği açısından silindire sıkıştırılmış beton yolun, 225 mm kalınlığında olması gerektiği sonucuna varılmıştır. Tasarım abağında yol temeli için bir kriter yer almadığından, uygulamada yol sathının düz bir zemine oturması için bitümlü sıcak karışımında kullanıldığı gibi bu kaplamada da 10 cm kalınlığında plent-miks temel yapılması uygun bulunmuştur. Rijit kaplamaya ait belirlenen kesit Şekil 8’de gösterilmiştir.



Şekil 8. Rijit kaplama kesit

2.2. Maliyet Analizleri

Bu bölümde, kaplama tasarımı yapılan Alaşehir-Salihli bağlantı yolu için belirlenen kesitlerin maliyet analizi yapılmıştır. Her bir kaplama sınıfı için ayrı ayrı maliyet hesaplanmış ve tabaka türlerine göre 1 m² fiyatı kümülatif olarak bulunmuştur. Yapılan hesaplamalarda %25 oranında müteahhit karı da eklenmiştir ve ihale edilecek şekilde yaklaşık maliyet esas fiyatlar bulunmuştur.

Maliyet analizlerinde birim fiyata dahil olmayan nakliye giderleri Çevre, Şehircilik ve İklim Değişikliği Bakanlığı tarafından belirlenen nakliye formülleri üzerinden belirlenmiştir.

2.2.1 Sathi Kaplama Maliyet Hesapları

Esnek üstyapı kaplamalarında ilk olarak 1 m² sathi kaplama yapılmasının maliyeti ele alınacaktır. Bunun için Şekil 3’te belirtilen kesit elemanlarının her birinin yapım maliyeti ayrı ayrı hesaplanarak sathi kaplama için yaklaşık maliyet bulunmuştur. Sathi kaplama yapımı için üç poz analizinden yararlanılmıştır. Bu kaplama türüne ait analiz icmali Tablo 3’te sunulmuştur.

Tablo 3. Sathi Kaplama Maliyet İcmali

Sıra No	Poz No	Birim	Miktar	Birim Fiyat	Tutar
1	Çift kat sathi	DA	0,001	73.442,65	73,44265
2	PMT	TON	0,45	212,66	95,70
3	PMAT	TON	0,39	192,96	75,254
Toplam Tutar (K.D.V. Hariç)					244,397

Bunlardan ilki, yüzeyde taşıtların temas ettiği ve çift kat yapılması öngörülen bitümlü tabakadır. Pozun birimi dekar (DA) olduğundan, 1 m² sathi kaplama maliyeti için miktar olarak 0,001 DA alınmıştır.

İkincil olarak, kaplamada bir tabaka temel görevi görecektir olan plent-miks temel yapılmasının 1 m² fiyatına yer verilmiştir. Plent-miks tabasının kalınlığı Şekil 3’te gösterildiği üzere 20 cm’dir. Buradan yola çıkarak, özgül ağırlığı 2,258 ton/m³ olan (Tatlı, 2004) plent-miks temelin 1 m²’deki miktarı (1 x 1 x 0,20 x 2,258) 0,45 ton olarak bulunmuştur.

Son olarak, en alt tabakada yer alan ve 18 cm kalınlığında öngörülen plent-miks alttemel tabakasının yapım maliyeti “PMAT” poz analiziyle bulunmuştur. PMAT pozunun birimi ton olduğu için sıkışmış birim hacim ağırlığı 2,174 ton/m³ (Tatlı, 2004) alınarak m² başına (1x 1 x 0,18 x 2,174) 0,39 ton hesaplanmıştır.

2.2.2. Bitümlü Sıcak Kaplama Maliyet Hesapları

Esnek üstyapı kaplamada bir diğer alternatif olarak ele alınan kaplama türü bitümlü sıcak karışımdır. Yapılan hesaplar doğrultusunda kaplama tabakalarını, 6 cm binder, 8 cm bitümlü temel ve 10 cm kalınlığında plent-miks temel tabakası oluşturmaktadır.

Bu kaplama türüne ait maliyet analiz icmalı Tablo 4'te sunulmuştur. Analizde, 1 m² bitümlü sıcak karışım imalatı yapılması için gereken tutar bulunmuştur.

Tablo 4. Bitümlü Sıcak Kaplama Maliyet İcmali

Sıra No	Poz No	Birim	Miktar	Birim Fiyat	Tutar
1	6 cm binder	M ²	1	104,38	104,38
2	8 cm bit. tem.	M ²	1	126,58	126,58
3	PMT	TON	0,23	212,66	48,92
Toplam Tutar (K.D.V. Hariç)					279,87

2.2.3. Rijit Kaplama Maliyet Hesapları

Bu bölümde tasarımda göz önüne alınan yol güzergahı için bir alternatif olarak, rijit yol kaplamasının 1 m² yapım maliyeti belirlenecektir. Rijit kaplama, Silindire Sıkıştırılmış Beton (SSB) tekniği ile yapılacaktır. Bu nedenle belirtilen imalat tekniğine uygun olan kurum pozları kullanılmıştır.

Kaplama 22,5 cm kalınlığında beton ve 10 cm kalınlığında plent-miks temel tabakasından oluşmaktadır. Bu kalınlıklar dikkate alınarak rijit kaplamanın 1 m² maliyet analizi Tablo 5'te gösterilmiştir.

Tablo 5. Rijit Kaplama Maliyet İcmali

Sıra No	Poz No	Birim	Miktar	Birim Fiyat	Tutar
1	20 cm SSB	M ³	0,225	1327,84	298,764
2	PMT	TON	0,23	212,66	48,9118
Toplam Tutar (K.D.V. Hariç)					347,66

2.2.4. Bakım-Onarım Maliyetleri

2007 yılında yapılan bir çalışmada (Giriş, 2007); bitümlü sıcak karışım kaplama, sathi kaplama ve rijit üstyapı kaplama türleri için bakım-onarım maliyetleri tespit edilmiştir. BSK ve sathi kaplamaların 2007 yılı için bir yıllık kilometre başına bakım-onarım maliyetleri sırasıyla 632,00 TL ve 5.224,00 TL'dir.

Rijit kaplamalı yollar için 20 yıllık servis ömrü boyunca gerçekleştirilecek bakım-onarım maliyetleri 269.780,00 TL olarak bulunmuştur. Esnek kaplamalı yolların 20 yıllık servis ömrü boyunca harcanacak bakım-onarım giderleri ise aşağıdaki gibidir.

- BSK için :12.640,00 TL
- Sathi kaplama için :104.480,00 TL

Analiz süresi için belirlenen maliyetler 2007 yılı itibari ile belirlendiği için, bu maliyetlerin 2021 yılına güncellenmesi gerekmektedir. Bu tespiti yapabilmek için her ay TÜİK tarafından yayımlanan Yİ-ÜFE (Yurt İçi Üretici Fiyat Endeksi ve Değişim Oranları) katsayıları baz alınmıştır. Temel ay olarak 2007 yılı Ocak (E₀= 135,09), gerçekleştirme ayı olarak 2021 Ocak (E_s=583,38) ayları dikkate alınmıştır. Böylelikle, güncellemeye esas katsayı 8,36 olarak bulunmuştur. Buradan yola çıkarak, 2021 yılı itibariyle her kaplama türü için belirlenen bakım-onarım maliyetleri aşağıda gösterilmiştir.

Sonuç olarak her bir kaplama türü için 20 yıllık süreçte 1 m² alanda yapılacak bakım-onarım maliyetleri Tablo 6'da gösterilmiştir.

Tablo 6. Bakım-Onarım Maliyetleri

	Sathi Kaplama	BSK	Rijit Kaplama
1 km için (20 yıl)	873.452,80	105.670,04	2.255.360,08
1 km için (1 yıl)	43.672,64	5.283,50	112.768,04
1 m ² için (1 yıl)*	6,07	0,73	15,66
*Genişlik: 7,20 m		Uzunluk: 1000 m	

2.3. Mekanistik Analizler

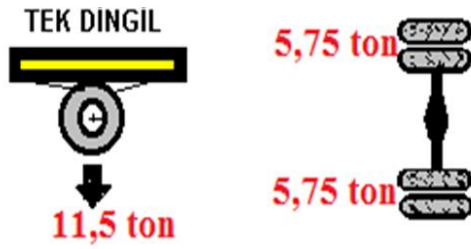
Bu bölümde, belirlenen kaplama kesitleri ile mekanistik analiz yapılmıştır. Bu analizler için sonlu elemanlar yöntemi ile işlem yapan ANSYS WORKBENCH (2021 R1) programı kullanılmıştır. Yapılan analizler sonucunda belirlenen alana uygulanan yüklerin yol kaplamasına olan etkileri araştırılmıştır. Mekanistik analizde dikkate alınan malzeme özellikleri Tablo 7'de gösterilmiştir.

Tablo 7. Programda kullanılan değerler

Malzeme Türü	Elastisite Modülü (mpa)	Poisson Oranı	Yoğunluk kg/m ³
Beton (C30/37)	32837 mpa	0,2	2400
Binder Tabakası	3500 mpa	0,3	2400
Bitümlü Temel Tabakası	3500 mpa	0,3	2400
Plent-Miks Tabakası	172 mpa	0,35	2258
Plent-Miks Alt temel Tabakası	138 mpa	0,4	2174
Taban Zemini	124 mpa	0,45	2200

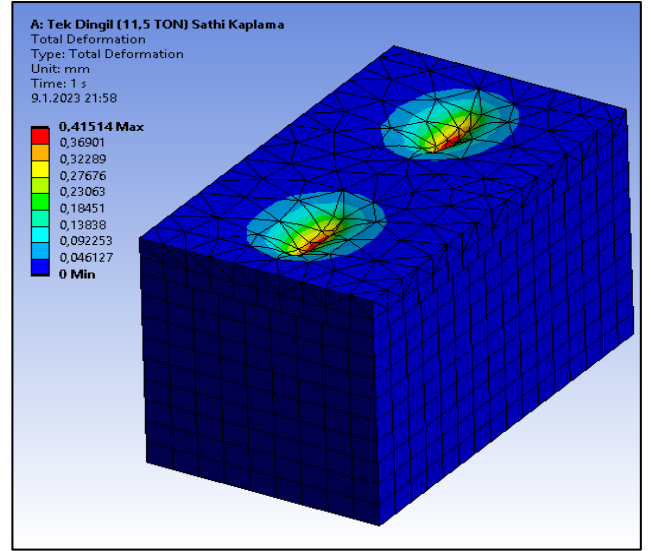
Kaplama analizlerini ANSYS programında yapabilmek için ilk olarak "Toolbox" menüsünden "Static Structural" çalışma planı oluşturulmuştur. Bu planda gerçekleşmesi gereken ilk işlem, kaplamada kullanılacak malzeme özelliklerinin programa tanıtılmasıdır. Ardından, dikkate alınan kesitlerin üç boyutlu model tanımlaması yapılmıştır. Modelin oluşturulmasından sonra, sistem "mesh" adı verilen küçük elemanlara ayrılmıştır. Bu adımdan sonra, sınır koşulları tanımlanmış ve yükleme oluşturulmuştur.

Hesaplarda, tahrikli tek dingilde izin verilen maksimum yük olan 11,5 ton değeri de dikkate alınmıştır.

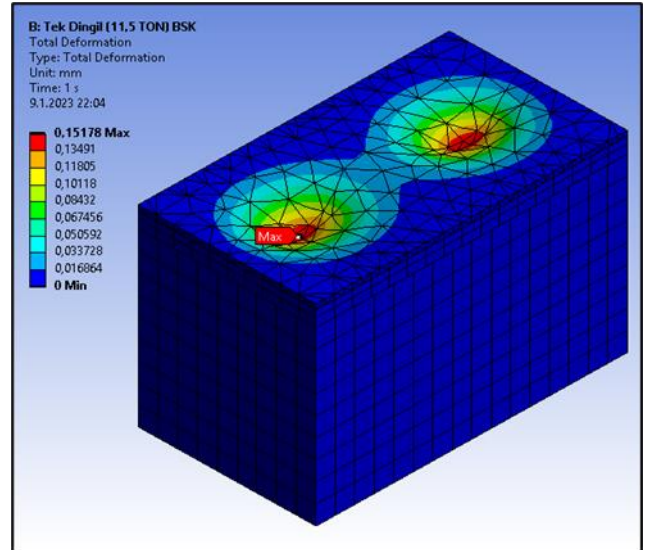


Şekil 9. Tasarım şematik gösterimi

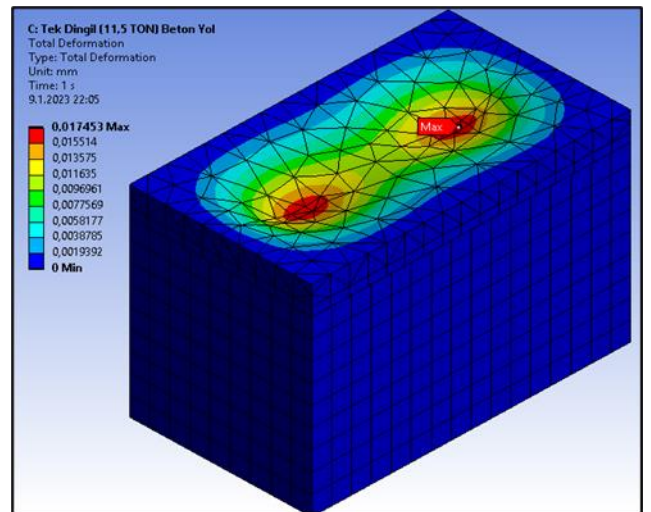
Yapılan mekanistik analizlere ait sonuçlar Şekil 10, Şekil 11 ve Şekil 12'de gösterilmiştir.



Şekil 10. Sathi kaplama deplasman sonucu (0,42 mm)



Şekil 11. BSK deplasman sonucu (0,15 mm)



Şekil 12. Rijit kaplama deplasman sonucu (0,017 mm)

3. Araştırma Sonuçları ve Tartışma

Bu bölümde, tasarımı yapılan kaplama türlerine ait elde edilen bulgular paylaşılacaktır. Her bir kaplamaya ait kesite göre çalışmadan elde edilen değerlerin özeti Tablo 8’de gösterilmiştir.

Tablo 8. Kaplama türlerine göre çalışmadan elde edilen değerler

	KAPLAMA TÜRLERİ		
	Sathi Kaplama	BSK	Rijit Kaplama (SSB)
Üstyapı Tabaka Bilgileri	Çift Kat Sathi	Binder (6 cm) Bitümlü Temel (8 cm)	Beton Plak (22,5 cm)
	PMT (20 cm) PMAT (18 cm)	PMT (10 cm)	PMT (10 cm)
Yapım Maliyet (TL/m ²)	244,397	279,87	347,66
Bakım-Onarım Maliyeti (TL/m ²)	6,07	0,73	1,57
Üstyapı Kalınlığı (cm)	38 cm	24 cm	32,5 cm
Toplam Maliyet (TL/m ²)	250,46	280,60	363,32
Toplam Deformasyon (mm) (Tek dingil)	0,415114	0,15178	0,017453

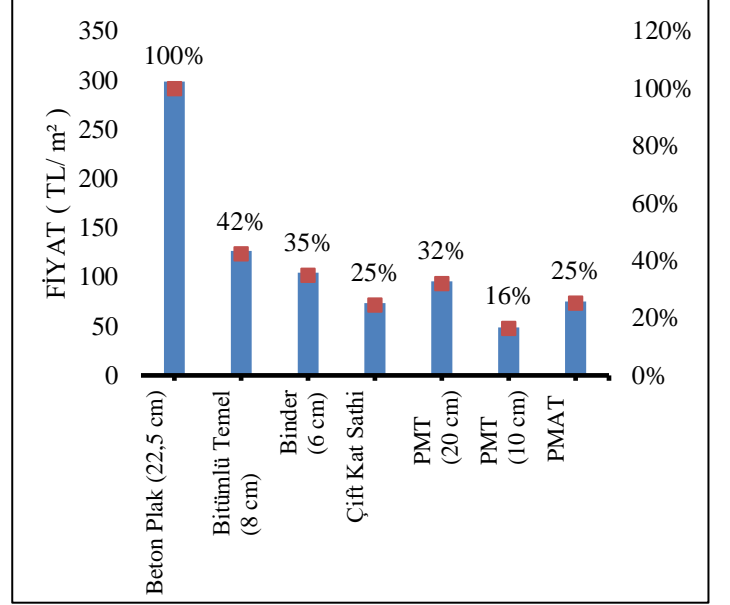
Kaplamalarda kullanılan her bir tabakanın yapım (malzeme dahil) maliyetleri Tablo 9’da gösterilmiştir.

Tablo 9. Birim maliyetler

Tabaka Türü	Birim Maliyet (TL/m ²)
Beton (22,5 cm)	298,76
Bitümlü Temel (8 cm)	126,58
Binder (6 cm)	104,38
Çift Kat Sathi	73,44
PMT (20 cm)	95,70
PMT(10 cm)	48,92
PMAT	75,25

Tablo 10’den görüldüğü üzere, yol üstyapısında kullanılan tabakalar arasında metrekare birim fiyatı en yüksek kalem beton kaplamadır. Bu kalem baz alınrsa; bitümlü temel yapılması %58, binder yapılması %65, çift kat sathi kaplama yapılması %75 daha ucuz olduğu görülmektedir.

Tablo 10. Tabakalar maliyet-yüzdellik ilişkisi



Üstyapıya temel teşkil edecek tabakalar kendi içinde değerlendirildiğinde, 20 cm kalınlığında PMT yapılması, 18 cm PMAT yapılmasından %22 daha pahalıdır.

Üstyapı kalınlıklarının kıyaslanması ile ilgili olarak, kalınlığı en fazla olan kesit, 38 cm ile çift kat sathi kaplama kesitidir (20 cm PMT + 18 cm PMAT). Bu kalınlığı sırasıyla 32,5 cm ile beton kaplama (22,5 cm beton plak + 10 cm PMT) ve 24 cm bitümlü sıcak kaplama (6 cm binder + 8 cm bitümlü temel + 10 cm PMT) kesitleri izlemektedir.

Mekanistik tasarımdan elde edilen maksimum deformasyon seviyelerine bakıldığında; sathi kaplamalarda tek dingil yüküne (11,5 ton) maruz bırakılan kaplamada maksimum 0,41514 mm deformasyon gözlemlenmiştir. Bitümlü sıcak kaplama için ise tek dingil yükünde oluşan maksimum deformasyon 0,15178 mm’dir. Rijit kaplamalarda ise esnek kaplamalara kıyasla çok küçük bir deformasyon gözlemlenmiştir. Bu kaplama türünde tek dingil yükünün neden olduğu deformasyon 0,017453 mm’dir.

Kaplama türleri deformasyon açısından birbiriyle kıyaslandığında en fazla deformasyonun sathi kaplamada olduğu gözlemlenmiştir. Sathi kaplamalara göre, bitümlü sıcak karışımda %63 oranında daha az, rijit kaplamada %96 daha az deformasyon gözlemlenmiştir.

4. Sonuç

Bu bölümde, çalışma kapsamında ele alınan ve Manisa İlinde yer alan diğer kırsal yollar için en uygun kaplama alternatifleri sunulacaktır. Her ne kadar uygulanan yük altında sathi kaplama türünde en fazla deformasyon görülse de tasarımı yapılan her üç kaplama türü için deplasman değerleri kabul edilebilir sınırlardadır. Bu açıdan düşünüldüğünde, en uygun

kaplama türü seçiminde yapım maliyeti ve uygulanabilirlik ön plana çıkmaktadır.

Alaşehir-Salihli bağlantı yolunda en az maliyetle uygulanabilecek kaplama türü sathi kaplamadır. Ayrıca bahse konu yol güzergahında genellikle tarım faaliyetleri için taşımacılık yapıldığından, yol yapım süresinin mümkün olan en kısa sürede tamamlanması gerekmektedir. Mahalle ve köy yollarında, elektrik ve iletişim hatlarının havai hat şeklinde olmaları, finişer makinasının kullanımı zorunlu olan SSB ve BSK kaplamalar için bir dezavantajdır. Finişer makinasının yüksekliği nedeniyle bu gibi yerlerde kullanılması zaman zaman olanaksız hale gelmektedir. Bu yüzden imalat zorlaşmakta ve zaman kaybına neden olmaktadır. Dolayısıyla bu durum, yerel halk için ulaşım aksamalarına neden olmaktadır.

Sonuç olarak maliyet, imalat tekniği ve yolun trafiğe açılması durumları değerlendirildiğinde, sathi kaplama türü en elverişli alternatif olarak ön plana çıkmaktadır.

5. Teşekkür

Bu çalışmanın hazırlanmasında vermiş oldukları destek ve katkılarından dolayı Manisa Büyükşehir Belediyesi Yol Yapım, Bakım ve Onarım Dairesi Başkanlığı'na teşekkür ederiz.

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The Effect of TiO₂ on Anthra Red B and Acid Black 194 Dyed Worsted Fabrics

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Abstract

Nano sized Titanium dioxide (TiO₂) produced by sol-gel method was applied on worsted fabrics using mini stenter before and after dyeing with Anthra red B and Acid black 194. The effect of TiO₂ on breaking strength, tear strength, seam slippage, hydrophobicity, fastness and color change of the fabrics examined comparatively by considering the application step. The effect of TiO₂ application on brightness and dyeing of the fabrics were measured using a spectrophotometer and FTIR-ATR, respectively. It was observed that TiO₂ application increased the brightness of the black colored fabrics, while it dulled the pink colored fabrics.

Keywords: Nanosized TiO₂, Self-Cleaning, Worsted Fabric, Sol-Gel Method, Dyeing.

TiO₂'in Anthra Red B ve Acid Black 194 Boyalı Kamgarn Kumaşlara Etkisi

Öz

Sol-jel yöntemi ile üretilen nano boyutlu Titanyum dioksit (TiO₂), Anthra red B ve Acid black 194 ile boyama öncesi ve sonrası mini ramöz kullanılarak kamgarn kumaşlar üzerine uygulanmıştır. TiO₂'in kumaşların kopma mukavemeti, yırtılma mukavemeti, dikiş kayması, hidrofobiklik, haslık ve renk değişimi üzerindeki etkisi, uygulama aşaması dikkate alınarak karşılaştırmalı olarak incelenmiştir. TiO₂ uygulamasının kumaşların parlaklığı ve boyanması üzerindeki etkisi, sırasıyla spektrofotometre ve FTIR-ATR kullanılarak ölçülmüştür. TiO₂ uygulamasının siyah renkli kumaşlarda parlaklığı arttırdığı, pembe renkli kumaşlarda matlaştırdığı görülmüştür.

Anahtar Kelimeler: Nano Boyutlu TiO₂, Kendi Kendini Temizleyen, Kamgarn Kumaş, Sol-Jel Yöntemi, Boyama.

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1. Introduction

Titanium dioxide and organic or inorganic modified titanium dioxide find applications in the textile industry for various different purposes such as antibacterial effect, photo-catalysis, self-cleaning ([1], [2]), UV-protecting ([1], [3]), hydrophilicity, super hydrophobicity, dye degradation, water and air purifying. In addition, it is used as gas sensor, photocatalyst in solar cells, co-catalyst for cotton cross-linking and photo-stabilizer of wool [1]. Due to the many uses of TiO₂, research and applications are increasing day by day with the increase of demand. In recent years, there have been some research on positive or negative effects of various textile surfaces after TiO₂ application.

Zgura et al. examined adhesion on materials, an important parameter of deposited thin films, TiO₂ material was applied to polyester textile surface by sol-gel or sputtering methods and its adhesion was examined by ultrasonic method. Despite the low application temperature, the nanoparticles showed good adhesion before and after the test [4].

Mori worked on the effect of 11 different chemicals used in dyeing and finishing processes on wool fabric handle. It was found that the fabric handle is highly dependent on the fabric structure. The study also examined the differences between the damage level of the chemicals and the hydrophilicity of the wool fiber [5].

Mirkhan et al. applied titanium nanoparticles to polyester cotton fabrics to achieve white washing and self-cleaning properties. They also examined the effects of TiO₂ on gloss and transparency, as well as the effects on natural dyed textiles. By checking physical and mechanical properties of cotton fabrics at different times, changes in time-dependent effect of nano-TiO₂ were observed. In the conclusion, it was stated that TiO₂ caused more fading on white samples and the presence of TiO₂ in white samples caused a higher reflection. When the fabrics treated with TiO₂ were subjected to UV treatment, the color strength was lowered. In the TiO₂ applied painted samples, tensile strength, strength and tension within the first 48 minutes found to be higher than the samples without TiO₂. However, it was the opposite after 48 minutes [6].

Harifi and Montazer studied the effect of nano TiO₂ on dyeing behaviour of polyester fabric. The polyester fabric was applied with nano TiO₂ and subsequently painted with two different disperse dyes without a carrier. It was observed that dye adsorption and color strength of TiO₂ pretreated polyester fabrics were increased. In addition, it was proven that there was no adverse effect on the fastness properties [7].

Nazari et al. worked on optimization of nano TiO₂ pretreatment on free acid dyeing of wool using central composite design. In the study, wool acid dyeing nanotechnology was developed at a lower temperature than the boiling point without the use of acid auxiliaries. Wool fabrics were treated with TiO₂ and BTCA (1,2,3,4-butanetetracarboxylic acid) under different conditions and then dyed with 2 different wool acid dyes. Pretreatment on wool surfaces showed significantly improved absorption of acid dyes and higher fastness properties [8].

Xu et al. successfully modified Kroy-processed and the original woolen fabrics by using TiO₂/SiO₂ 70:30 sol with the stabilization of BTCA. All treated and untreated fabrics were investigated by Color Measuring & Matching System and the contact angles of fabrics were evaluated. It was observed that the

total color difference (ΔE) of the coated wool fabrics increased from 30.35 to 43.09 by 42% after the application of the Kroy-treatment. It was also determined that the contact angle of Kroy-finished wool fabric fell from 140.3° to 133.5° [9].

Nateri studied dyed cotton fabrics and compared the properties of these fabrics before and after treatment with TiO₂. Some of these properties were color of fabric, depth of shade etc. In addition to that characterisation studies were carried out using FESEM (field emission scanning electron microscopy) to determine the morphology of coated fabrics [10].

Ahmad et.al. studied on cotton fabric coating with dye sensitized/TiO₂ for self-cleaning and UV blocking properties. Reactive Blue-25 (RB-25) was used as a visible light scavenger for TiO₂. Characterisation of the coated cotton fabric was carried out using FTIR-ATR, UV-Visible absorption, XRD, SEM and reflectance measurements [11].

Frunza et al. investigated functionalized wool fabrics with semiconductor nanoparticles against the photodegradation of Rhodamine B. The samples coated with oxide particles were characterised using optical microscopy, XRD, SEM, TGA, UV-Vis spectroscopy and FTIR-ATR. Rhodamine B solution was applied to the fabrics by sessile drop method. After the fabrics were dried, the change on the sample surfaces were monitored by UV-vis light as the function of the time [12].

Al-Etaibi & El-Asasery investigated the effect of TiO₂ nanoparticles on cotton fabrics dyed at high temperature. Increasing self-cleaning, light fastness, anti UV and antifungal properties were obtained [13].

Kafafy et al. immobilized ZnO, TiO₂, and CuO nanoparticles onto the cotton and wool fabrics at room temperature. After pretreatment of nanoparticles, antimicrobial activity (optical density method), color strength (K/S), colorimetric data (L*, a*, and b*), washing, rubbing, perspiration, and lightfastness of the fabrics were tested. Besides, UV blocking and self-cleaning of the pretreated fabrics were evaluated [14].

In the literature, effects of TiO₂ on dyeing, fastness and fabric hydrophilicity were investigated on different fabrics; and adhesion properties of TiO₂ to the fabrics were observed. However, there are no comparative studies on undyed or dyed TiO₂ treated wool fabrics. In this study, nano TiO₂ was applied to 100% worsted fabric before and after dyeing with Anthra red B and Acid black 194 by sol-gel method and compared to reference fabrics. Analysis was performed to examine the surface properties of the coated fabrics. In addition, the effect of TiO₂ on breaking strength, tear strength, seam slippage, hydrophobicity, fastness and color change of the fabrics were examined comparatively by considering application step. Two different type of dyes, Anthra red B and Acid black 194, were used during these studies. The effect of TiO₂ application to the brightness of the fabrics was measured using spectrophotometer and the effect of TiO₂ presence on dyeing of the fabrics was observed using FTIR-ATR.

2. Material and Method

2.1. Material

Acetic Acid (Glacial 100% EMSURE, anhydrous for analysis) and Nitric Acid 65% (extra pure) were purchased from Merck. Titanium (IV) Isopropoxide (97%) was supplied from Sigma Aldrich.

In this research using the same warp and weft yarn as 100% wool Nm 57/2 with 1100 tpm in Z direction, reed width in 192 cm, reed drawing in at 80/3 has been produced as raw color namely ecru in Yünsa by Dornier weaving machine. Weft setting fabric sample has been 24 cm⁻¹ with straight draft under the same conditions. After weaving, the fabrics were washed in an open width washing machine at 55°C at a transition speed of 22 m/min. Some of the fabrics were pre-treated with TiO₂ using stenter. Then, untreated and pre-treated fabrics were processed with the Anthra red B and Acid black 194 in the wool dyeing program at 98°C for 45 minutes with the same recipe and under the same conditions. After the treatments, pink and black fabrics were successfully obtained. In addition, TiO₂ was applied to some of the untreated dyed fabrics. The performance of all fabrics in ecru, pink and black colors were tested and compared to each other.

The fabrics used in the study were pre-conditioned for 24 hours at standard atmospheric conditions (20 ± 2°C, 65 ± 2% RH). The breaking strength values were determined using Multipurpose Strength Tester, Zwick 1120, at 100 mm/min (stripe method) according to TSE EN ISO 13934-1. The seam slippage strength of the fabrics were determined according to TS EN ISO 13936-1 using Multipurpose Strength Tester, Zwick 1120. The tear strength of the fabric samples were measured using Zwick 1120 strength tester according to TS EN ISO 13937-1. The contact angle of the fabric samples were measured according to ASTM 7490-13. The FTIR spectra were acquired using Agilent Cary 630 FTIR-ATR spectrophotometer in the range of 650-4000 cm⁻¹ spectral region. Color measurement and brightness values were determined using CIE*a*b system as D65-10 measurement with Datacolor 800.

The rubbing fastness evaluation were carried out using the grey scales according to TS EN ISO 105 X12. The test results of the perspiration fastness values for acid and alkaline were determined according to TS EN ISO 105 - E04 standard. The dry cleaning and the water fastness were evaluated according to TS 473 EN ISO 105 D01 and TS EN ISO 105 - E01, respectively.

2.2. Method

2.2.1. Preparing of Sol-Gel

TiO₂ was prepared by sol-gel method in chemistry laboratory of Yünsa. A beaker filled with distilled water and heated up to 80°C. While stirring the solution vigorously with mechanic stirrer at 1200 rpm, Acetic Acid, Nitric Acid and Titanium (IV) Isopropoxide (TTIP) were added respectively. Stirring continued until a homogeneous and transparent solution was obtained [15].

2.2.2. Application Method

Application of the prepared solution to the fabrics was performed using mini stenter which was placed in the finishing department of Yünsa. Washed and dried fabrics were passed through the solution diluted in the ratio of ½. After squeezing at 7.5 bar pressurised cylinder, they were passed through at 180°C drying

and fixation cabin with 1 m/min velocity. The velocity of fans were set at 1800 cycle/min.

3. Results and Discussion

The effect of the application on the breaking strength for all the fabrics can be seen in Table 1. In addition to having no adverse effect of the application on seam slippage, there was only a slight increase in either direction. TiO₂ application had a negative effect on tear strength values for both pre-treated and post-treated black fabrics on warp direction, and post-treated pink fabric on weft direction. When all the contact angle test results were considered, only the result of the post-treated black fabric obtained lower than the others.

To examine the effect of dye binding of TiO₂, change of color fastness tests were carried out and all test results were found to be as required shown in Table 2. The lighter color, pink, gave the better fastness results as expected. It was observed that the application did not have a significant effect on the rubbing fastness. In other fastness tests, it was observed that it had a negative effect of 1 degree, especially on pre-treated fabrics in both colors.

TiO₂ application caused all fabrics to lighten as expected. Although pre-treated pink fabric was lighter in color than post-treated pink fabric, the opposite effect was observed in black fabrics. Considering the Da* and Db* values, it was observed that the application made the fabrics more green and blue; the highest change was observed in pre-treated pink fabric. When DC* values were interpreted, it was observed that TiO₂ application increased the brightness in black colored fabrics, while it dulled the pink colored fabrics. It was determined that pre-treated pink fabric was duller than post-treated pink fabric and the brightest fabric among the fabrics was post-treated black fabric. DE value was above the acceptable limit (≤1) in the both pre-treated pink and post-treated black fabrics (Table 3).

Chemical surface modification of the wool fabric coated with two different dyes and TiO₂ were studied by FTIR-ATR. The first band is the broadest and is observed at around 3400-3100 cm⁻¹ corresponding to the stretching vibration of the -OH and -NH groups.

Two bands at around 1510 cm⁻¹ and 1625 cm⁻¹ are related to the amide groups of the wool material and when the wool fabric was treated with dye or TiO₂, the intensity of the band decreased which shows chemical bonding occurrence. When the dye application was carried out before TiO₂ application, the intensity of the peaks is lower compared to the peaks of the untreated fabrics. When the TiO₂ application is before the dyeing application, the intensity of the peaks lowers less. These values can be seen in the Figure 1 and 2.

Table 1. The technical properties of sample fabrics

Test	Width	Weight	Breaking Strength (warp)	Breaking Strength (weft)	Seam Slippage (warp)	Seam Slippage (weft)	Tear Strength (warp)	Tear Strength (weft)	Contact Angle
Unit	cm	g/m ²	daN	daN	kg	kg	gf	gf	deg.
Standard	-	TSE 251	TS EN ISO 13934-1	TS EN ISO 13934-1	ISO 13936-1	ISO 13936-1	ISO 13937-1	ISO 13937-1	ASTM 7490-13
Untreated / ecru	154	192	32	20	>20	12	2686	1754	130
Treated / ecru	153	200	35	23	>20	18	2752	1623	126
Untreated / pink	154	215	31	24	19	20	2530	1865	126
Pre-treated / pink	153	208	34	25	>20	18	2442	1902	128
Post-treated / pink	150	213	36	25	>20	>20	2683	1622	133
Untreated / black	142	226	33	23	20	15	3021	1529	131
Pre-treated / black	143	239	39	25	>20	20	2687	1698	134
Post-treated / black	147	219	36	26	>20	>20	2685	1542	115

Table 2. Change color of fastness of the fabrics

Test	Rubbing Fastness (dry)	Rubbing Fastness (wet)	Perspiration Fastness-Acid	Perspiration Fastness-alkaline	Dry Cleaning Fastness	Water Fastness
Unit	Color Change	Color Change	Color Change	Color Change	Color Change	Color Change
Standard	TS EN ISO 105-X12: 2006	TS EN ISO 105-X12: 2006	TS EN ISO 105 E04	TS EN ISO 105 E04	TS 473 EN ISO 105 D01	TS EN ISO 105 E01
Standard	≥3.5	≥2.0	≥4.0	≥4.0	≥4.0	≥4.0
Untreated / pink	4.5	4.0	5.0	5.0	5.0	5.0
Pre-treated / pink	5.0	4.5	4.0	4.0	4.5	4.5
Post-treated / pink	5.0	4.0	5.0	5.0	5.0	5.0
Untreated / black	3.0	2.0	4.5	4.5	4.5	4.5
Pre-treated / black	3.5	2.5	4.0	4.0	4.0	4.0
Post-treated / black	3.0	2.0	4.5	4.5	4.5	4.5

Table 3. The color value changes on the spectrophotometer after TiO₂ application

Sample	DL*	Da*	Db*	DC*	CMC dE	Result
Pre-treated / pink	4.00	-4.92	-1.18	-4.66	3.00	Fail
Post-treated / pink	0.40	-0.95	0.07	-0.95	0.47	Pass
Pre-treated / black	0.26	-0.02	-0.17	0.16	0.36	Pass
Post-treated / black	1.07	-0.09	-0.53	0.51	1.31	Fail

	DL*	Da*	Db*	DC*
+	lighter	more red	more yellow	brighter
-	darker	more green	more blue	duller

CIE*a*b system with D65-10 measurement

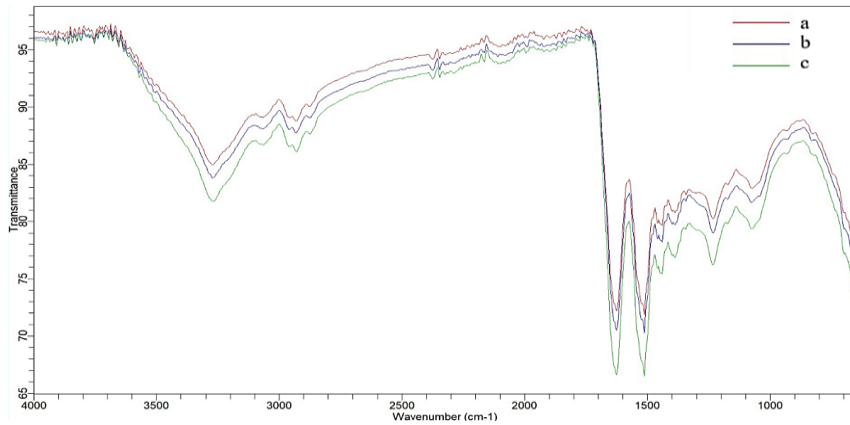


Figure 1. FTIR spectrums of pink colored fabrics which TiO₂ was applied to a) treatment after dyeing, b) treatment before dyeing, c) untreated

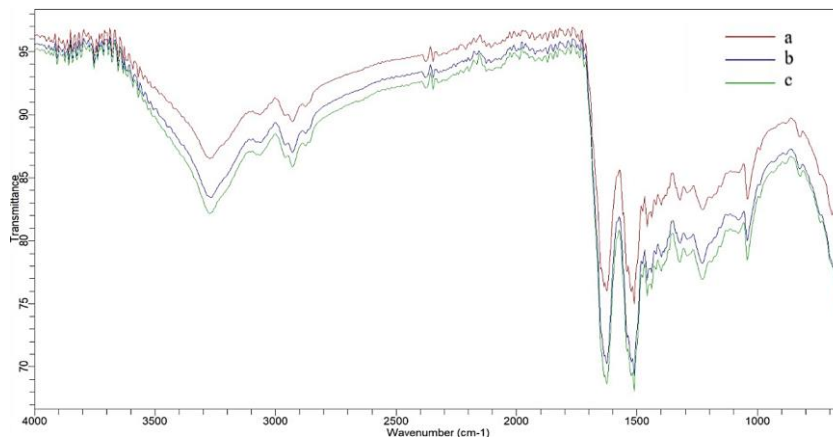


Figure 2. FTIR spectrums of black colored fabrics which TiO₂ was applied to a) treatment after dyeing, b) treatment before dyeing, c) untreated

4. Conclusions and Recommendations

In this study, nano-sized TiO₂ was applied to 100% worsted fabric before and after dyeing with Anthra red B and Acid black 194 by sol-gel method and compared to reference fabrics.

DE value was obtained above the acceptable limit (≤ 1) in the both pre-treated pink and post-treated black fabrics. As the dyeing process performed before TiO₂ application, the intensity of the peaks is the lowest and for untreated is the highest at FTIR spectrum. The fastness test results could not be correlated with logical explanations. However, spectrophotometer test results based on the color evaluations performed. The duller was

obtained for pre-treated pink fabric but the brightest color for the post-treated black fabric.

It is seen that nano-sized TiO₂ application to 100% worsted fabric before and after dyeing affects the color shades. It was observed that this situation changes from color to color; so more experiments can be carried out on the worsted fabrics dyed with different colors in the future studies.

5. Acknowledge

The author would like to thank the personnel of Yünsa for their help during the experimental phase of this study.

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Quantitative study for the effect of water velocity on water quality change

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Abstract

Atmospheric reaeration process plays a key role in degradation of organic matter and self-purification processes affecting dissolved oxygen (DO) concentrations in rivers and streams. Moreover, water quality (WQ) processes can be highly dependent on flow velocity conditions. Where, highly reaeration rates are positively correlated with high flow velocity. Therefore, the present work reports deep insights on the role of flow velocity with reaeration process in the concentration of DO and biochemical oxygen demand (BOD₅). This study was applied along the largest agricultural drainage water reuse project, El-Salam Canal in Egypt. The hydrodynamic (HD) characteristics and WQ parameters (DO and BOD₅) along the canal were simulated using a one-dimensional HD and WQ model (MIKE 11). The simulated results indicated that the canal was deteriorated towards El-Salam Canal after mixing with El-Serw and Bahr Hadous drains. Statistical regression fitted line and Pearson correlation analysis, were performed on the simulation results of the reaeration rates with flow velocity and WQ values, indicating a significant correlation. Accordingly, water velocity should be taken into account as a key factor for describing the WQ change.

Keywords: El-Salam Canal, flow Velocity, MIKE 11, Water Quality.

Su hızının su kalitesi değişimi üzerindeki etkisine yönelik nicel çalışma

Öz

Atmosferik yeniden havalandırma süreci, nehirlerde ve akarsularda çözülmüş oksijen (DO) konsantrasyonlarını etkileyen organik maddenin bozunmasında ve kendi kendini saflaştırma süreçlerinde kilit bir rol oynar. Ayrıca, su kalitesi (WQ) süreçleri büyük ölçüde akış hızı koşullarına bağlı olabilir. Burada, yüksek yeniden havalandırma oranları, yüksek akış hızı ile pozitif olarak ilişkilidir. Bu nedenle, mevcut çalışma, DO konsantrasyonunda ve biyokimyasal oksijen ihtiyacında (BOD₅) yeniden havalandırma işlemi ile akış hızının rolü hakkında derin görüşler bildirmektedir. Bu çalışma, Mısır'daki en büyük tarımsal drenaj suyu yeniden kullanım projesi olan El-Salam Kanalı boyunca uygulandı. Kanal boyunca hidrodinamik (HD) özellikler ve WQ parametreleri (DO ve BOD₅), tek boyutlu bir HD ve WQ modeli (MIKE 11) kullanılarak simüle edilmiştir. Simüle edilen sonuçlar, kanalın El-Serw ve Bahr Hadous drenleri ile karıştırıldıktan sonra El-Salam Kanalı'na doğru bozulduğunu gösterdi. Yeniden havalandırma hızlarının simülasyon sonuçları üzerinde, akış hızı ve WQ değerleri ile istatistiksel regresyon uydurma çizgisi ve Pearson korelasyon analizi yapılmış ve önemli bir korelasyona işaret edilmiştir. Buna göre, su hızı, WQ değişimini açıklamak için kilit bir faktör olarak dikkate alınmalıdır.

Anahtar Kelimeler: El-Salam Kanalı, Akış Hızı, MIKE 11, Su Kalitesi.

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1. Introduction

Atmospheric reaeration process plays a key role in degradation of organic matter and self-purification processes affecting dissolved oxygen (DO) concentrations in rivers and streams[1]. Where, DO concentrations are an important index for quantifying the water quality (WQ) of water bodies. Moreover, the level of DO reflects the ecological balance in water, decomposition of organic matter and breathing of aquatic ecosystem [2].

Recent studies illustrated that the DO distribution in water bodies has been strongly affected by the flow field and its turbulence characteristics [3]. Moreover, WQ processes can be highly dependent on flow velocity conditions. Where, highly reaeration rates are positively correlated with high flow velocity [4]. Based on the role of flow velocity with reaeration process in the concentration of DO and biochemical oxygen demand (BOD₅) were investigated.

To date, WQ models are an ideal approach in the holistic evaluation and prediction of temporal and spatial water quantity and quality characteristics in aquatic ecosystems [5]. As, the Environmental Fluid Dynamics Code (EFDC), SOBEK software, Delft 3D, MIKE software and the Water Quality Analysis Simulation Program (WASP). Among them, the one-dimensional finite-difference model MIKE 11 is considered the most widely used hydrodynamic (HD) and WQ simulation software. The MIKE 11 has proved its computational stability, high accuracy and reliability, and accordingly it can be applied in large-scale designs of both simple and complex channel systems [6].

Therefore, the HD and WQ model (MIKE 11) was developed and applied along El-Salam Canal in Egypt. It is considered the largest agricultural drainage water (ADW) reuse project in Egypt, which is mainly used for reclamation of 620,000 hectares of the land located along the Mediterranean Sea of Egypt [5]. In 2013, El-Salam Canal is established for reuse with a capacity of approximately 0.872 Billion Cubic Meters (BCM)/year from the Nile water to be mixed with 1.235 BCM/year of water from Bahr Hadous drain, 0.980 BCM/year from El-Serw drain and 0.255 BCM/year from Faraskor drain [7].

Thus, the present study reports deep insights on the role of flow velocity with reaeration process in the concentration of DO and BOD₅ values which resulted from the MIKE 11 simulation.

2. Material and Method

2.1. Study Area

El-Salam Canal is a part of the North Sinai development project, which is the largest drainage water reuse project in Egypt that continuously receives a mixture of Nile River water and ADW. The canal is lied in the Eastern North region of the Nile Delta, with a total length of 88 km (Figure 1a). The canal receives Nile fresh water from the Damietta tributary of which situated at upstream of Faraskor Dam. The ADW supply sites from Faraskor, El-Serw, and Bahr Hadous drains at distances of 1.80 km, 17.85 km, and 54 km from the intake, respectively (Figure 1b). This mixed water is mainly used to cultivate 220,000 hectares extending west of Suez Canal along the Mediterranean coast of Egypt [8]. By constructing Pump Stations 1 and 2 units, the flow rates along the main-stream of El-Salam Canal are controlled, to sustain a proper head for gravity flow (Figure 1b).

The monthly water discharges records along the canal were obtained from the Ministry of Water Resources and Irrigation (MWRI) for seven locations from the intake of the canal at 0.0 km, 1.80 km, 17.85 km, 22 km, 53 km, 54 km and 88 km, from September 2012 to August 2014. Moreover, the average monthly WQ data were collected by the Drainage Research Institute (DRI) from September 2013 to August 2014 at five locations at 0.0 km, 1.80 km, 17.85 km, 54 km and 88 km along the canal.

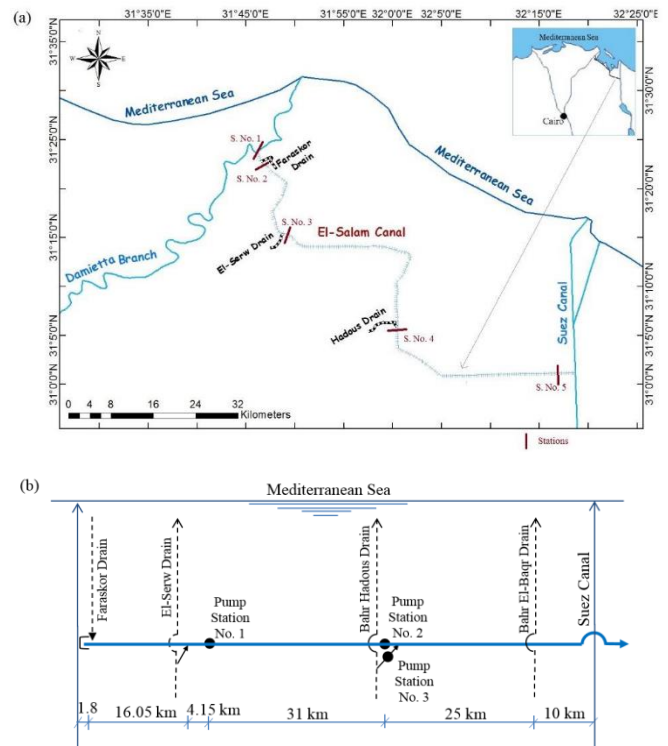


Fig. 1 (a) El-Salam Canal project layout, (b) schematic diagram of El-Salam Canal connected with Damietta Branch and agricultural drains

2.1.1. Water Quality Modeling

The ‘MIKE 11’ model was applied in this study to simulate the HD and WQ along El-Salam Canal. This model was originally developed by Danish Hydraulic Institute, for simulating hydrodynamics, advection-dispersion, WQ and sediment transport in rivers, lakes, estuaries and environmental hydraulics [9].

In the study, 88 km length of El-Salam Canal, with number of structures, specifically the head regulator of the canal intake, two siphons and two pump stations, was modelled. The MIKE 11 boundary editor was used to define the water levels and inflow hydrographs, where the initial upstream water level was set to 1.60 m. The simulation time step was set to five seconds to ensure the stability of the numerical calculations and keep the Courant number in the desired model’s range [9].

The calibration process of the HD model was performed manually to adjust the Manning’s roughness coefficient (*n*, sec/m^{1/3}) along El-Salam Canal, which considered the most critical factor in the HD simulation model [10]. The model was continuously run using HD data over one year from September 2012 to August 2013 to minimize the difference between the simulated and observed discharge records at two locations (Pump

Station 1 at 22.0 km and Pump Station 2 at 53.0 km), in the calibration phase.

For validation, the calibrated model was run using the data for a completely different year (from September 2013 to August 2014) to assess the ability to predict the water quantity and WQ under different conditions. The root mean square error (*RMSE*), mean absolute error (*MAE*) and normalized objective function (*NOF*) were applied to investigate the calibration and validation accuracy as follows:

$$RMSE = \sqrt{\sum (Simulated\ value - Observed\ value)^2 / N}$$

$$MAE = \sum_1^N |Simulated\ value - Observed\ value| / N$$

$$NOF = RMSE / O_{mean}$$

where:

N = the total number of values, and

O_{mean} = mean of the observed data.

Model simulations are acceptable for *NOF* values ranging from 0 to 1 [11].

3. Results and Discussion

The one-dimensional HD MIKE 11 model was developed to simulate the water quantity along El-Salam Canal. Firstly, the calibration process was performed from September 2012 to August 2013, enhancing the n value which achieved the lowest error was 1/40 sec/m^{1/3}. The results of performance statistics between the monthly observed and simulated discharges for Pump Stations 1 and 2 were 1.66 and 1.10 m³/s of *RMSE*, 1.29 and 0.99 m³/s of *MAE* and 0.02 of *NOF*, respectively. Secondly, from September 2013 to August 2014, the validation process displayed a good level of agreement between the simulated and observed discharges at Pump Stations 1 and 2. Where, the *RMSE*, *MAE* and *NOF* values were 2.94 m³/s, 2.24 m³/s and 0.04 for Pump Station 1, and 1.39 m³/s, 1.06 m³/s and 0.02 for Pump Station 2, respectively. The simulated results for the discharges of pump stations achieved from the model calibration and validation were consistent with the observed discharge values (with the low *NOF* values close to 0) evidenced the ability of the model to correctly simulate and investigate the impact of various processes along the canal. For the ECO Lab module (September 2013 to August 2014), the DO and BOD₅ values were calibrated at two different locations at: (1) 1.9 km after mixing with Faraskor drain (S. No. 2); and (2) 86 km before the downstream of the canal from the intake (S. No. 5), as shown in Figure 1a, (Table 1).

Overall, the model provided a reasonable agreement between the simulated and observed WQ data along El-Salam Canal.

The simulated DO and BOD₅ values were compared with the Egyptian standards for water reuse in irrigation purposes from September 2013 to August 2014 along El-Salam Canal at four selected stations from the intake and after mixing with the agricultural drains as shown in Figure 2. The four stations (S. No. 1, S. No. 2, S. No. 3 and S. No. 4) were located at 0.0 km, 1.85 km, 18.5 km and 55.0 km, from the intake, respectively, as shown in Figure 1a.

Table 1. The *RMSE*, *MAE*, and *NOF* for water quality parameters of El-Salam Canal

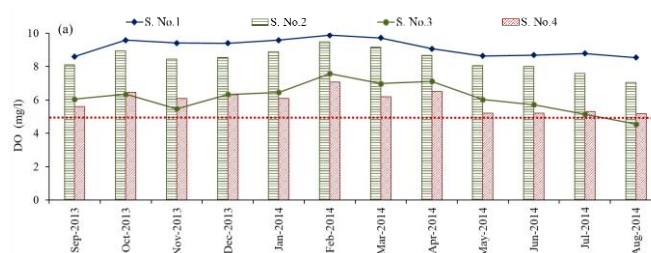
WQ Parameter	At 1.9 km			At 86 km		
	<i>RMSE</i>	<i>MAE</i>	<i>NOF</i>	<i>RMSE</i>	<i>MAE</i>	<i>NOF</i>
Temperature	0.02	0.01	0.001	0.09	0.09	0.004
DO	0.56	0.46	0.07	1.77	1.52	0.39
BOD ₅	3.00	2.42	0.16	3.90	2.57	0.14

The simulated average monthly data for DO along El-Salam Canal varied from 4.5 mg/l to 9.88 mg/l, during September 2013 to August 2014, as presented in Figure 2a. The DO concentrations were within the Egyptian standards (DO > 5 mg/l) for direct reuse in irrigation along El-Salam Canal except at El-Serw drain (S. No. 3) in August. A significant decrease was observed in the DO levels after El-Serw (S. No. 3) and Bahr Hadous drains (S. No. 4), Figure 2a. For instance, the average DO concentration after the connection with El-Serw drain was 4.5 mg/l and 5.1 mg/l after the connection with Bahr Hadous drain in August. This was mainly due to the discharge of pollutants into these drainage canals resulting a depletion of oxygen concentration. [12], reported that the DO values decreased sharply towards the down-stream of El-Salam Canal after mixing with El-Serw and Bahr Hadous drains, which is consistent with the simulation results. Moreover, El-Gammal and Othman et al [8], [13] indicated that El-Serw and Bahr Hadous drains received a significant amount of untreated wastewater which subsequently adversely affected the DO concentration of El-Salam Canal.

As presented in Figure 2b, the simulated BOD₅ values along El-Salam Canal complied with the Egyptian standards (BOD₅ < 30 mg/l) for the direct water reuse for irrigation. However, the simulated BOD₅ concentration gradually increased from the intake point towards the down-stream after the connection with the drainage canals, as it exceeded the limit of 30 mg/l for reuse in May and June 2014, Figure 2b. The highest values of BOD₅ were 41.6 mg/l and 60.9 mg/l in May, and 34.3 mg/l and 44.7 mg/l in June at (S. No. 3) after mixing with El-Serw drain and at (S. No. 4) after mixing with Bahr Hadous drain, respectively. [14] reported that the supply of ADW to the canal caused high levels of BOD₅. Where, the BOD₅ values were 75 mg/l in June 2004 and 33 mg/l in November 2004 after mixing with El-Serw drain.

Therefore, the BOD₅ values of the canal were varied due to seasonal effects, as the high BOD₅ values were during summer season. It could be due to the discharge of wastewater rich inorganics into the drains, which negatively affected the WQ of the canal.

These results illustrated that the canal ecosystem deteriorated after mixing with water from El-Serw and Bahr Hadous drains due to the highly polluted untreated water discharged into the drains.



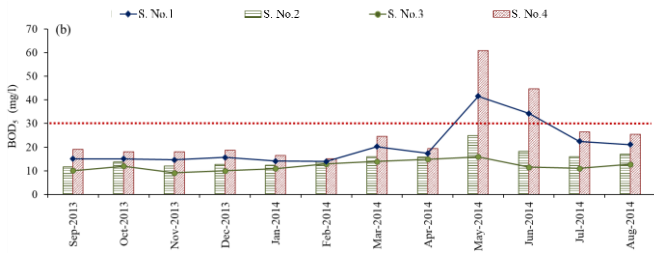


Fig. 2 Simulated (a) DO and (b) BOD₅ parameters at four stations (Stations No. 1–4) for the period from September 2013 to August 2014.

Statistical analysis was performed on the simulation results for obtaining quantitative relationships using Minitab software with a significance level of $p < 0.05$. The inversely proportional between the DO and BOD₅ results was clearly showed from the simulated distribution along the canal, as Figure 3. Where, the high BOD₅ associated with the degradation of organic matters by heterotrophic bacteria occurred due to the decrease of DO [15]. These results were confirmed with the results of Pearson correlation analysis (r), which applied to evaluate the relationship between various variables. DO showed a significant strength negative relationship with BOD₅ ($r = -0.975, p < 0.05$), as Figure 4a, that obviously illustrated the fitted regression line between the DO and BOD₅ parameters.

Where, the DO deficit in the waterbody was proportional with the reaeration process, which, considered the difference between the saturated DO and the present DO concentration in the waterbody [16]. The higher rate of reaeration rates indicates the larger DO deficit. Moreover, the large reaeration process positively based on water flow capacity, which lead to strong turbulence and mixing activities in the waterbody, as presented in Figure 3. Therefore, the correlation between the flow velocity and reaeration rate was displayed, as shown in Figure 4b. The result of relationship between reaeration rates and flow velocity along the canal were demonstrated a significant positive correlation ($r = 0.910, p < 0.05$).

Accordingly, water flow velocity is considered a key role for describing the WQ change along the canal, which should be taken into account in investigating various WQ processes in waterbodies.

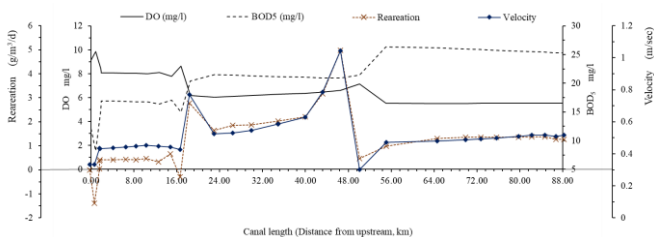
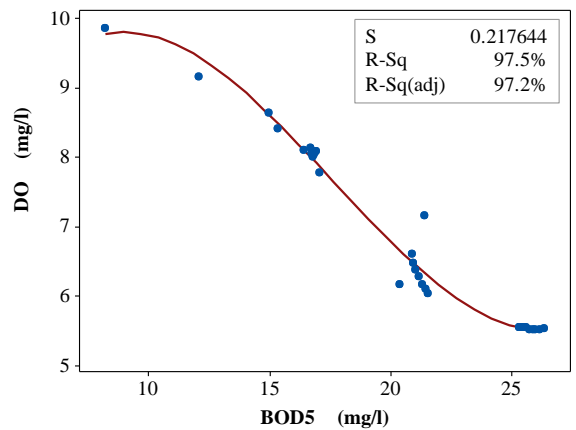


Fig. 3 The distribution of flow velocity, reaeration process and the simulated WQ parameters in terms of DO and BOD₅, along El-Salam Canal from September 2013 to August 2014.

(a) Regression Fitted Line Plot
 $DO = 5.008 + 1.200 BOD - 0.08947 BOD^2 + 0.001694 BOD^3$



(b) Regression Fitted Line Plot

$$Velocity = 0.4015 + 0.05736 Reaeration + 0.02150 Reaeration^2 - 0.001292 Reaeration^3$$

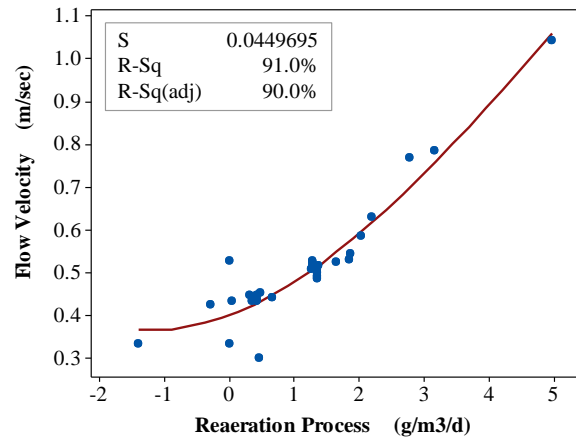


Fig. 4 The regression fitted line results between (a) DO with BOD₅ parameters, and (b) flow velocity with reaeration process values, along El-Salam Canal from September 2013 to August 2014.

5. Conclusion

This study was applied along the largest agricultural drainage water (ADW) reuse project, El-Salam Canal in Egypt. A one-dimensional HD and WQ model (MIKE 11) were developed to acquire the HD characteristics and WQ parameters (DO and BOD₅) along the canal. The calibration of HD module was applied from September 2012 to August 2013 and the verification process was from September 2013 to August 2014 along El-Salam Canal. The WQ module was developed and calibrated for the period from September 2013 to August 2014. The simulated results evidenced the reliability of the model in simulating the water quantity and WQ along the canal with a reasonable agreement between the observed and simulated data. The results illustrated that the WQ deteriorated towards the downstream of the canal due to the polluted water discharged from the El-Serw and Bahr Hadous drains. Statistical analysis was performed on the simulation results for obtaining a quantitative relationship, as regression fitted line and Pearson correlation analysis. The results showed that the DO with BOD₅ and reaeration rates with flow velocity values had a significant correlation of ($r = -0.975$) and ($r =$

0.910), respectively. Accordingly, water velocity is an important parameter which should be taken into account for describing the water quality change.

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Is the recycling of purified water from the Ain El Arbaa region for agricultural purposes possible?

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Abstract

The region of Ain El Arbaa, like all Algerian municipalities, suffers from a water shortage crisis. The main objective of this work is to investigate the possibility of reusing treated water from the region.

For this purpose, we have examined the quality of the water treated by the D'Ain El Arbaa treatment plant.

The analyzes carried out on the incoming sewage and outgoing waste water from the lagoon focused on the following parameters: (pH, total suspended solids (TSS), biological oxygen demand (BOD₅), chemical oxygen demand (COD), NH₄, electrical conductivity). This during the period from January 2021 to May 2021 with a sampling frequency of twice a month.

The results obtained show that this purification process using two sectors (pre-treatment, secondary treatment) is insufficient and does not meet the quality standards required for agricultural use for the parameters: TSS, COD, and electrical conductivity. For the preservation of the receiving environment, the results did not comply with the standards for the parameters TSS, DOC, NH₄.

The abatement yields of the lagoon treatment plant studied were average for all the parameters studied.

So according to this work we can conclude that natural lagooning alone is not sufficient to have purified water that complies neither with the quality required for agricultural reuse, nor with the quality required for discharge into the natural environment.

Then the addition of a complementary tertiary treatment, such as filter basins planted with macrophytes is necessary.

Keywords: wastewater, purification, Algeria, Ain El Arbaa. recycling of purified water,

Ain El Arbaa bölgesinden arıtılmış suyun tarımsal amaçlar için geri dönüşümü mümkün mü?

Öz

Ain El Arbaa bölgesi, tüm Cezayir belediyeleri gibi bir su kıtlığı krizi yaşıyor. Bu çalışmanın temel amacı, bölgeden arıtılmış suyun tekrar kullanılma olasılığını araştırmaktır.

Bu amaçla D'Ain El Arbaa arıtma tesisi tarafından arıtılan suyun kalitesini inceledik.

Lagüne gelen kanalizasyon ve lagünden çıkan atık sularda yapılan analizlerde şu parametrelere odaklanılmıştır: (pH, toplam askıda katı madde (TSS), biyolojik oksijen ihtiyacı (BOD₅), kimyasal oksijen ihtiyacı (COD), NH₄, elektriksel iletkenlik). Bu, Ocak 2021'den Mayıs 2021'e kadar ayda iki kez örnekleme sıklığı ile yapılır.

Elde edilen sonuçlar, iki sektör (ön arıtma, ikincil arıtma) kullanılarak yapılan bu saflaştırma işleminin yetersiz olduğunu ve TSS, KOİ ve elektriksel iletkenlik parametreleri için tarımsal kullanım için gerekli kalite standartlarını karşılamadığını göstermektedir. Alıcı ortamın korunması için, sonuçlar TSS, DOC, NH₄ parametreleri için standartlara uymadı.

İncelenen lagün arıtma tesisinin azaltma verimleri, incelenen tüm parametreler için ortalamaydı.

İncelenen lagün arıtma tesisinin azaltma verimleri, incelenen tüm parametreler için ortalamaydı.

Dolayısıyla bu çalışmaya göre, ne tarımsal yeniden kullanım için gerekli kaliteye ne de doğal çevreye deşarj için gerekli kaliteye uygun olmayan arıtılmış suya sahip olmak için doğal göllenmenin tek başına yeterli olmadığı sonucuna varabiliriz.

Ardından, makrofitlerle ekilen filtre havuzları gibi tamamlayıcı bir üçüncül işlemin eklenmesi gerekir.

Anahtar Kelimeler: atık su, arıtma, Cezayir, Ain El Arbaa. Arıtılmış suyun geri dönüşümü.

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1. Introduction

Natural lagooning is a purification system grouping together two or three ponds in series or more, whose principle of operation is based on natural forces, without any energy input.

Among the most used configurations, we find: anaerobic lagoon, facultative lagoon, maturation lagoon. Therefore it is a question, on the one hand, of promoting the slow flow of water in successive basins, and on the other hand of relying on a biological association covering an entire food chain (aerobic bacteria, anaerobic bacteria, algae or phytoplankton, zooplankton in some cases. [1].

Natural lagooning has many advantages, among which we can cite:

- The low operating cost, little or no electricity, and the good landscape integration. In addition it is very effective in the elimination of pathogens, nitrogen and phosphorus;
- Lower sludge production (compared to an activated sludge treatment plant); therefore the need for cleaning is infrequent once every 10 years in the first basins and more easily recoverable sludge. [2]
- On the other hand, the disadvantages of natural lagooning are as follows:
 - The strong grip on the ground;
 - the presence of a high concentration of suspended solids in the discharged water;
 - Seasonal variations in the quality of purified water;
 - In the event of low purification performance, the risk of odors and the development of insects (mosquitoes) is very high. [3].

Due to the low purification performance of natural lagoons, an association of existing lagoons + 2 vertical planted filter floors is used in several cases around the world. Increasing quality requirements for sensitive environments leads to the necessity to development of complementary treatments.

A study in an experimental station in the commune of Aurignac (France) has shown that the introduction of a percolation infiltration system downstream of a lagoon improves the quality of the effluent and respects the level D4: $COD \leq 125 \text{ mg/l}$, $BOD_5 \leq 25 \text{ mg/l}$. [4]

2. Material and Method

To study the quality of treated water in the municipality of Ain Arbaa. we analyzed incoming and outgoing wastewater during the period from January 2021 to May 2021. The physicochemical parameters studied are: pH, biological oxygen demand (BOD5), chemical oxygen demand, total suspended solids (TSS), dissolved oxygen, ammonium (NH_4^+), and electrical conductivity.

2.1. Geographical location of the study area:

The municipality of Ain El Arbaa is located east of the capital of Wilaya de Ain Témouchent, 35 km away, covers an area of 71 km². It is delimited:

- to the north by the great Sebkhia.

- to the south-west by the municipality of Sidi Boumedienne,
- to the south east by the municipality of Tessala.
- to the east, the commune of Oued Sebbah
- to the west by the commune of hammam Bouhadjar.

The geographical location of Ain El Arbaa is shown in Figure 01.



Figure 01: Geographical location of Ain El Arbaa

2.2. Climate:

In the climatic context we will describe precipitation, temperature, and evaporation. The temperature and precipitation values were recorded in the Hammam Bouhdjar station during the period: 1994-2001.

a. Precipitation:

The rainfall of the region is shown in figure 02.

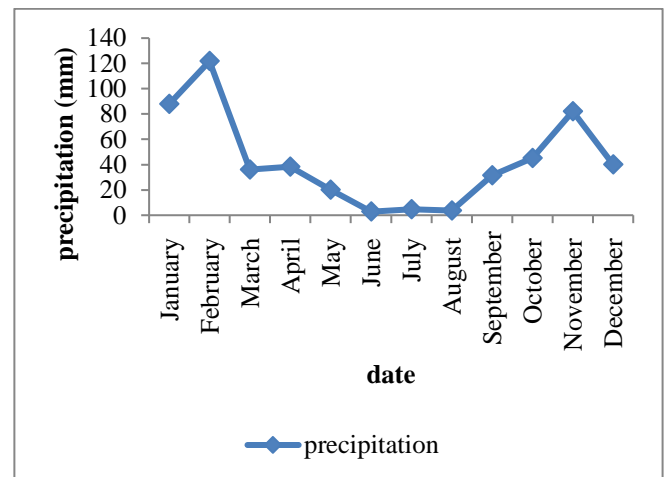


Figure 2: Monthly average rainfall (1994-2001)

From figure 02, we notice that the precipitation has imploring values during the winter season (December, January, February), the maximum value was recorded during the month of January with 120 mm, then the precipitation begins to decrease gradually

during the period: March to August, the minimum value is recorded in August 3.67mm. In September the precipitation begins to have the important values wich are between 31.63 mm in September to 88.25 in November.

b. The temperatures:

The temperatures are shown in Figure 3.

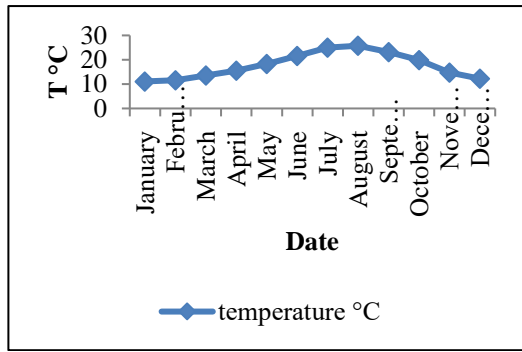


Figure 3: Monthly temperature variation (1994-2001)

From Figure 3, we notice that the minimum temperature is recorded during the month of January (with 11.1°C), then they begin to increase to record the maximum value during the month of August (with 25.75°C). From September the temperature begins to decrease until December when the value of 12.2 °C is recorded.

c. Evaporation :

The maximum evaporation is reached in August (with 165mm) and the minimum in January (with 69.1mm). It is greater than 100 mm for seven months of the year.

2.3. Description of Ain El Arbaa treatment plant:

The lagoon of Ain El Arbaa is composed of:

2.3.1. Pretreatment:

The pre-treatment of the Ain arbaa lagoon consists of a screen with a spacing between the bars: E = 60 mm, and two grit and oil separators

2.3.2. Biological treatment:

The biological treatment consists of two anaerobic basins, two facultative basins and two maturation basins.

3. Results and Discussion

3.1. Results

The results obtained are shown in figures 04, 05, 06, 07, 08, 09, 10, 11.

• pH :

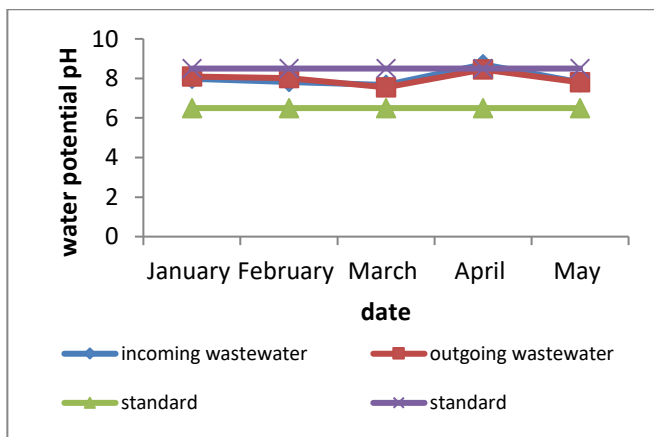


Figure 04: Changes in pH

• Dissolved Oxygen:

The dissolved oxygen values are shown in figure 05 in mg/l.

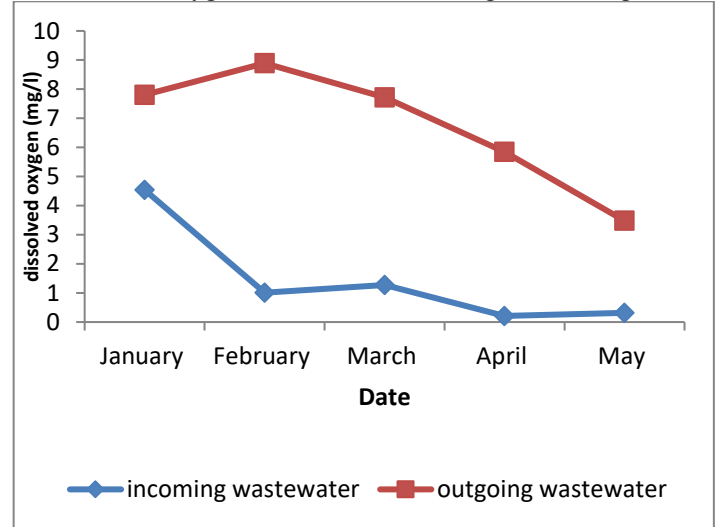


Figure 05: Changes in Dissolved Oxygen

• Total Suspended solids (TSS):

The concentrations of incoming and outgoing wastewater in total suspended solids are indicated in figure 06.

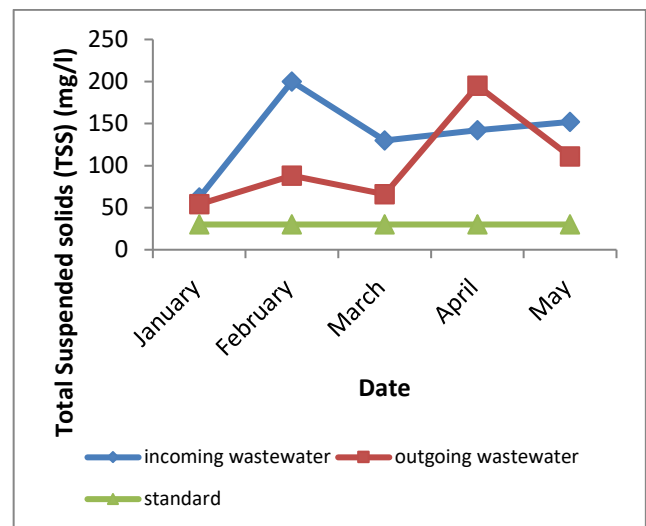


Figure 06 : Changes in TSS concentration

• The biological oxygen demand (BOD₅):

The concentrations of incoming and outgoing wastewater in BOD₅ are indicated in figure 07 in mg/l.

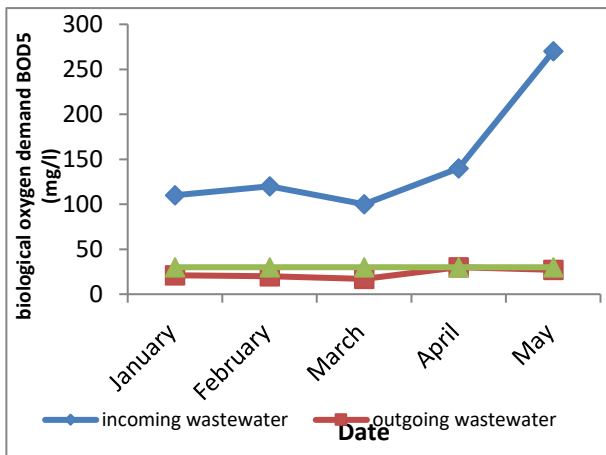


Figure 07: Changes in BOD₅ Concentration

The chemical oxygen demand (COD) :

The concentrations of wastewater entering and leaving the lagoon are shown in figure 08.

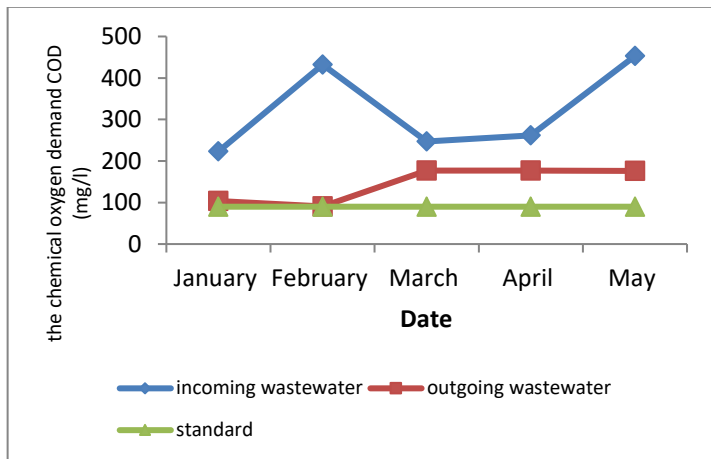


Figure 08: Changes in COD Concentration

Ammonium NH₄:

The NH₄ concentrations of incoming and outgoing wastewater are indicated in figure 09 in mg/l.

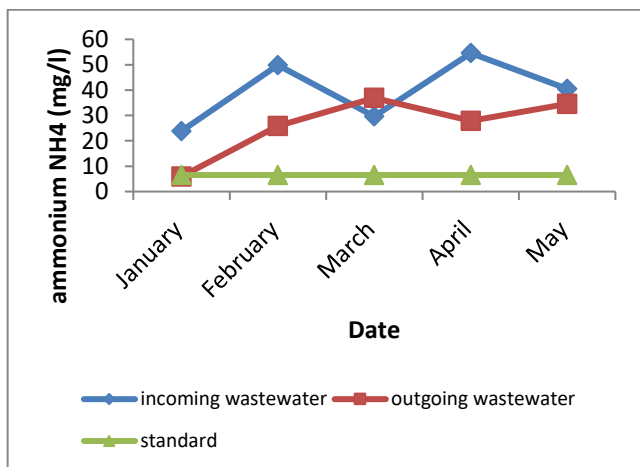


Figure 09: Changes in NH₄

Electrical conductivity (EC) :

Incoming and outgoing wastewater conductivities are shown in Figure 10.

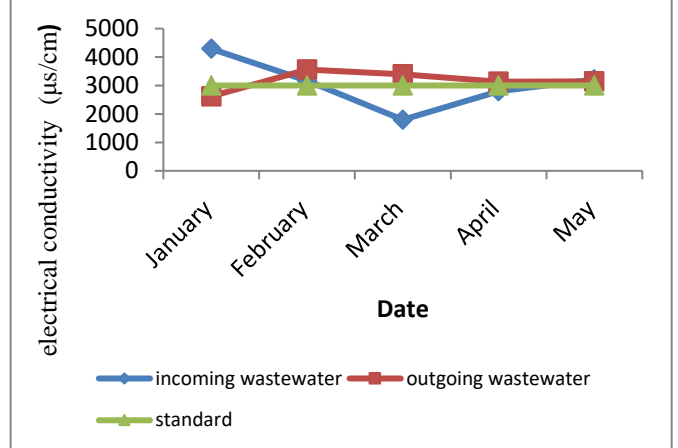


Figure 10: Changes in Electrical conductivity

3.2. DISCUSSION

pH:

From Figure 04, we notice that: the pH graphs of the incoming and outgoing wastewater are almost confused, which leads us to conclude that the pH variation is very small. In addition, the pH values of incoming and outgoing wastewater are located between the values limited by Algerian standards (6.5 ≤ pH ≤ 8.5). So for the pH we can say that the quality of the water purified by this process complies with the standards of agricultural reuse, and with the standards for discharge into the natural environment.

Dissolved Oxygen:

From Figure 05, we see that there is a very good improvement in the level of oxygen saturation in the purified water. This can be justified by the good degradation of organic pollution. This increase in oxygen concentration comes from dissolved oxygen in the atmosphere, without forgetting the additional quantity provided by the operation of photosynthesis by algae.

Total Suspended solids (TSS):

From figure 06, we notice that the concentrations of incoming wastewater are very high, varying between 60 to 200 mg/l. the concentrations of outgoing water are less significant, which means that there is a degradation of suspended solids which varies between low and medium.

The minimum yield of removal of TSS is recorded in January with 12 %, and the maximum yield is 56 % during the month of February. In the lagoon of Ain El Arbaa, we had a low average yield of TSS reduction like all natural lagoons without tertiary treatment around the world.

This high concentration of suspended solids in the purified water can be explained by the quantity of algae remaining in the purified water.

The concentrations of the outgoing wastewater are all above the standard (30 mg/l), so the efficiency of the Ain El Arbaa lagoon is very low in the elimination of suspended solids

The biological oxygen demand (BOD₅):

From Figure 07, we notice that the BOD₅ abatement is significant, such that the minimum yield is 70%, the maximum yield is 90%, and the average yield is 82.8%.

The concentrations of the outgoing wastewater are all below the value limited by the standards for agricultural reuse and the preservation of the natural environment (30 mg/l). So the natural lagoon treatment process is effective in eliminating organic pollution.

- **The chemical oxygen demand (COD) :**

From Figure 08, we notice that the graphs of incoming and outgoing wastewater are not very far from each other, which means that there is an average removal of COD.

The values of the average, minimum and maximum COD abatement yields are as follows: 50.6 %, 28 %, and 79 %.

We also notice that all the concentrations of outgoing water are higher than the value set by the standards for agricultural reuse.

- **Ammonium NH₄:**

We note that there is an average decrease in the concentrations of wastewater in NH₄, but the outgoing values remain above the standard for the preservation of the receiving environment (6.5 mg/l). The average ammonium abatement yield is low 32.51%, the maximum yield is 75.14%, and the minimum yield is -24.33%.

For the standards of agricultural reuse there is no limit value, because this element is considered as fertilizing material.

- **Electrical conductivity (EC) :**

We notice that there is a decrease in conductivity in the months of January and May, and an increase in February, March and April. This increase can be explained by the quantity of salts added by the degradation of organic matter.

The electrical conductivity values of the outgoing water exceeded the maximum value set by the standard for agricultural reuse.

4. Conclusions and Recommendations

From this study, we can conclude that:

Natural lagooning containing two purification channels (pre-treatment and biological treatment) gives satisfactory results for the parameters: pH and BOD₅. On the other hand, the purification is insufficient and the concentrations of purified water are higher than the maximum values fixed by the standards for the parameters : TSS, COD, and conductivity.

For the NH₄ parameter, the results are acceptable for agricultural reuse and unacceptable for discharge into the natural environment.

We recommend to complete the lagooning of Ain El Arbaa with a tertiary treatment ..

5. Acknowledge

- Recycling purified water is a solution for reducing water stress.
- The quality of the purified water of Ain El Arbaa is not adequate with the standards for reuse or with the standards for the preservation of the environment.
- Tertiary treatment is essential and makes it possible to reuse treated water.

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Mikro Rüzgâr Türbin Modelleri Üzerine Bir Araştırma

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Öz

İnsanoğlunun geçmişten günümüze kadar olan en büyük sorunlarından biri enerji ihtiyacı olup teknolojinin günden güne ilerlemesiyle birlikte hayatın tüm evresindeki gereksinimlerini enerji kaynakları karşılamıştır. Günümüzde iklim değişiklikleri ele alınırken gelecekteki dünya enerji ihtiyaçlarını karşılamak için konvansiyonel enerji kaynakları üzerinde daha fazla baskı oluşmaktadır. Sürdürülebilir enerji kaynaklarından biri rüzgâr enerjisidir. Fosil yakıtlarla karşılaştırıldığında rüzgâr enerjisi, bugün dünyanın karşı karşıya olduğu birçok çevre sorununun (sera etkisi, atmosfer, toprak ve su kirliliği) çözülmesine yardımcı olan alternatif bir enerji çözümüdür. Ancak büyük ölçekli rüzgâr enerji santrali kurulmasının iklim şartlarına ve çevreye potansiyel etkileri (yüksek desibelde gürültü oluşturmaları, yerleşim yerlerine yakın kurulamamaları, göçmen kuşlara ve tabiata zarar vermeleri, şebekeye aktarma ve depolama sorunları, kurulumda yüksek maliyetler gerektirmesi, ışık kirliliği ve görüntü kirliliği oluşturmaları vb.) olduğundan, merkezi olmayan mikro rüzgâr türbinleri bu etkileri minimize etmek için sürdürülebilir bir seçenektir. Bu derleme çalışması mikro rüzgâr türbinlerinin üstünlüklerini ve farklı kanat sayısına sahip mikro türbinleri uygulanabilirliğini göstermek amacıyla yapılmıştır. Çok kanatlı (6 ve üstü) mikro rüzgâr türbinlerinin daha verimli olduğu belirtilmiştir. Ancak çalışmalar genellikle simülasyon ağırlıklı olduğundan deneysel çalışmalar yapılması ve mikro rüzgâr türbinlerinin yerleşim alanlarında kullanılabilirliğini göstermek gerekmektedir.

Anahtar Kelimeler: Mikro rüzgâr türbini, Rüzgâr enerjisi, Türbin modeli, Yerleşim alanı, Verim.

A Research on Micro Wind Turbine Models

Abstract

One of the biggest problems of mankind from the past to the present is the need for energy, and with the advancement of technology day by day, energy resources have met the requirements of all stages of life. Today, while addressing climate change, there is more pressure on conventional energy sources to meet the future world's energy needs. One of the sustainable energy sources is wind energy. Compared to fossil fuels, wind energy is an alternative energy solution that helps to solve many environmental problems (greenhouse effect, atmosphere, soil and water pollution) facing the world today. However, the potential effects of large-scale wind power plants' installation on climatic conditions and the environment (they create high-decibel noise, they cannot be established close to settlements, damage to migratory birds and nature, transmission and storage problems to the grid, high costs in installation, light pollution and visual pollution, etc.), decentralized micro wind turbines are a sustainable option to minimize these effects. This review study was conducted to present the advantages of micro wind turbines and the applicability of microturbines with different blade numbers. It has been stated that multi-blade (6 or more) micro wind turbines are more efficient. However, since the studies are mostly simulation-based, it is necessary to carry out experimental studies and to demonstrate the usability of micro wind turbines in residential areas.

Keywords: Micro wind turbine, Wind energy, Turbine model, Residential area, Efficiency.

1. Giriş

Ülkelerin gelişmişlik durumlarını gösteren önemli faktörlerden biri olan enerji üretiminde ham madde olarak büyük oranda fosil yakıtların (kömür, petrol, doğal gaz, nükleer) kullanılması, bu yakıtların hızla tükenmesine ve bu kaynaklara sahip olmayan ülkeler için dışa bağımlılığı artırmaktadır. Ayrıca bu yakıtların kullanılması ile ortaya çıkan zararlı gazlar (karbon dioksit, sera gazları, kükürt dioksit, sülfat vb) ve nükleer enerjiye karşı gösterilen tepkiler bilim insanlarını, yeni ve yenilenebilir enerji kaynaklarını değerlendirmeye yöneltmiştir (Köse vd.,2012). Bu nedenle oldukça iyi bir potansiyele sahip olan ülkemizin için yenilenebilir enerji kaynakları büyük bir öneme sahiptir. Türkiye için önemli bir potansiyele sahip olan rüzgâr enerjisi atmosferde bol ve serbest olarak bulunan, güvenilir, kararlı ve sürekli bir enerji kaynağıdır (Dursun, 2006). Rüzgâr enerjisinden elektrik üretilmesi üzerine ülkemizde ve dünyada gerçekleştirilen çalışmalar ve konu ile ilgili kurum ve kuruluşlar tarafından yapılan ve yapımı devam eden alt yapı çalışmaları, dünyada ve ülkemizde sürdürülen ve planlanan reformlar ile enerji piyasası kalkınma projeleri yenilenebilir enerji kaynaklarından elektrik enerjisi üretilmesini desteklemektedir.

Rüzgâr enerjisinden elektrik enerjisi üretmek için kurulan rüzgâr enerjisi santrallerinde kullanılan klasik rüzgâr türbinleri; yüksek rüzgâr hızları, kesintili bir enerji kaynağı olması, yüksek desibelde ses oluşturmaları, yerleşim yerlerine yakın kurulmaması, kurulum için geniş sahalara ihtiyaç duyması, göçmen kuşlara ve tabiata zarar vermesi, şebekeye aktarma ve depolama sorunları, yüksek meblağlar gerektirmesi, TV sinyallerini bozması, ışık kirliliği ve görüntü kirliliği oluşturmaları vb. dezavantajlara sahiptir. Bu dezavantajları gidermek veya minimize etmek için tasarlanan mikro rüzgâr türbinleri; klasik rüzgâr türbinlerinin küçük bir parçası boyutunda olup en küçük rüzgarlarda dahi enerji üretebilmektedir (Tuncer, 2021).

Global Wind Energy Council (GWEC) 2022 yılı verileri incelendiğinde; dünya genelinde kurulu rüzgâr kapasitesi 2020 yılına kıyasla %12,4 lük bir artışla 837 GW'a yükseldiği ve bu durumun dünyada yılda 1,2 milyar tondan fazla CO2 salınımının önlediği görülmektedir. 2021 yılında büyüme oranı %-1,8 olmasına rağmen dünya çapında yeni 93,6 GW rüzgâr kapasitesi eklenmiştir. Bu düşüşün nedeni Çin ve ABD'nin 2020 yılına kıyasla %10'luk pazar payı kaybetmesidir. Bu gerilemeye rağmen Çin yeni kurulumun %80'inden fazlasına sahip durumdadır.

GWEC araştırmaları, rüzgâr enerjisinin güvenli ve esnek bir küresel enerji geçişini gerçekleştirmek için hızlı ve yeterince geniş bir büyüme göstermediğini, bu durumda 2030 yılında hedeflenen kapasiteye ulaşamayacağını göstermektedir. Bunun için önümüzdeki beş yıl içinde 557 GW yeni kapasitenin eklenmesi beklenmektedir. Eğer dünya 2050 yılı hedeflerine ulaşmak ve iklim hedeflerini yakalamak istiyor ise rüzgâr enerjisi kurulumunda on yıl sonunda dört kat hızlı bir büyüme göstermelidir (GWEC, 2021).

Türkiye Rüzgâr Enerjisi Potansiyeli Atlası (REPA-V1) verilerine göre yer seviyesinden 50 metre yükseklikte ve 7,5 m/s üzeri yıllık ortalama rüzgâr hızlarına sahip kullanılabilir alanlarda kilometrekare başına 5 MW gücünde rüzgâr santrali kurulabileceği kabul edilmiş ve Türkiye'de kurulabilecek rüzgâr elektrik santrallerinin toplam kapasitesinin 47.849,44 MW olduğu belirlenmiştir (ETKB, 2022a). Sonuçlar dikkat edilirse mikro rüzgâr türbinlerin enerji ürettiği rüzgâr hızları ve yükseklikler bu

kapasite içine alınmamıştır. Dolayısıyla mikro rüzgâr türbinlerinin kullanılabilirdiği hız ve yükseklikler dikkate alındığında insanoğlunun yaşamını sürdürdüğü alanlardaki rüzgâr enerjisi potansiyeli bu değerden çok daha yüksek çıkacaktır. Türkiye'de 2011 yılında 1.729 MW rüzgâr kurulu gücüne sahip olurken 2022 de 10.976 MW kurulu güce ulaşmış ve toplam kurulu güç içerisindeki oranı %10,81 yükselmiştir (ETKB, 2022b). Enerji kaynaklarını büyük oranda doğalgaz, kömür ve hidroelektrik oluşturduğu ülkemizde diğer kaynaklara oranla bakıldığında rüzgâr enerjisi için son 10 yılda büyük yatırımlar yapılmıştır (Ertan, 2022). Türkiye'nin; 2022 yılı aralık ayı sonu itibarıyla kurulu gücü 103.809 MW'a ulaşmıştır. Kurulu gücümüzün kaynaklara göre dağılımı; %30,4'ü hidrolik enerji, %24,4'ü doğal gaz, %21'i kömür, %11'i rüzgâr, %9,1'i güneş, %1,6'sı jeotermal ve %2,5'i ise diğer kaynaklar şeklinde olup rüzgâr enerjisi yenilenebilir enerji kaynakları arasında ilk sırada yer almaktadır (ETKB, 2022c). Türkiye Ulusal Enerji Planı raporlarına göre; 2020 yılında yeni kurulu güç içinde %52,0 olan yenilenebilir enerji kaynaklarının payı 2035 yılına kadar %64,7'ye ulaşmaktadır. Rüzgâr enerjisi kurulu gücünün ise 2035 yılında 29,6 GW'a ulaşması öngörülmektedir. Ayrıca 2020 yılında elektrik üretiminde %42,4 olan yenilenebilir enerji kaynaklarının payı 2035 yılında %54,8'e çıkmaktadır. Rüzgâr enerjisinin elektrik üretimindeki payı 2020 yılında %8,1 iken bu oranın 2035 yılında %17,1'e çıkarak yenilenebilir enerji kaynakları arasında ilk sırada yer alacaktır (ETKB, 2022d). Tüm araştırma ve raporlar rüzgâr enerjisinin elektrik üretimindeki önemine ve hızla artan payına dikkat çekmektedir.

Rüzgâr enerjisi oldukça geniş bir kullanım alanına sahip olup özellikle, elektrik, mekanik ve ısı enerjisi uygulamalarında öne çıkmaktadır. Rüzgâr enerjisi aydınlatma sistemleri, su depolama ve su pompalama sistemleri, ısıtma ve soğutma mekanizmaları, şarj sistemleri, tahıl öğütme mekanizmaları ve taşımacılık sektörü gibi çok farklı alanlarda da kullanılmaktadır (Tuncer, 2021). Rüzgâr enerjisinden elektrik enerjisi üretimi için ana yapı elemanı türbindir. Genel tanımıyla rüzgârın oluşturduğu kinetik enerji, rüzgâr türbinleri sayesinde mekanik enerjiye ve daha sonra da elektrik enerjisine dönüştürülür (Tummala vd., 2016). Enerji üretim maliyetlerindeki yükseliş sonsuz ve sıfır hammadde gideri nedeniyle ucuz bir enerji kaynağı olan rüzgâr enerjisinden elektrik enerjisi üretimi özellikle mikro rüzgâr türbinlerinin kullanımının yaygınlaştırılması kişilerin kendi enerjilerini çok düşük maliyetlerle ve çevreye zarar vermeden üretebilmelerine olanak sağlayacaktır.

Geçmiş eskilere dayanan ve temiz bir enerji kaynağı olarak bilinen rüzgâr enerjisinin sahip olduğu avantajlar; tükenmeyen ve bedava bir enerji kaynağı olması, kirlilik yaratmayan ve çevreye çok az zarar veren, temiz ve yenilenebilir bir enerji kaynağı olması, dışa bağımlılığın olmamasıdır. Ayrıca rüzgâr türbinleri karmaşık olmayan otomatik makineler olup periyodik bakımlar sonucu uzun yıllar sorunsuz çalışabilirler (Ünal, 2021). Rüzgâr enerjisinden elektrik enerjisi elde etmenin dezavantajları ise; rüzgârın kesilmesi veya hızının azalmasıyla enerji kaybı oluşması, frekansın değişken olması, sadece yeterli rüzgârın bulunduğu alanlarda kurulabilir olmaları, santralin kurulacağı arazinin engebeli oluşu veya sit alanlarına yakın olma durumu olumsuzluk yaratabilir, rüzgâr türbinlerinin meydana getirdiği ses şiddeti çevreye gürültü olarak yansımakta, türbin maliyetleri yüksek olabilmekte, türbin büyük dönel bir makine olduğundan dolayı çevrede kuş ölümlerine neden olabilmekte, türbinlerin aydınlatılması gerektiğinden ışık kirliliğine neden olmakta, türbinler ortamda bulunan elektromanyetik dalgayı etkilemesidir

(Ünal, 2021). Mikro rüzgâr türbinleri, rüzgâr enerji santrallerindeki klasik türbinlerin dezavantajlarına çözüm getirmekte ve bu dezavantajları minimize etmektedir.

Bu inceleme çalışmasının amacı; ülkemiz için önemli bir potansiyele sahip olan rüzgâr enerjisine dikkat çekmek ve düşük hızlarda elektrik enerjisi üreten mikro rüzgâr türbinlerinin insanoğlunun yaşam alanlarında kullanılabilirliğini göstermektir.

2. Mikro Rüzgâr Türbinleri

Mikro rüzgâr türbinleri klasik rüzgâr türbinlerin mikro boyutlara indirgenmiş hali olup ve 2m/s'lik rüzgâr esintisinde dahi elektrik enerji üretebilmektedir. Klasik rüzgâr türbinlerinin enerji üretebilmeleri için 8-15 m/s'lik bir rüzgâr hızı gerekmektedir. Ancak yeryüzünde standart yüksekliklerde ve normal hava şartlarında ortalama rüzgâr hızı 0-7 m/s arasında değişmektedir (Tuncer, 2021). Mikro rüzgâr türbinleri düşük rüzgâr hızlarında dahi elektrik enerjisi üretebildikleri için rüzgâr enerjisinin kullanımında öne çıkmaktadır.



Şekil 1. Mikro rüzgâr türbini (Tuncer, 2021)

Mikro rüzgâr türbinleri enjeksiyonla kalıplanmış plastik polimer dişlilerden oluşturulmuştur. Her biri 26 cm çapında ve birbirlerine çatı üstüne, balkonlar gibi herhangi bir yere yerleştirilebilecek iskelet diziler ile bağlanmıştır. Dişliler birbirine bağlanarak sistemin daha çok elektrik üretmesi sağlanmıştır. 6-8-10 ve 20'lik dişli paketleri şeklinde satılmaktadır. Tıpkı küçük rüzgâr değirmenleri gibidirler ve dizilerin boyutu müşterinin özel alan ve enerji ihtiyaçlarına göre ayarlanabilir (Gambarota, 2022).



Şekil 2. Mikro rüzgâr türbin paneli (Gambarota, 2022)

Klasik rüzgâr türbinlerinde olduğu gibi, mikro rüzgâr türbinlerinde de enerji çıkışı tabii ki rüzgârın hızına bağlıdır. 1 m² boyutunda olan ve 20 dişliden oluşan bir sistem 5 m/s rüzgârla 15-17 W güç üretmektedir. 6 m/s rüzgârdaki güç çıkışı 27-39 W, saniyede 8 m/s rüzgârdaki 64-65 W enerji üretilir. Rüzgâr hızı her 2 katına çıktığında güç çıkışı 8 katına çıkmaktadır. Bu teknoloji,

üretim süreci göz önünde bulundurularak ve bakım için kolayca kullanılacak bir boyutta tasarlanmıştır. Seri üretimin düşük maliyete sahip olması için plastik polimerden (nylon) üretilmiştir. Plastik polimer kimyasallar, kirlilik, tuzlu su, kum, ısı, soğuk, kardan etkilenmez. Bu nedenle dünyanın herhangi bir yerinde kullanılmaya uygundur (Tuncer, 2021; Gambarota, 2022).

2.1. Mikro Rüzgâr Türbinlerinin Üstünlükleri

Klasik türbinlerinin dezavantajlarını minimize etmek için tercih edilen mikro türbinlerini üstünlüklerini aşağıdaki şekilde inceleyebiliriz.

2.1.1. Bakım

Yenilenebilir enerji kaynaklı sistemlerde bakım çok önemli olup klasik rüzgâr türbinlerinin bakımı karmaşık ve profesyonel işçilik nedeniyle yüksek maliyetler gerektirmektedir. Ancak mikro rüzgâr türbinlerinde bakım çok basit olup kullanıcı tarafından dahi yapılabilmektedir. Sistem kurulumunda kullanılan bileşenler yerli üretim olduğundan yedek parça maliyetleri de oldukça düşüktür (Tuncer, 2021; Gambarota, 2022).

2.1.2. Yapısal Güvenlik Faktörü

Rüzgâr enerji santrallerinde kullanılan klasik türbinler, 60 m/s rüzgâr hızına 3 saniye dayanacak şekilde tasarlanmış olup bu rüzgâr basıncına kule, bu kuvvetin 1,2 ile 1,3 katına dayanacak şekildedir ve güvenlik faktörü 1,2-1,3'tür. Ancak mikro rüzgâr türbinlerinde güvenlik faktörü 3 ile 4 arasında olduğundan kaza olasılığı çok düşüktür (Tuncer, 2021; Gambarota, 2022).

2.1.3. Çevresel Faktörler

Rüzgâr enerji santrallerinde kullanılan klasik türbinler, buzu, kumlu, karlı hava şartlarında türbin kanatları zarar gördüğü için kullanılamazlar. Ancak mikro rüzgâr türbinleri, paslanmaz çelik çerçeve üzerine plastik polimer malzemeden üretildikleri için bu hava şartlarından etkilenmezler (Tuncer, 2021; Gambarota, 2022).

2.1.4. Gürültü Kirliliği

Konvansiyonel türbinler düşük frekanslı ses yaydığı ve insanlar ile hayvanlara zarar verdiği için rüzgâr enerji santralleri yaşam alanlarından en az 2-3 km'lik mesafede kurulmalıdır. Mikro rüzgâr türbinleri çok daha sessizdir ve etrafa bu tür bir gürültü yaymaz. Türbinler, rüzgâra karşı direnç gösterirken oluşturduğu titreşimde yüksek bir ses oluşturur ancak mikro rüzgâr türbinlerin üretildiği plastik polimer malzeme titreşmez ve buna bağlı ses oluşturmaz (Tuncer, 2021; Gambarota, 2022).

2.1.5. Diğer Canlılara Zarar Verme

Rüzgâr enerji santrallerinde kullanılan konvansiyonel türbinler tasarım ve büyüklük nedeniyle, çalışırken özellikle kuşlara ve uçan hayvanlara zarar vermektedir. Ancak mikro rüzgâr türbinleri tasarım ve büyüklüğü nedeniyle tabiiata hiçbir zarar vermemektedir (Tuncer, 2021; Gambarota, 2022).

2.1.6. Üretim Parametreleri

Konvansiyonel türbinlerde maksimum verimlilik için çok önemli olduğu için rüzgâr yönünü takip edebilmesi gerekirken mikro rüzgâr türbinlerinin simetrik olmaları ekstra takip sistemi gerektirmemektedir. Klasik türbinler enerji üretimine başlamak için en az 4-5 m/s rüzgâr hızına ihtiyaç duyarlar. Mikro türbinler ise 2 m/s rüzgâr hızında enerji üretimine başlamaktadır. Konvansiyonel türbin kullanılarak kurulan enerji santralleri AC üretim yaptıklarından doğrudan şebekeye bağlanmalıdır, enerji

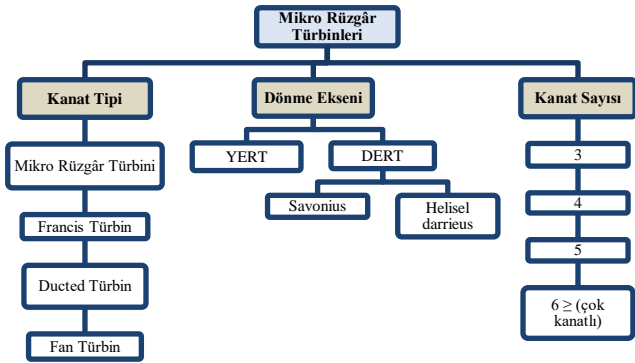
depolama yapılamaz. Mikro türbin kullanılarak kurulacak enerji sistemlerinde ise üretim DC olacağından depolama yapılabilmektedir. Ayrıca mikro türbin sistemleri diğer yenilenebilir enerji kaynakları (güneş panelleri vb) ile uyumlu olduğundan hibrit sistemler de kurulabilir (Tuncer, 2021; Gambarota, 2022).

2.1.7. Kullanılan Alan ve Görsellik

Rüzgâr enerji santrallerinde kullanılan klasik türbin için çok geniş arazi (1-2 dönüm) gerekirken aynı gücü sağlayacak mikro türbin sistemi için onda bir oranında arazi yeterli olacaktır. Ayrıca mikro rüzgâr türbinleri kullanılarak farklı renkli grafik ve logo tasarımları ile klasik türbinlerin neden olduğu görüntü kirliliği görsel bir şölene dönüştürülebilir (Tuncer, 2021; Gambarota, 2022).

3. Mikro Rüzgâr Türbinleri Modelleri

İlk olarak İtalyan mucit Lucien Gambarota tarafından tasarlanan mikro türbinler, farklı kullanım alanları ve ihtiyaçlara göre geliştirilmiş ve değişik modelleri oluşturulmuştur. Sınıflandırma klasik türbinlerden farklı olarak tasarımsal modeller üzerinden yapılmıştır.



Şekil 3. Mikro rüzgâr türbinlerin sınıflandırılması (Tuncer, 2021)

Mikro rüzgâr türbinlerinde kanat sayısı ile ilgili klasik rüzgâr türbinlerinde olduğu gibi bariz bir sınıflandırma mevcut olmayıp mikro rüzgâr türbinler tasarımıda istenildiği kadar kanat sayısı ile üretilebilmektedir. Tek kanatlı mikro rüzgâr türbinini ile ilgili herhangi bir çalışmaya rastlanmamış olup iki kanatlı yatay eksenli mikro rüzgâr türbinini deneysel bir çalışma için üretilmiş ve çalışma sonuçları teorik olarak değerlendirilmiş ve verimli bulunmamıştır (Hogan, 2011).



Şekil 4. İki kanatlı mikro rüzgâr türbinini (Hogan, 2011)

Mikro rüzgâr türbinleri genellikle en az 3 kanatlı üretilmekte olup, ihtiyaca göre daha fazla kanatlı üretim gerçekleştirilmektedir.



Şekil 5. Üç kanatlı mikro rüzgâr türbinini (World Energy, 2022)



Şekil 6. Beş kanatlı mikro rüzgâr türbinini (Reve, 2022)



Şekil 7. Çok kanatlı mikro rüzgâr türbinini (Gambarota, 2022)

Mikro rüzgâr türbinleri üzerine yapılan bir çalışmada; 13,8 cm çapında 2-3-6 kanatlı üç adet mikro rüzgâr türbinini kullanarak türbinlerin ürettiği güçler incelenmiş ve 6 kanatlı mikro rüzgâr türbininin, 7 m/s rüzgâr hızı ile 439 mW'lık bir üretme gücüne sahip en güçlü performansa sahip olduğu belirlenmiştir (Park vd., 2012).

Bir diğer çalışmada, 2 - 4 m/s 'lik düşük rüzgâr hızı olan yerlerde bile istikrarlı güç kaynağı sağlayabilen sürdürülebilir bir rüzgâr enerjisi sistemi geliştirmek amacıyla 3 kanatlı mikro rüzgâr türbinini ile yapılan araştırma sonucunda çatılarda 3-6 m/s'lik rüzgâr hızlarında ticari olarak kullanılabilirliğini göstermiştir (Tiwari ve Harinarayana, 2014).

Konut enerji üretimi için çatı üstü güneş panelinin yanı sıra, düşük rüzgâr çalışma kabiliyeti nedeniyle yerel güç talebini

desteklemek için dikey eksenli mikro rüzgâr türbinlerini performanslarının incelendiği çalışmada; sabit rüzgâr (8,5 m/s) hızında 30 cm çapında 8, 16 ve 24 kanatlı türbinler için maksimum güç çıkışları sırasıyla 1,2- 2,3- ve 3,6 W bulunmuştur (Loganathan vd., 2018).

Mikro ölçekli bir rüzgâr türbini sistemi için çok kanatlı bir yaklaşım tercih edilen çalışmada, kanat sayıları 3 ile 12 arasında değişen farklı türbinler test edilmiş ve 8 veya daha fazla kanatlı türbinlerin torkunda belirgin bir fark olmadığı görülmüştür (Leung vd., 2010).

Diğer bir çalışmada, mikro rüzgâr türbinlerinin çevresel sürdürülebilirliği fotovoltaik panel ile karşılaştırılarak değerlendirilmiş ve rüzgâr türbininin %7,5 daha düşük ötrofikasyondan %85 daha düşük ozon tabakası incelmeye kadar değişen 11 çevre kategorisinin yedisinde fotovoltaik panellerden daha çevresel olarak sürdürülebilir olduğu belirlenmiştir (Greening ve Azapagic, 2013).

Santimetre ölçekli mikro rüzgâr türbinleri (2-12 cm) üzerine yapılan çalışmalarda, 3-12 kanatlı türbinlerin üretiminin çok ekonomik olduğu ve performansının 120-240 cm türbinlere nazaran düşük olduğu belirtilmiştir. Ancak, düşük rüzgâr hızı olan coğrafyalarda ve yerleşim yerlerinde verimli bir şekilde kullanılabilecekleri gösterilmiştir (Zakaria vd., 2015; Akour vd., 2018).

Mikro rüzgâr türbinlerinin yerleşim alanlarında kullanım performansının incelendiği bir çalışmada, şebekeden elektrik almaya nazaran daha rekabetçi olduğu ve yerleşim alanlarında tercih edilebilir olduğu gösterilmiştir (Pellegrini vd., 2021).

Çatı üzerine mikro rüzgâr türbinlerini kurulmasının incelendiği bir çalışmada ise, düz çatılara kurulumun rüzgâr akışı, rüzgâr hızı ve türbülans yoğunluğu dikkate alındığında daha performanslı olacağı belirtilmiştir (Ledo vd., 2021).

4. Sonuç

Rüzgâr enerji santrallerinde kullanılan büyük ölçekli rüzgâr türbinlerinin küresel iklim üzerine olumsuz etkileri ve çevreyi etkilemeleri, gürültü ve ışık kirliliğine neden olduğu dikkate alındığında mikro rüzgâr türbinleri bu olumsuz etkileri minimize etmesi ve yerleşim alanlarında insan oğlunun yaşamının her alanında yeterli elektrik enerjisi üretmek için alternatif bir uygulama alanı sunmaktadır. Yapılan araştırmalar genellikle kanat sayısı fazla olan (6 ve üzeri) mikro türbinlerin daha verimli olduğunu göstermektedir. Ancak mikro rüzgâr türbinlerinin yerleşim alanlarında uygulanabilirliği, çevresel parametrelerin mikro türbinlere etkileri, mikro türbinlerin kanat sayısı ve farklı çaplarda değişik rüzgâr hızlarındaki performansı konularında yeterli araştırma mevcut değildir. Mikro rüzgâr türbinlerinin yerleşim yerlerinde kullanılabilir hale gelmesi için bu alanda simülasyon uygulamalarının yanı sıra detaylı deneyler ve fiziki uygulamalar yapılması gerekmektedir.

5. Teşekkür

Bu araştırma Adıyaman Üniversitesi Bilimsel Araştırma Projeleri Birimi tarafından TEBMYOMAP/2021-0004 numaralı proje ile desteklenmiştir.

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Determination of Diameter of Belled Shafts with respect to Uplift Forces Resulted from Expansive Soil Layer in Active Zone

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Abstract

Expansive soils are found in many parts of the world that are especially arid and semi-arid regions. They have caused several damages of lightweight structures for decades. For this reason, a more suitable foundation type should be selected and designed for the lightweight structures built on these soils. For example, the application of belled shaft foundation at expansive soil layer is preferable method in practice. However, one of the worst cases at the design of this foundation is accepted that the swelling of expansive soil placed in active zone. Therefore, this condition should be taken into account at the design process of this foundation. In this study, the diameter of belled shaft was separately determined with respect to some factors such as the diameter of shaft, the depth of active zone, the friction angle between shaft and soil, and the ratio between the undrained cohesion of soil at stable zone and the swelling pressure of expansive soil placed in active zone. In the calculation process, four different shaft diameters that are 0.3 m, 0.45 m, 0.60 m, and 0.75 m were utilized. Also the depth of active zone that started from 1.5 m to 15 m was specified. To sum up, the optimum shaft diameter was found as 0.45 m.

Keywords: Belled shaft, Expansive soil, Active zone, Swelling pressure, Cohesion

Aktif Bölgedeki Şişen Zemin Tabakasından Kaynaklanan Kaldırma Kuvvetine Göre Genişletilmiş Şaftın Çapının Belirlenmesi

Öz

Şişen zeminler, dünyanın birçok bölümünde özellikle yarı kurak ve kurak bölgelerinde bulunmaktadır. Bu zeminler, yıllarca hafif yapılarda hasarlara neden olmaktadır. Bu yüzden, bu zeminlerin üzerine inşa edilecek yapılar için en uygun temel tipi seçilmeli ve tasarlanmalıdır. Örneğin, genişletilmiş şaft temel uygulaması pratikte tercih edilen bir metottür. Bununla birlikte, aktif bölgede yer alan şişen zeminin kabarması bu temel tasarımındaki en kötü senaryolardan bir tanesi olarak kabul edilmektedir. Bu yüzden bu temel tasarım sürecinde bu durum göz önüne alınmalıdır. Bu çalışmada, genişletilmiş şaftın çapı; şaftın çapı, aktif bölge derinliği, şaft ve zemin arasındaki sürtünme açısı ve sağlam bölgedeki zeminin drenajsız kohezyonu ile aktif bölgede yer alan zeminin şişme basıncı arasındaki oran gibi faktörler dikkate alınarak ayrı ayrı hesaplanmıştır. Hesaplama sürecinde, dört farklı şaft çapı (0.3 m, 0.45 m, 0.60 m ve 0.75 m) kullanıldı ayrıca 1.5 metre ile 15 metre arasında aktif bölge derinliği belirlendi. Özet olarak, optimum şaft çapı 0.45 m olarak bulunmuştur.

Anahtar Kelimeler: Genişletilmiş şaft, Şişen zemin, Aktif bölge, Şişme basıncı, Kohezyon

1. Introduction

Expansive soils are generally known as problematic soils by civil engineers as the volumes of these soils depend on the water content of these soils. Thus, several damages of lightweight structures are originated in the change of volumes of these soils. To sum up, these damages generally induce considerable economic loss rather than life loss. These soils are found in many parts of the world that have especially semi-arid or arid regions. Turkey is one of the richest countries in terms of the deposits of expansive soil. These deposits are particularly in some parts of this country such as Central Anatolia region, West Anatolia region, Southeast Anatolia region and East Anatolia region (Chen 1988, Çokça 1991, Hong 2008, Mishra et al. 2008, Nelson et al. 2015, Parhi et al 2017).

Expansive soils have been intensively studied for last decades. While some of these studies related to the stabilization of these soils, some of them are investigated in the suitable foundation for the structures built on these soils. In addition to this, chemical stabilization, compaction, removal and replacement are commonly preferable methods to improve these soils. As these methods are generally suitable for upper layer, these methods is not feasible for a layer placed in deeper. For this reason, a drilled shaft foundation is applied for expansive soil layer. At the application of this foundation type, the length of drilled shaft should be greater than active zone of expansive soil that is defined that a region has heave potential. Since a part of drilled shaft that is found at the active zone may be subjected to uplift forces formed the result of swelling of expansive soil. To solve this problem, the active zone should be carefully determined prior to design of this foundation type (Nelson and Milner 1992, Nelson et al. 2001, Brown et al. 2010, Nelson et al. 2015, Das and Sivakugan 2018).

Two different types of drilled shaft foundation may be constructed at the field with respect to the properties of soil layer. These types are named as straight and belled shaft in practice (Figure 1).

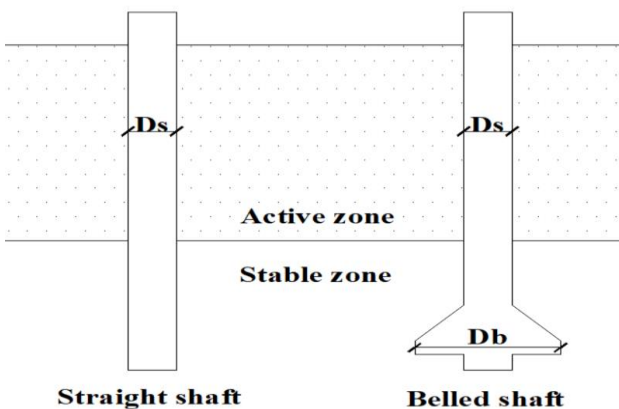


Figure 1. Straight shaft and belled shaft

The straight shaft foundation is usually utilized when it is either socketed or lapped in rock layer. Belled shaft that is known as underreamed shaft is more advisable foundation type for the soil layer that has very deep soft soil such as expansive soil, loose sand etc. (Brown et al. 2010, Das and Sivakugan 2018).

The dimensions of belled shaft depend on some soil parameters that are called as active zone, swelling pressure, and undrained cohesion. Active zone may alter some factors that are climatic condition, drainage, gradation etc.. The values of both swelling pressure and undrained cohesion of expansive soil affect many soil properties that are clay mineralogy, dry density, plasticity index, water content (Ajmera et al. 2012, Zumrawi 2012, Su et al. 2018).

Uplift forces resulted from expansive soil in active zone depend heavily on the diameter of shaft and the roughness between shaft and soil. The diameter of shaft can be both selected and applied with a wide range in the field. However, the diameter of shaft foundation built in expansive soil layer should be determined at lower value. Since, the uplift force increases with the diameter of shaft due to the rise of friction area. The roughness between shaft and soil (Nelson and Milner 1992, Kulhawy 1991, Das and Sivakugan 2018).

The diameter of belled shaft was determined with respect to some parameter that are diameter of shaft, the ratio between unconfined cohesion and swelling pressure, and the depth of active zone. To sum up, main aim of this study is an assumption of the ratio between belled shaft diameter and shaft diameter by using these parameters mentioned above.

2. Materials and Methods

Methodology of this study is given at this part. Then, information of both soil profile and belled shaft were examined in detail.

2.1 Capacity of Belled Shaft Against Uplift Force

The capacity of belled shaft against uplift force is calculated with respect to Figure 2.

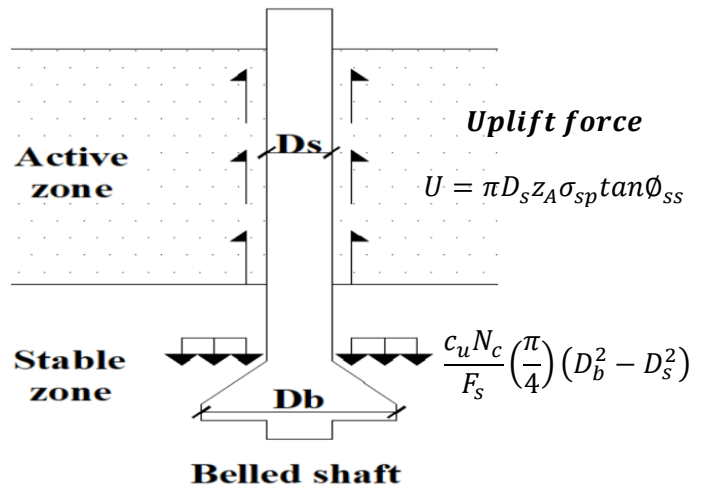


Figure 2. Uplift force and the capacity of belled shaft

Uplift force results from the swelling of expansive soil existed in active zone. This force are determined by using Equation 1.

$$U = \pi D_s z_A \sigma_{sp} \tan \phi_{ss} \quad Eq.1$$

where z_A is the depth of active zone in expansive soil layer. Swelling pressure of expansive soil found in active zone is shown

as σ_{sp} in Eq. 1. The friction angle between shaft and soil are illustrated as ϕ_{ss} in this equation.

The capacity of belled shaft was calculated at heaving condition by using Equation 2 that is given below (Das and Sivakugan 2018).

$$Q_{net} = U - D = \frac{c_u N_c}{F_s} \left(\frac{\pi}{4} \right) (D_b^2 - D_s^2) \quad Eq. 2$$

where U and D are represented uplift force and dead load, respectively. Dead load is taken zero at worst condition in this equation. c_u is undrained cohesion at stable zone of expansive layer. N_c is bearing capacity factor and the value of this parameter is taken as 6.14 in this study. F_s is factor of safety and is generally assumed as 1.25 (Das and Sivakugan 2018). The diameter of both belled shaft and shaft are shown as D_b and D_s in Equation 2, respectively.

The parameters given in both Equation 1 and Equation 2 are examined in detail. ,

2.2 Profile and Parameters of Soil Layer

Soil profile was assumed as deeper expansive soil layer. In other words, either bedrock or rigid stratum is existed at very deep.

Two properties of soil that are undrained cohesion and swelling pressure are seminal parameters for the design of belled shaft foundation. Besides these parameters, the depth of active zone is another keystone properties of soil layer. However, these parameters may change according to some soil properties such as dry density, clay mineralogy, water content etc.. Thus, these parameters generally alter from region to region. An extensive both site investigation and laboratory work should be done prior to the design of belled shaft.

In practice, undrained cohesion(c_u), swelling pressure(σ_{sp}), and the depth of active zone of expansive soil layer (z_A) are measured after both site investigation and laboratory work. Each design of belled shaft foundation are evaluated as independent and original when expansive soil deposits are considered.

A parameter, which is presented as a ratio between undrained cohesion and swelling pressure of soil was assumed to facilitate this problem. The ratio between undrained cohesion of expansive soil at stable zone and swelling pressure of expansive soil existed in active zone were estimated as 0.25, 0.5, 0.75, and 1, respectively.

The depths of active zone have been reported as a wide range that starts from 1.5 m to 15 m for expansive soil deposits in the world. Therefore, the depth of active zone was verified from 1.5 m to 15 m (O'Neill and Poormoayed 1980, Das and Sivakugan 2018).

2.3 Parameters of Belled Shaft

Three parameters related to belled shaft foundation, which are the diameter of shaft, the friction angle between shaft and soil, and the length of belled shaft were investigated in the scope of this study.

Four different values of shaft diameter were selected as 0.3m, 0.45 m, 0.60 m, and 0.75 m, respectively. The diameter of belled

shaft was separately calculated with respect to the diameter of shaft.

The friction angle between shaft and soil is utilized the calculation of either friction force at loading condition or uplift force at swelling condition. This angle are generally alters from 10° to 20° (Das and Sivakugan 2018).

The length of belled shaft was easily determined with respect to both the depth of active zone and stable zone at expansive soil layer.

3. Results

The design of belled shaft that built in expansive soil layer is specific as this process depends on some factors such as field conditions, shaft properties, soil properties etc. Thus, the diameter of belled shaft alters due to the change any of these parameters. For this reason, the diameters of belled shaft were calculated by using two parameters that are the ratio between undrained cohesion of expansive soil at stable zone and swelling pressure of expansive soil in active zone, and the depth of active zone by using the diameter of shaft.

Four different shaft diameter that 0.3 m, 0.45 m, 0.6 m, and 0.75 m and six different friction angles between shaft and soil that are 10° , 12° , 14° , 16° , 18° , and 20° were selected in this study. Besides these, two different soil parameters were used in the calculation step of this study. First parameter is the ratio between undrained cohesion of expansive soil at stable zone and swelling pressure of expansive soil existed in active zone and the values of these parameters are accepted as 0.25, 0.5, 0.75, and 1 in this study. The second one is depth of active zone of expansive soil layer and the value of this parameter alter from 1.5 m to 15 m.

Fifteen graphs were plotted after the calculation process. These graphs are given in Figure 3-6 with respect to the diameter of shaft.

Belled diameter should be greater than shaft diameter and the maximum belled diameter cannot be greater than three times shaft diameter due to the structural design. Thus, the ratio between belled diameter and shaft diameter is determined from 1 to 3. In addition to this, this ratio increases with the depth of active zone in expansive soil layer.

The possibility of the construction of belled shaft in expansive soil layer depends on the ratio between undrained cohesion of expansive soil at stable zone and swelling pressure of expansive soil existed in active zone. When swelling pressure of expansive soil in active zone is much greater than undrained cohesion of expansive soil in stable zone, the achievement of belled shaft is not enough against uplift force.

The increase of friction angle between shaft and soil result in the raise of uplift force. The decrease of void ratio of expansive soil result in the decrease of contact area between shaft and soil. In addition to this, the roughness of shaft affects friction angle between shaft and soil. For this reason, the roughness between shaft and soil should be minimized. Thus, the greater friction angle between shaft and soil needs the greater belled diameter.

The diameter of shaft that is either 0.3 m or 0.45 m is suitable for the deeper expansive soil layer (approximately 15 m). However, the maximum depth of active zone should be lower than 9 m for the shaft diameter that is 0.6 m. In addition to this, this value is lower (approximately 7 m) for 0.75 m shaft diameter. In

conclusion, the depth of active zone is keystone parameter for the selection of shaft diameter.

The optimum shaft diameter was found as 0.45 m in the calculation process for all properties of both soil and shaft.

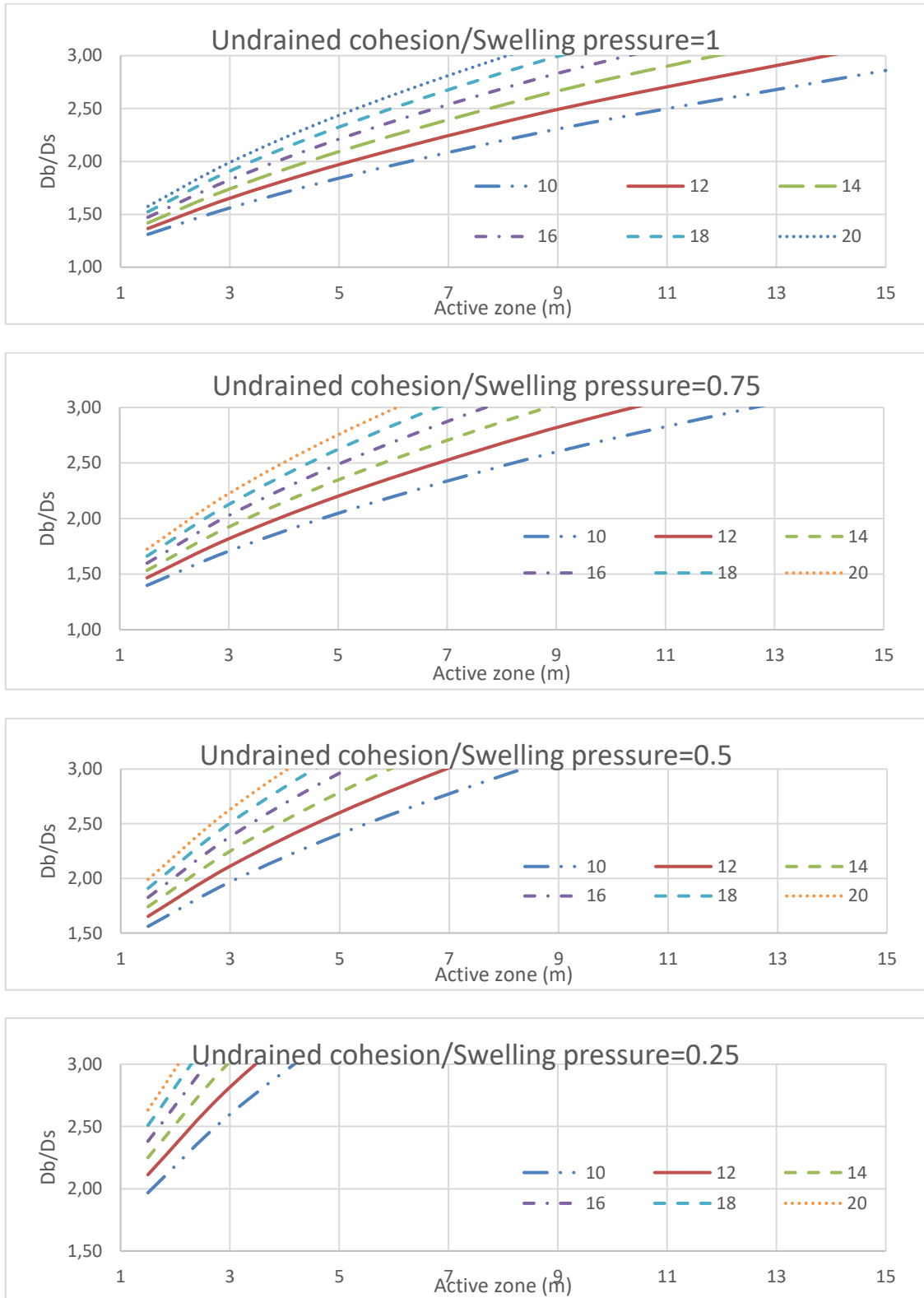


Figure 3. The diameter of belled shaft with respect to the depth of active zone, the friction angle between shaft and soil, and 0.3 m shaft diameter

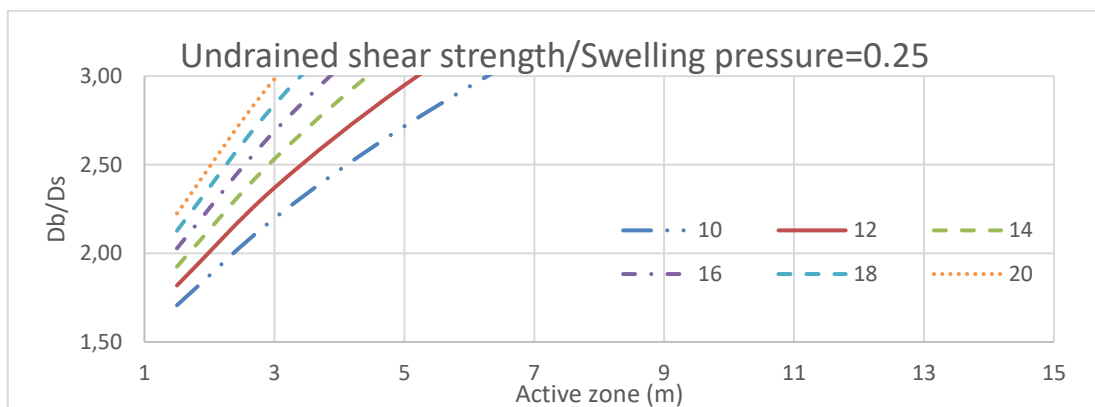
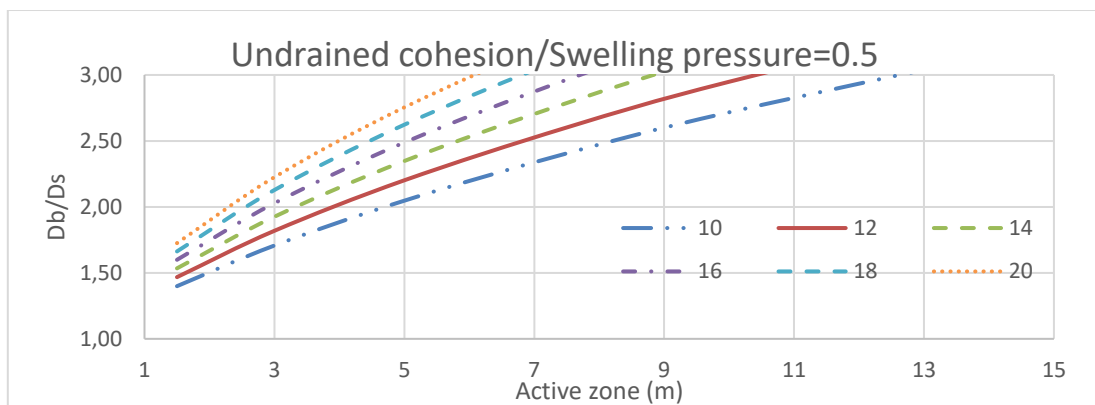
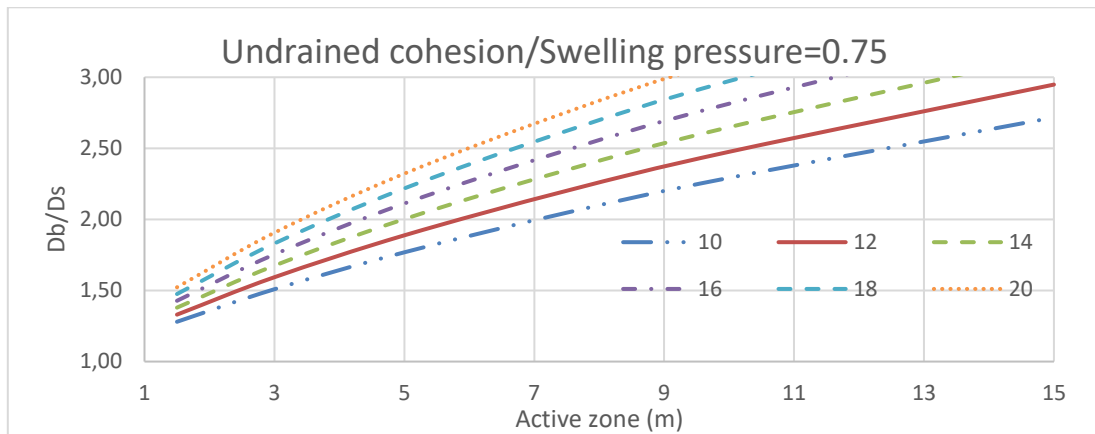
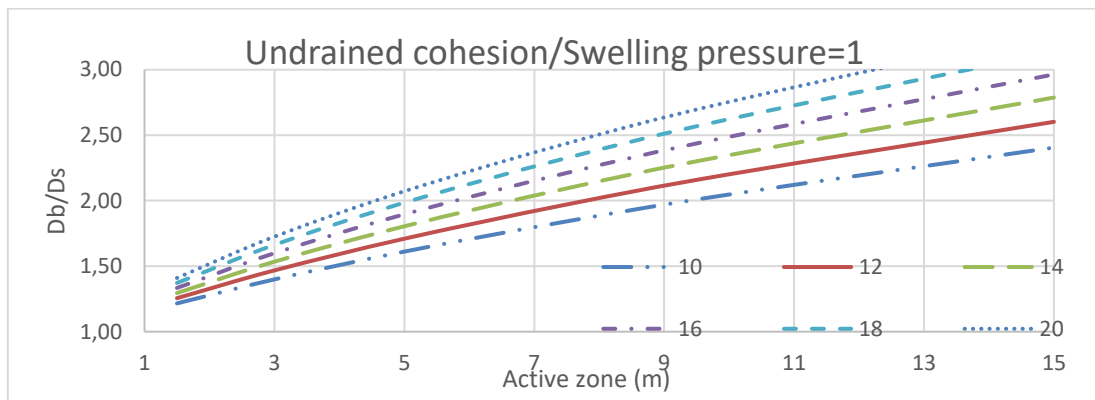


Figure 4. The diameter of belled shaft with respect to the depth of active zone, the friction angle between shaft and soil, and 0.45 m shaft diameter

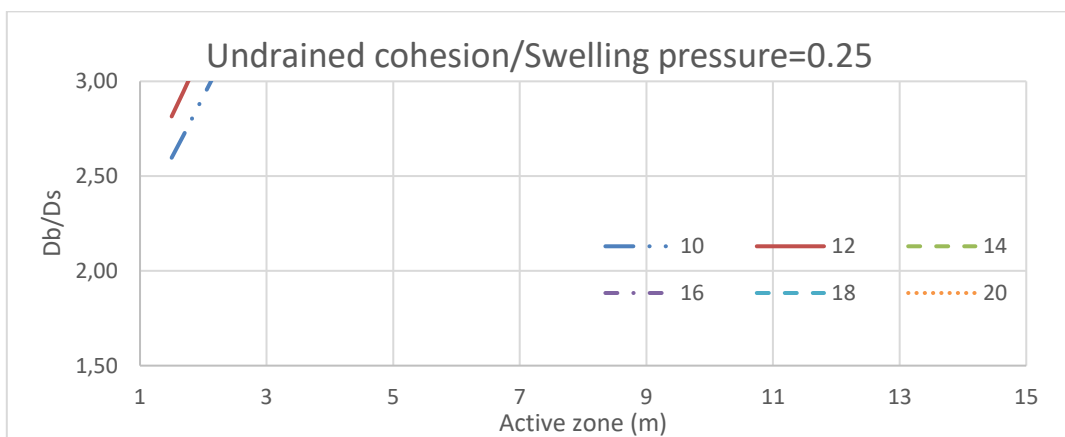
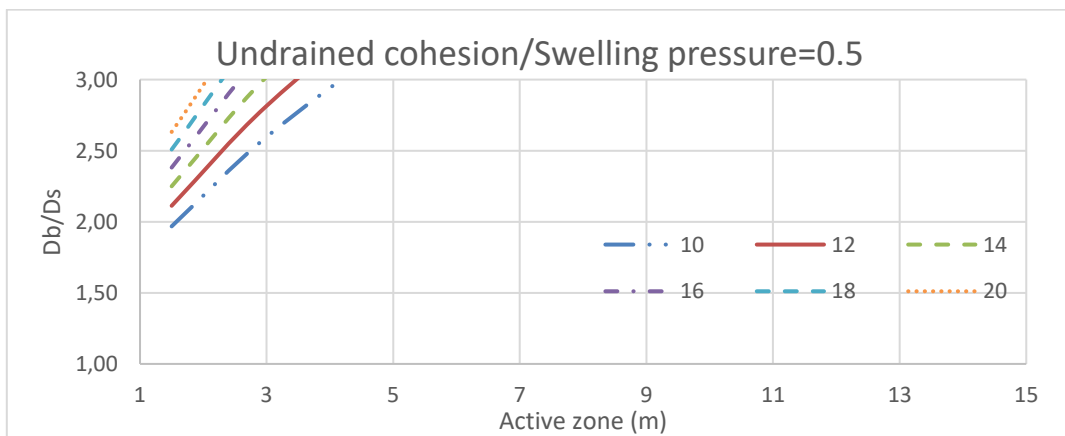
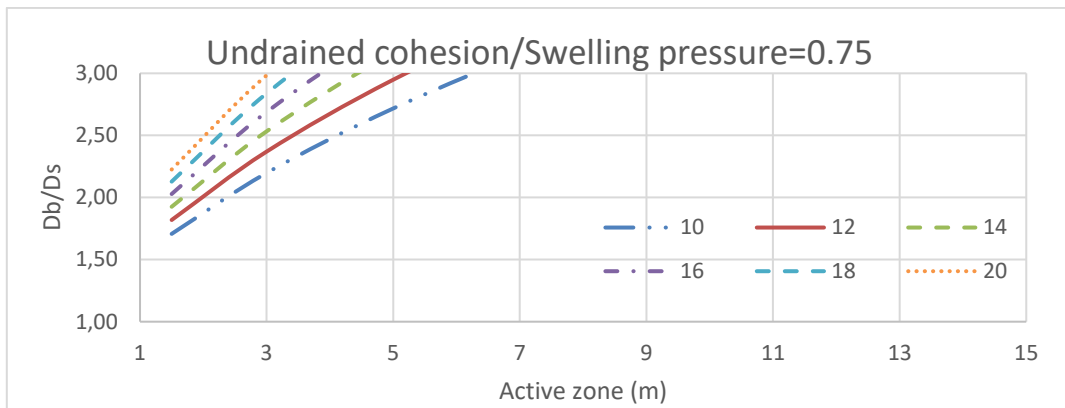
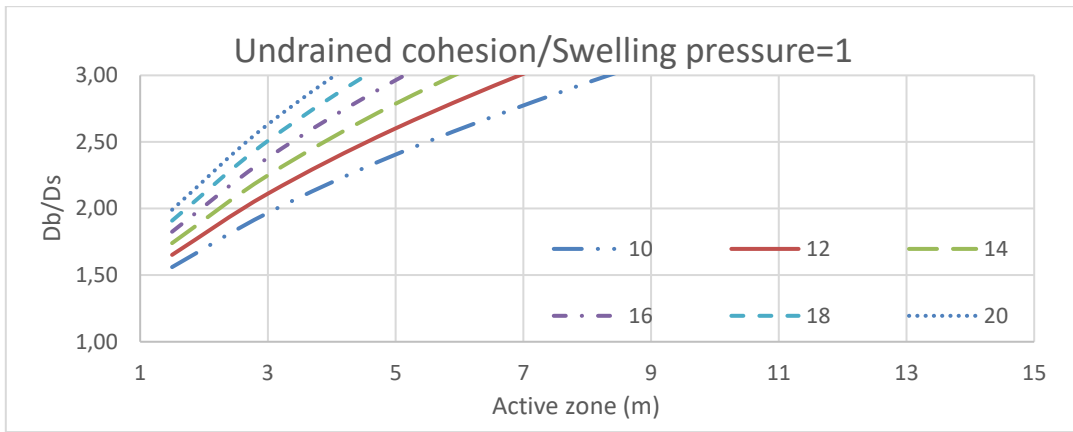


Figure 5. The diameter of belled shaft with respect to the depth of active zone, the friction angle between shaft and soil, and 0.6 m shaft diameter

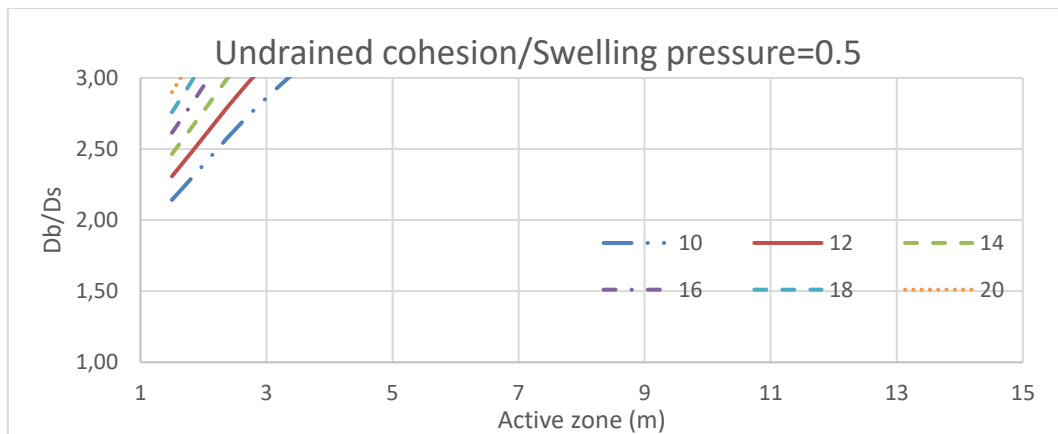
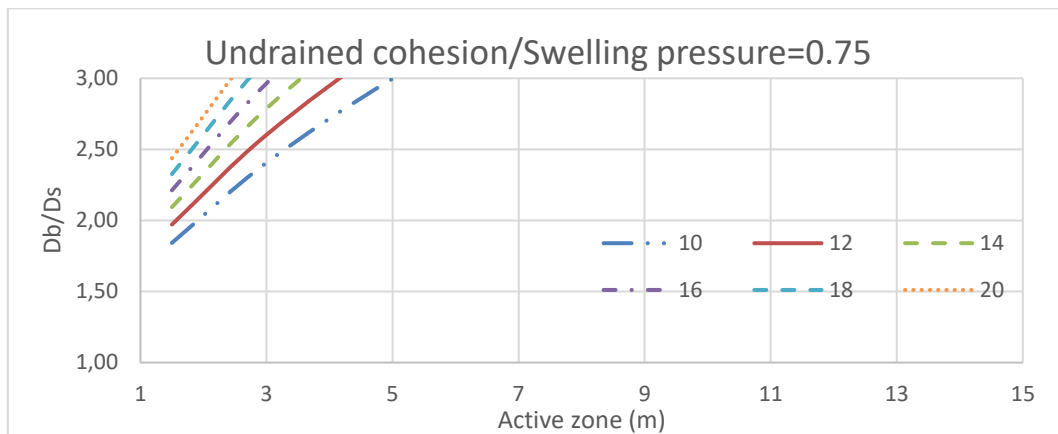
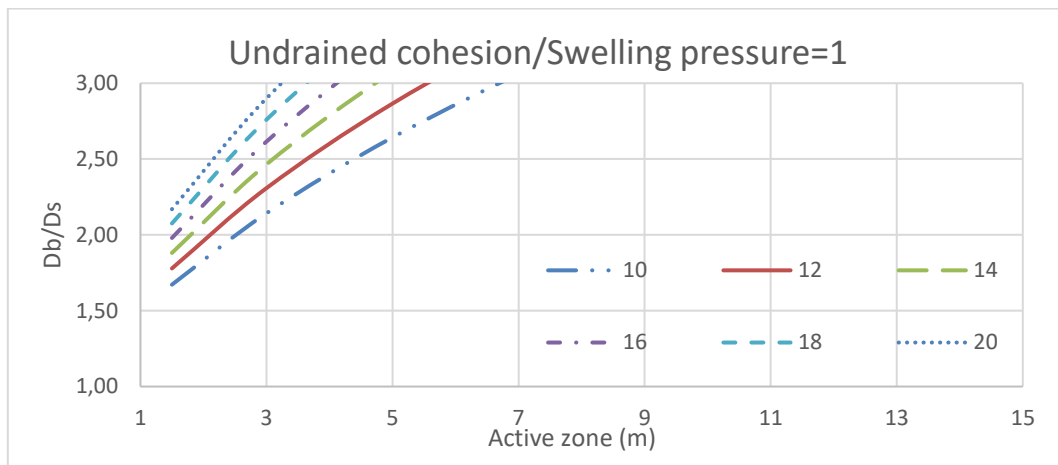


Figure 6. The diameter of belled shaft with respect to the depth of active zone, the friction angle between shaft and soil, and 0.75 m shaft diameter

4. Conclusion

The main aim of this study is that the determination of belled shaft diameter built in expansive soil layer. By all means, this process has been very complex when it is considered in some factors such as field conditions, properties of soil and shaft. For this reason, field investigation and laboratory work should be properly and carefully done prior to design of belled shaft in expansive soil layer. Some outputs obtained from this study are given below.

The diameter of shaft built in expansive soil layer should be lower value that are either 0.3 m or 0.45 m as the uplift force increases with the diameter of shaft. However, these shaft diameters may be selected as bigger values when these shaft diameter are not sufficient for design.

The depth of active zone affects the determination of diameter of belled shaft in expansive soil layer. For example, the depth of active zone is greater than 10 m, the diameter of shaft should be either lower or equal to 0.45 m.

The optimum shaft diameter was found as 0.45 m for belled shaft built in expansive soil layer.

The friction angle between shaft and soil depends on both the roughness of shaft and the index properties of soil such as density, void ratio, etc.

In conclusion, the design of belled shaft in expansive soil layer is original process due to the many factors that are related to parameters of soil, shaft, and field conditions. For this reason, the comprehensive both laboratory and field investigation should be done prior to design process.

5. Acknowledgments

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The Effect of Blend, Mordant and Waste Ratio on Dyeing of Denim Products with Coffee Waste

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Abstract

Natural dyestuffs, which took the place of synthetic dyestuffs in the past, have started to be used consciously again thanks to the increasing understanding of 'environmentally friendly textile'. These natural dyestuffs are mostly obtained from plants or food waste. Coffee is the most consumed nutrient in the world after water. Therefore, there is a lot of waste of coffee in nature and it contains pigments that give it its natural color. In this study, products with different fiber contents (100% cotton, 98% cotton 2% elastane, 80% cotton 20% recycled cotton) were dyed using coffee waste, and different mordant substances (aluminum sulfate, chitosan, quaternary ammonium compounds). It has been tried to reduce the amount of coffee waste used by dyeing with coffee wastes at different rates by weight (1/1, 2/1, 4/1, 8/1). Thus, it is aimed to provide less waste to the environment and to increase the color efficiency by making a more sustainable dyeing process. In addition, it is aimed to give a new direction to the denim sector by improving the rubbing and washing fastness values of dyed products. As a result of the studies, products with a product weight/coffee waste weight ratio of 8/1 were obtained with high crocking and washing fastnesses and without major losses in color tone.

Keywords: Natural dyestuff, Cotton, Coffee, Food waste, Mordant

The Effect of Blend, Mordant and Waste Ratio on Dyeing of Denim Products with Coffee Waste

Öz

Geçmişte sentetik boyarmaddelerin yerini alan doğal boyarmaddeler, artan 'çevre dostu tekstil' anlayışı sayesinde yeniden bilinçli olarak kullanılmaya başlanmıştır. Bu doğal boyarmaddeler çoğunlukla bitkilerden veya gıda atıklarından elde edilir. Kahve, dünyada sudan sonra en çok tüketilen besin maddesidir. Bu nedenle doğada çok fazla kahve israfı vardır ve kahveye doğal rengini veren pigmentler içerir. Bu çalışmada, farklı lif içeriğine sahip (%100 pamuk, %98 pamuk %2 elastan, %80 pamuk %20 geri dönüştürülmüş pamuk) ürünler, kahve atıkları ve farklı mordan maddeler (alüminyum sülfat, kitosan, quaternary amonyum bileşikleri) kullanılarak boyanmıştır. Ağırlıkça farklı oranlarda (1/1, 2/1, 4/1, 8/1) kahve atıklarıyla boyama yapılarak kullanılan atık kahve miktarı azaltılmaya çalışılmıştır. Böylece hem çevreye daha az atık verilmesi hem de daha sürdürülebilir bir boyama işlemi yapılarak renk etkinliğinin artırılması amaçlanmıştır. Ayrıca boyalı ürünlerin sürtünme ve yıkama haslık değerleri iyileştirilerek denim sektörüne yeni bir yön verilmesi amaçlanmıştır. Çalışmalar sonucunda, ürün ağırlığı/kahve atığı ağırlığı oranı 8/1 ile renk tonunda büyük kayıplar olmadan, yüksek sürtünme ve yıkama haslıklarına sahip ürünler elde edilmiştir.

Anahtar Kelimeler: Doğal boyarmadde, Pamuk, Kahve, Gıda atıkları, Mordan

1. Introduction

Mordant types used in dyeing made with coffee grounds, which is a sustainable resource, make a difference according to the fabric types used. Iron was used for cotton and linen, alum for silk, and copper for rayon [1]. It has been observed that another parameter affecting dyeing is the type and the roasting rate of the coffee. Greenish, brown and dark brown tones and good fastness results were obtained in cotton fabric dyeing made with raw, medium roasted and dark roasted Ethiopian and Congo type coffee extracts [2].

In another study; It was observed that some trials dyed with cotton fabrics, 40 different plants provided color efficiency and sufficient fastness values. Cationization of cotton fibers by pre-treatment with chitosan and improvement of dyeability with natural dyes were also investigated [3].

In this study, using natural dyestuff, coffee waste, products with different fiber content were mordanted with aluminum sulfate, iron sulfate, chitosan, quaternary ammonium compounds and dyeing experiments were carried out at different coffee waste rates.

2. Material and Method

Coffee wastes were collected, mixed homogeneously and dried at 60°C for 8 minutes. and used in experiments. All dyeing processes were performed at 90°C for 45 minutes.

Color fastness tests against home washing were carried out according to ISO-105 C06, color fastness tests against cracking were carried out according to ISO 105-X12 standard.

In order to examine the effect of fiber content on color tone, 100% cotton, 98% cotton 2% elastane, 80% cotton 20% recycled cotton woven fabrics were used and the differences in the color effects of the mixture change were observed.

In another trial set, the effects of different mordants on color tone and fastness values were investigated.

Dry-wet crocking and washing fastness tests of dyed products were carried out in order to improve the fastness properties of natural dyed products. As a result of the trials, when the fastness values were evaluated on the gray scale, it was observed that they were below the desired standards. In order to increase the fastness, aqueous crosslinker with cationic character and methylisothiazolinone-based resin application studies were applied on products.

With the use of food waste, a sustainable product with high added value emerges. However, even if it is waste, studies have been carried out to reduce the amount of waste coffee used in recipes in order to ensure that this resource is limited in nature and that resources are used efficiently.

3. Results and Discussion

As a result of dyeing the products consisting of fabrics with different fiber content with coffee waste, it has been observed that they meet the desired standards in terms of both color efficiency and fastness.

In the experiments we performed at the 1/1 coffee/weight ratio, color changes were observed due to the difference in fiber content (Figure 1).

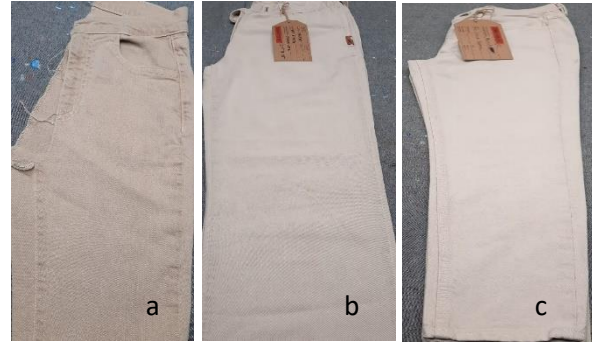


Figure 1. Dyed products which contains a) %98 CO %2 EL b) %100 CO c) 80% CO 20% RCY CO

Experiments have also been made with natural mordants. Their fastness tests are given in the Table 1. Related images are available in the Figure 2.



Figure 2. Product dyed with 1/1 product weight/coffee waste weight ratio and mordanted with a) quaternary ammonium compound, b) chitosan

Table 1. Fastness test results of the products dyed with 1/1 product weight/coffee waste weight ratios and different mordants

	Mordant Type	Quaternary ammonium compound	Chitosan	Aluminum sulphate
Color Fastness to Home Laundering	Color Change	1-2	1-2	4-5
	Acetate	5	5	5
	Cotton	5	5	5
	Nylon	5	5	5
	Polyester	5	5	5
	Acrylic	5	5	5
	Wool	4-5	4-5	4-5
Color Fastness to Crocking	Dry	4-5	4-5	5
	Wet	3	3	4-5

The coffee ratios were the same, and when the fastness values were examined as a result of dyeing using different mordants, it had been determined that the product using aluminum sulfate gave better results.

In addition, fastness values were tested by applying fixator and resin to the products dyed at 1/1 coffee ratio. It was observed that the use of fixator and resin provided improvements in fastness results without causing a negative effect on color (Table 2).

Table 2. The fastness test results of the products which fixator and resin was applied on

		dye	dye & fixator	dye & fixator & resin
Color Fastness to Home Laundering	Color Change	2	2-3	3-4
	Acetate	5	5	5
	Cotton	5	5	5
	Nylon	5	5	5
	Polyester	5	5	5
	Acrylic	5	5	5
	Wool	4-5	4-5	4-5
Color Fastness to Crocking	Dry	4-5	4-5	4-5
	Wet	4-5	4-5	4-5

The physical test results of samples dyed with different amounts of coffee using aluminum sulfate mordant are given in the Table 3 and the images of the products can be seen at Figure 3.

Table 3. Fastness test results of the products dyed with different product weight/coffee waste weight ratios and aluminum sulphate mordant

Product weight/coffee waste ratio (w/w)		1/1	2/1	4/1	8/1
Color Fastness to Home Laundering	Color Change	4-5	4-5	4	3-4
	Acetate	5	5	5	5
	Cotton	5	5	5	5
	Nylon	5	5	5	5
	Polyester	5	5	5	5
	Acrylic	5	5	5	5
	Wool	4-5	5	4-5	4-5
Color Fastness to Crocking	Dry	5	5	5	4-5
	Wet	4-5	4-5	4-5	3-4

When the visual and test results were evaluated, it was seen that the desired color tone and fastness values could be obtained even when the coffee ratio was reduced to one-eighth.

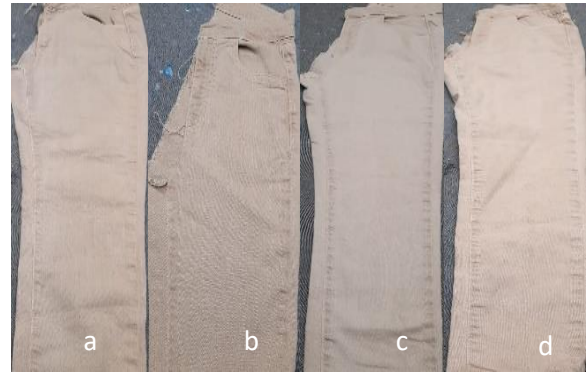


Figure 3. Products images dyed with a) 1/1, b)2/1, c)4/1, d)8/1 Product weight/coffee waste weight ratios

4. Conclusions and Recommendations

Today, as a result of the increase in environmental pollution and the preference of environmentally friendly and recyclable products, there is an increasing interest in natural dyestuffs that have lost their value in the past. It seems that there are studies on this subject today. However, when these studies are examined, the fastness values seem to be low. For this reason, we have done this work to improve fastness and achieve the desired color effects with less food waste. And as a result, we have reached the most suitable fastness values by using natural products. Thus, we have obtained an environmentally friendly product. In addition, we have obtained color effect products that meet the demands of the customers.

Different color tones were observed in the dyeing of fabrics with different fiber content. In addition, it has been observed that the desired color tone can be obtained when the coffee ratio is reduced to one-eighth. It has been observed that rubbing and washing fastness values can be improved with fixator and resin support.

5. Acknowledge

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Development of Permanganate-Free and Stone-Free Ecological Snow Washing Process for Denim Products

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Abstract

Denim products are still popular today, as they provide wearing comfort and a sense of specialness to those who wear them. The most important factor that makes it popular is the denim washing processes that give the final appearance to denim products. Permanganate and stone washing processes are two of the most frequently applied methods in washing processes. Although the chemical potassium permanganate provides a good bleaching effect, it is a harsh chemical that is harmful to human health and to the environment. In this study, it is aimed to eliminate the stone and permanganate used in denim washing process by imparting the snow washing process, which is also available in our company, and to eliminate the environmental pollution caused by permanganate and stone, and thus lower the problems affecting manpower. It is aimed to find a solution to the problems of loss of strength in the product, tearing in the belt parts, the formation of broken traces and the presence of stone fragments in the wastewater by performing the permanganate and stone-free ecological snow washing process without permanganate and stone. After completion of the process, the physical performance of the products (tensile strength, tear strength and stretch & growth) were tested, and color removal effectiveness was observed, and thus the effects of the snow washing process on the performance properties of the denim product were examined. It has been observed that the desired effect as well as the strength values are in accordance with the standards.

Keywords: Denim Fabric, Washing, Stone-Free, Permanganate-Free, Snow Washing

Denim Ürünleri İçin Permanganat ve Taşsız Ekolojik Kar Yıkama Prosesinin Geliştirilmesi

Öz

Denim ürünler, giyen kişiye rahatlık ve ayrıcalık hissi sağladığı için günümüzde de popülerliğini koruyor. Popüler olmasını sağlayan en önemli unsur denim ürünlere son görünümünü veren denim yıkama işlemleridir. Permanganat ve taş yıkama işlemleri, yıkama işlemlerinde en sık uygulanan yöntemlerden biridir. Potasyum permanganat kimyasalı iyi bir ağartma etkisi sağlasa da insan sağlığına ve çevreye zararlı bir kimyasaldır. Bu çalışmada firmamızda da mevcut olan kar yıkama işleminin ortadan kaldırılarak bu süreçte kullanılan taş ve permanganatın ortadan kaldırılması, permanganat ve taşın neden olduğu çevre kirliliğinin ve insan gücünü etkileyen sorunların ortadan kaldırılması amaçlanmaktadır. Permanganatsız ve taşsız ekolojik kar yıkama işlemi yapılarak üründe mukavemet kaybı, bant kısımlarında yırtılma, kırık izlerin oluşması ve atık sularda taş parçalarının bulunması sorunlarına çözüm bulunması amaçlanmaktadır. Yapılan çalışmalarda ürünlerin fiziksel özellikleri (kopma mukavemeti, yırtılma mukavemeti ve esneme & büyüme), renk değişimleri test edilmiş ve yıkama işleminin denim kumaşın performans özelliklerine etkisi incelenmiştir. İstenilen görüntü ve dayanım değerlerinin standartlara uygun olduğu görülmüştür.

Anahtar Kelimeler: Denim Kumaş, Yıkama, Taşsız, Permanganatsız, Kar Yıkama

1. Introduction

Among all textile products, no other fabric has received as wide acceptance as denim jeans [1]. Denim jeans washing is a new process to give clothes a worn look, change appearance and increase comfort ability [2]. For this reason, companies have been trying to develop various techniques in recent years to improve the visual appearance of fabrics, especially their pale appearance [3]. Potassium Permanganate (KMnO₄) is an inorganic salt in solid form that is widely used around the world. It is a strong oxidizing agent and used to make color fading effect on denim jeans [4]. No matter how much the negative effects of these chemicals on the environment and human health have been kept in the background for years, this situation is changing with the understanding of sustainability and nature-friendly products created by consumers. In this project, it is aimed to eliminate the stone and permanganate used in denim washing process by imparting the snow washing process, to eliminate the environmental pollution caused by permanganate and stone and the problems affecting the human power. It is aimed to find a solution to the problems of loss of strength in the product, tearing in the belt parts, the formation of fracture marks and the presence of stone fragments in the waste water by performing the permanganate and stone-free ecological snow washing process. In this study, washing recipes were prepared without using stones and trials were carried out with the supplied permanganate-free denim washing chemicals. The physical properties of the products (tensile strength, tear strength and rupture & elongation) were tested, color removal effectiveness was observed, and the effects of the washing process on the performance properties of the denim fabric were examined.

2. Material and Method

Table 1. Washing processes of denim products

Washing Processes
Pre-washing (10 min)
Hot rinsing washing (2 min)
Anhydrous enzyme (30 min)
Rinsing (2 min)
Spinning
Drying
Snow Washing (30min)
Rinsing (2 min)
Spinning
Drying

The most preferred fabric blends in the denim industry were used in the experiments (see Table 2). Washing recipes were prepared with the chemicals supplied by different companies, and washing trials were carried out. The chemical used for snow washing is a mixture of acidic, inorganic and oxidizing substances. Details on the applied washing process are given in Table 1.

3. Results and Discussion

The most preferred fabric blends in the denim industry were used in the experiments (see Table 2). Washing recipes were prepared with the chemicals supplied by different companies, and washing trials were carried out. The chemical used for snow washing is a mixture of acidic, inorganic and oxidizing substances. Details on the applied washing process are given in Table 1.



Figure 1. After snow washing denim products

Table 2. Physical test results of denim products after snow

Fabric Fiber Content	Tensile Strength (N)		Tear Strength (N)		Stretch & Growth (N)	
	Warp	Weft	Warp	Weft	Stretch	Growth
%80 ORCO	70	69	6400	6400	26	5
%20 PRRCO	67	69	6400	6400		
%79 CO	67	38	6272	4608		
%20 PCW					26	5
%1 EL	74	40	6144	4608		
%94 CO %2 EL	75	32	6272	4800	36	5
%4 EME	70	32	6400	4992		

4. Conclusions and Recommendations

The main factors that affect consumers while choosing are aesthetics, appearance and fashion in clothes. Denim products are subjected to industrial washing to obtain specific finish which adds value to the final product. This study analyzed the effect of washing without the use of stone and permanganate, and negative results were not encountered visually or regarding physical performance.

5. Acknowledge

This study is part of SuGlobal R&D Center Project RD-009 entitled "Development of Permanganate and Stone Free Ecological Snow Washing Process in Denim Products ".

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Normal Distribution on Energy Saving Problem for the Wireless Sensor Network Life on the Vacation Period

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Abstract

Based on math operations, we can do some analytic approaches for the energy saving for the WSN life. We will study the vacation period time using numerical methods for studding the energy saving mechanism in analytic models. Several research papers have reported that the normal distribution of a random variable has an enormous contribution in analyzing and comparing the data with each other, making the process easier according to methods used or observing the tendencies of numerous occurrences in life applications. This paper focuses on analyzing two problems: the first one is the normal distribution and its special cases by solving real problems of WSN node operations and the second one is the application of standard normal distribution relate to saving energy during vacation time in a certain time interval. The goal of our work is to obtain the appropriate algorithm to minimize the risk of data loss during the network vacation period, which is associated with the organization of network node structures after this period time, and to maximize the battery life of individual sensors. For that, we will use math methods and based on probability distribution theory, we derive some distributions of the processing period duration from an arbitrary fixed time up to a variable time t . The analytic approach based on the conception of Laplace transform and the Lagrange method performs better than the previous results. We continue by examining them through detailed calculations and graphs. We compare the predicted energy saving and the average real energy.

Keywords: Numerical Methods, Lost Packets, Time Charging, Sensors, Programming Complexity

1. Introduction

For a long time, the authors studied a challenge way for solving the problem of energy saving in WSNs based on the selection of the shortest route, so uses various-type shortest path algorithms. They used the way of minimizing the costs of energy consumption can lead to an increase in the ratio of lost packets, giving a relatively small ratio of lost packets (MDPI, 2019). This paper discussed the problem of time delay in WSN and suggested an appropriate solution to reach that goal. In previous article (Loubna, A&Hajrulla, Sh, Souliman, N), we proposed solution based on two ideas: using two cluster's heads and reducing programming complexity (Gou, H&Yoo, Y, 2010, pp. 822-827). A challenge for us was the occurrence of temporal death in some sensor nodes (Tan, L.,& Tang, S, 2017, pp. 896-909). The energy consumption evaluation is considered using the discrete time model (Lee, D.H.& Yang, W.S. 2013), (Li, J.; Zhou, D.C.; Hou. K.M.; Xie, H.P; Zhou, P, 2014). In the network security theory, the issue of energy saving in wireless sensor networks (WSNs) is very complicated. Many scientists studied a lot from the point of view of network security, including energy life operations, securing an adequate level of data transmission quality and algorithms used. We use normal distribution as a probability distribution theory (Keim, R, 2020), distribution that is symmetric about the mean. This indicates that the data approaching the mean are more frequently occurring than data placed far from the mean. This theory states that the averages of independent, identically distributed random variables do have approximately normal distributions. Using Python program, we apply algorithms for self-organization of sensor networks to minimize the risk of data loss during transmission, which is associated with the organization of network node structures, and secondly to maximize the battery life of individual sensors (Pathan, A.S.K, 2011), (Ruiz, L.B., Braga. T.R.M, Silva, F.A, Assunção, 2005, pp. 95-102). When the wireless sensor network is dense (the cluster size is large and the number of sensors in each cluster is large), the moving cluster head maybe run out of energy before ending the specific period and it's probably to end the specific period before collecting the data from all nodes in the clusters (Loubna A, Hajrulla Sh, Souliman, N). In some previous articles, the researchers discussed the wireless sensor network in the framework as the WSN suffers from the death of network because one or more sensor nodes run out of energy. An energy-balancing algorithm for wireless sensor networks is applied (Gou H& Yoo Y, 2010, pp. 822-827). So that, the most of previous searches focus on reducing the consumption of energy in WSN in order to extend the network's lifetime (Heinzelman, Rabiner W, Chandrakasan A, Balakrishnan, 2000), (Purohit, Rakhi, Keswani B, 2015). We use our method to reduce the delay of data collect and using the normal probability distribution, we complete the time life distributions of power energy. We can approximate the solution of the problem and can compare the obtained results with the predicted one. Then, someone can use those results to calculate the errors of the process. Giving some data tables and *e-ISSN: 2148-2683*

graphic, we perform visually the previous technique. Graphically, we use the normal distribution for the said problem.

We deal with the analysis of the functioning of packet network nodes and in the process of network optimization by algorithms, mathematics operators, normal distributions, numerical methods and getting conclusions from comparison of graphic results. This paper present a solution to increase the efficacy of WSN energy, but by no using of two mobile cluster's head and parallel processing technology, as in the our previous article. Therefore, we also canceled the collection function of all nodes' data due to the time that the moving nodes will take to achieve this process (Loubna A, Hajrulla Sh, Souliman N). The representation for the Laplace transform of the distribution at arbitrary fixed time t and processing periods are presented in our research.

The distributions processing period duration and numerical results are derived. We can see the improvement in the time delay achieved by this work. In a later study, we will discuss the effect of suggestions that helped reduce the time delay on energy consumption, considered as a challenge in the field of WSN. Using the modular matrix through the Python program (Hajrulla Sh, Bezati L, Demir, T, Desantila, H, pp. 45-55), we would be able to take the best results related to the approximation theory for the solution of the WSN problems. Normal Distribution in the standardized form is very important for our research. A standard deviation is a measure of the spread of the distribution – the bigger the standard deviation, the more spread out the scores in the population. We can show it by graphics. We analyze the distribution on the vacant period of the system as well as we give explicit results for the probability distribution function of the number of packets present in the system.

2. Material and Method

2.1. General theory description of the probability distribution theory

When dealing with the graph the shape of the normal distribution function will be nearly flat on top, quickly decreasing toward the x-axis and at a point, it will slowly decrease towards the “tails” of the distribution. Frequency distribution describes a random variable, but it does not fit the normal distribution graph perfectly. The formula of the probability density function of the normal distribution is used to study the distribution of energy life.

$$f(x) = \frac{e^{-(x-\mu)^2/(2\sigma^2)}}{\sigma\sqrt{2\pi}} \quad (1)$$

where μ is the location parameter and σ is the scale parameter. Especially we use the special case of normal distribution is the standard normal distribution. For the standard normal distribution, the value of the mean is equal to zero ($\mu=0$), and the value of the standard deviation is equal to 1 ($\sigma=1$) using the general formula:

$$f(x) = \frac{e^{-x^2/2}}{\sqrt{2\pi}} \quad (2)$$

We formulate some knowledge for the distributions energy consumption and processing period duration of battery is derived. Giving some numerical examples, we perform better our numerical process concluding with important results.

2.2. Standardization of normal distribution

Let us take in consideration the standardization of normal distribution. To standardize a normal distribution function, we change the random variable X to Z . To do this we use the formula: $z = \frac{x-\mu}{\sigma}$. This formula shifts all the data so that they can give a mean of zero rather than μ . Note that in the standard normal distribution $\mu=0$, (x is a particular measurement, μ is the population mean, and σ is the population standard deviation). The graphic of Normal Distribution has a peak in the middle where most people's score and tapering ends where only a few peoples score. The area under the curve between scores corresponds to the percentage in the population between those scores. The scores on this curve are color coded in standard deviation units. A standard deviation is a measure of the spread of the distribution – the bigger the standard deviation, the more spread out the scores in the population.

2.3. Model description

We have attached a Python Code in Appendix/Calculations, which explains the distribution of scores and result generation of normal distribution data. The method with finite absorber capacity and an energy saving mechanism being a mix of the classical multiple vacation policy (Keim R, 2020). The problem is solved according to a Poisson distribution with rate λ and with a maximum system size K . Using the property of the exponential distribution for some different values of times, the following graphic representations are true. We state the representation for the probability $P(X(t))$ with a specific characteristic function and we identify the vacant (suspension) period with its duration as discussed (Keim R, 2020), but we will not deal with the algebraic representations. The formula of total probability gives. We are interested in the probability distribution of the next state at the completion of the arbitrary processing vacant period

$$P(X(t) = m) = \sum_{j=1}^{\infty} P(X(t) = m, t \in I_j) + P(X(t) = m, t \in \mu I_j) \quad (3)$$

Using the properties of the exponential distribution, the sequence $X(t_i), i = 1, 2, \dots$, where t_i stands for the i^{th} processing time after the starting moment, is an embedded Markov chain for the process $\{X(t), t \geq 0\}$. The sum on the right side of the formula above is taken over all possible values of $l, \dots, l_{i-1} \in \{N, \dots, K\}$, (Keim R, 2020). We use the representation of Laplace transform for size distribution in the considered method with a controlled multiple vacation policy.

The second problem discuss the time between saving energy. This time is normally distribution with a mean of 50 hours and a standard deviation of 15 hours. We need to calculate the probability that the time will be between 50 and 70 hours. Given, e-ISSN: 2148-2683

the mean value (μ) = 50 and standard deviation, $\sigma = 15$, we are required to find the probability that y lies between 50 and 70 or $P(50 < y < 70)$. If we consider $x = 50$, then $z = (50 - 50) / 15 = 0$.

If we consider $x = 70$, then $z = (70 - 50) / 15 = 1.33$. $P(50 < x < 70) = P(0 < z < 1.33) = \text{area to the left of } z = 1.33 - \text{area to the left of } z = 0$.

$P(0 < z < 1.33) = 0.9082 - 0.5 = 0.4082$. The probability that saving energy has a time-period between 50 and 70 hours is 0.4082.

3. Results and Discussion

3.1. Research Proposals

To support the research proposals with practical results, NS2 simulator had been used accompanied by Xgraph application to display the research results (Loubna A, Hajrulla Sh, Souliman N). The figures above "Figures 1, "Figure 2," show the studied networks after placing the nodes by the network designer in the search area.

3.2. Graphical Results

For the goal of comparing the two cases, two scenarios had been applied.

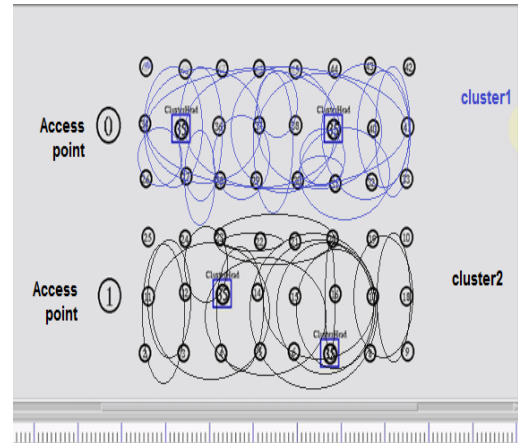


Figure 1 First scenario using one cluster's head

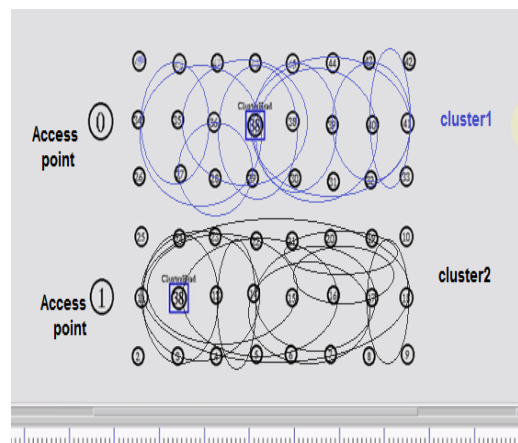


Figure 2 Second scenario using one cluster's head

To support the research proposals with practical results, NS2 simulator had been used accompanied by Xgraph application to display the research results (Loubna A, Hajrulla Sh, Souliman N). The figures above "Figure 1, "Figure 2," show the studied networks after placing the nodes by the network designer in the search area. For the goal of comparing the two cases, two scenarios had been applied.

The following "Figure 3," Figure 4," show the studied networks probability after placing the nodes by the network designer in the search area. The output of Xgraph application, "Figure 3," shows the difference of the delay between the previous two scenarios before reducing the program complexity and the delay after reducing the program complexity. "Figure 4," shows the delay after decreasing the complexity of the software when the simulation is finished, and it was equal to 0.0025ms.

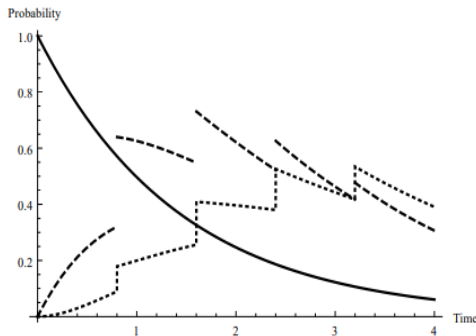


Figure 3 $P \{X(t) = m, t \in II\}$ for $\lambda = 1.1$

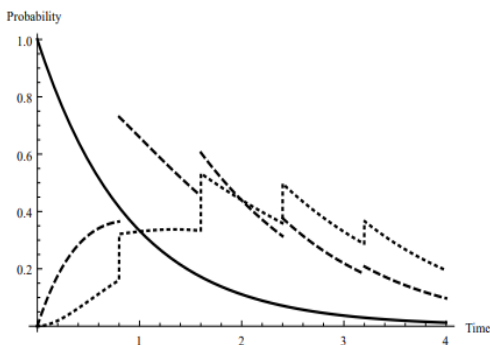


Figure 4 $P \{X(t) = m, t \in II\}$ for $\lambda = 0.7$

The following "Figure 5," Figure 6," show the time delay at the end of the simulation when applying the proposed mechanism in

this

research.



Figure 5 Difference of the delay between two scenarios

The above figures "Figure 7," Figure 8," show the delay between two scenarios and the delay after reducing the complexity. In addition, it shows that the maximum of the distribution moves to the right with the decrease of λ (Keim R, 2020).

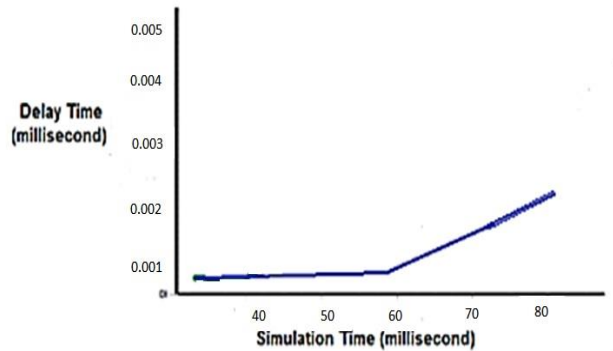


Figure 6 Delay after reducing the complexity.

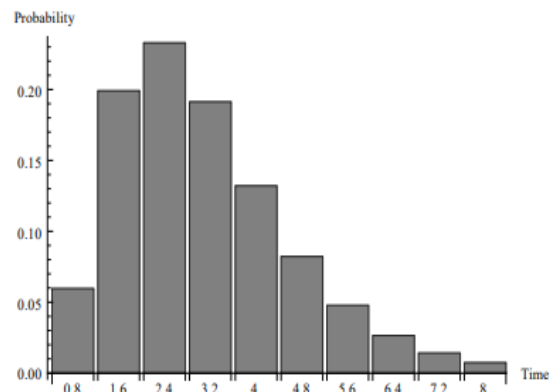


Figure 7 Distribution of vacant period for $\lambda = 1.1$

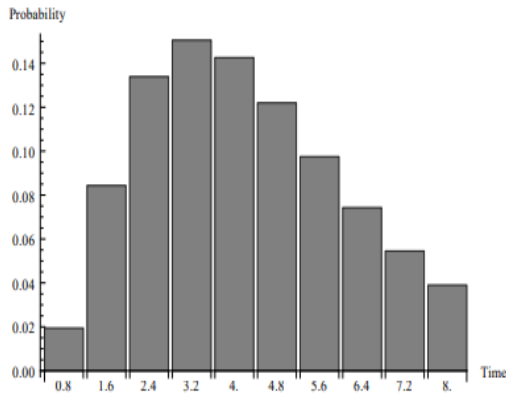


Figure 8 Distribution of vacant period for $\lambda = 0.7$

Further, our program investigates the number of packets at the completion epoch of vacant period of energy. The following figures "Figure 9," Figure 10," represent it for different values of λ in different cases.

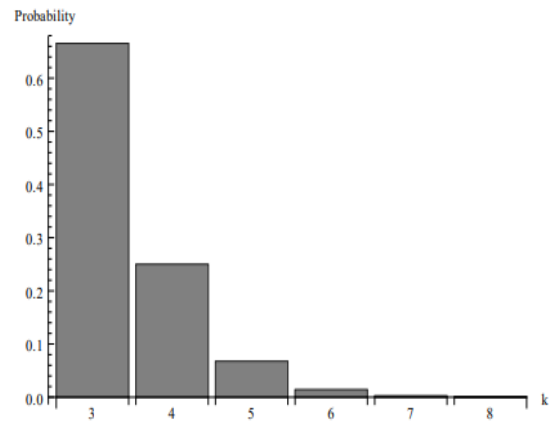


Figure 9 Number of packets at the vacant period for $\lambda = 1.1$

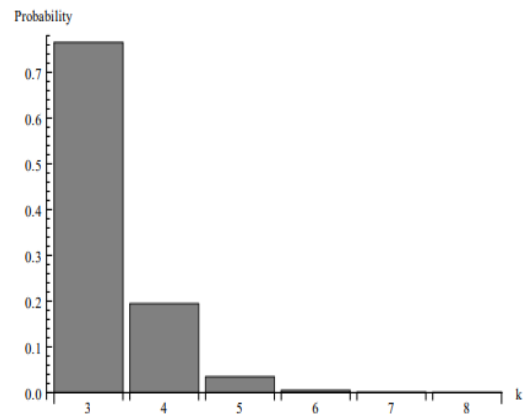


Figure 10 Number of packets for $\lambda = 1.1$

3.3. Discussion

Our program investigate the behavior of the probability distribution of the vacant period duration. The paper represent it for different values of λ in different cases. It shows that the greater arrival intensity, the greater probability that the vacant time-period will finish.

We have used desmos graphing and python programing to achieve correct results throughout the article. Python provides a simpler graphing methodology and desmos makes the graph more readable. The vacation time-period related to standard normal distribution is studied, applying the analytic approach based on the idea of the embedded Markov chain, integral equations and renewal theory.

4. Conclusions and Recommendations

In this paper, we have introduced how it makes the data to be easier for an analytical approach. We have also standardized the normal distribution function in the research application. Through the calculations, we also proved that standardization would make the data comparison easier and faster. On the other hand, we analyzed how normal distribution predicts the failure of energy conserving in terms of time and predicting the time interval for the next period of energy conserving to fail.

Through normal distribution, we have proved that data distribution in relationship with each other are comparable and easier to be read and analyzed. Additionally, we have also observed a symmetry in the mean for the real-valued random variables under fair conditions.

A future study will be organized to benefit from the interest's coverage in the places where sensors places are hard to reach, for the purpose of reducing the period of collecting information on the network and consequently conserving energy.

In the near future, we will address the problem using Hamiltonian operator. The operator can used to approach the Hamiltonian simulation in saving WSN energy, as we can use it in quantum computing to handle computational complexity and algorithms needed for simulating systems. Hence, we will discuss how Euler-Lagrangian equation can be used for solving the same problem in a more efficient way. We exemplify this formalism with some widely studied models, including the standard formulas for each method, simulations and graphs.

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Synthesis of Voltage PID Controller to Improve INC- MPPT Algorithm for Cascade Regulation of KC200GT Panel-Based Solar System

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Abstract

This paper proposes the Maximum Power Point Tracking MPPT method based on the Incremental Conductance INC algorithm. The primary goal is to prevent the ripple problem that is occurred in the output responses of the solar panel system. This last includes the KC200GT panel system, while using it to supply a resistive load throughout the DC-DC boost converter. This goal is reached through respecting the two following steps. First, the INC algorithm modified so that it produces an optimal reference voltage rather than a duty cycle control, which is often utilized in the standard INC-MPPT control strategy for controlling the switch button of the DC-DC boost converter. Second, the solar system behavior is modeled by the linear small-signal model for the design of the voltage PID controller. At each sample, a voltage discrepancy is generated as a result of comparing the previous reference voltage to the one delivered by the KC200GT panel where the introduction of the voltage PID controller becoming indispensable. These two steps create the development of a novel strategy that is afterwards known as improved INC-MPPT. The performance assessments of the proposed strategy are carried out by simulation using MATLAB®/SIMULINK software, and the obtained results reveal the crucial importance of including the voltage PID controller to overcome the ripple issue, occurred when applying the standard INC-MPPT control strategy.

Keywords: PV system; DC-DC Boost Converter; Maximum Power Point Tracking MPPT; INC algorithm.

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1. Introduction

Maximum Power Point Tracking MPPT techniques are typically used in solar systems to extract the maximal power output of KC200GT panels where the Maximum Power Point MPP must be continually followed, regardless of the current climatic conditions like the absolute temperature and the solar irradiation. The MPPT issue has been addressed in several aspects in the literature [1, 2].

Among them, the INC-based algorithm is the most often used one since it is the easiest to implement in the real-world applications [3]. Accordingly, in energy solar domain, many researchers have worked to develop MPPT algorithms methods [4]. They presented a large number of simulations and experimental tests to control the switch of the buck chopper. In addition, they employed a proportional-integral PI controller whose corresponding pulse-width modulation (PWM) has been implemented directly in the buck converter [5]. The experimental results also demonstrated that the incorrect manual selection of the fixed-step size, whether large or small in standard INC-MPPT control strategy is well overcome. This can be accomplished by changing it to a variable-step size that was generated automatically to update the existing duty cycle control, regardless the changing of the two previous climatic conditions. In the same direction, the high-performance adaptive Perturb and Observe P&O algorithm was introduced through [6] in 2011. This enabled the MPP tracking in PV- based micro-grids. To improve the oscillation performances around the MPP, the real-time adaptive control was implemented under a variety of weather conditions. As a result, two main drawbacks that directly affect the required control have appeared, especially in the event of gradual variation of solar irradiation and absolute temperature. Accordingly, the operating point of the preceding system has oscillated around the MPP, resulting in a loss of a more or less important of the available energy. Besides, the INC algorithm can be confusing when the atmospheric conditions change rapidly.

In this paper, it will be illustrated that the negative effects associated with the second drawback mentioned above can be significantly improved. This will be possible by including a voltage PID controller in the inner loop of the overall control system where the output voltage, which is needed to power the resistive load, will be well stabilized. This control design is called also cascade regulation where the MPPT algorithm is operated indirectly, i.e., for a cascade voltage regulation (with respect to a cascade current regulation), the MPPT algorithm must be modified to provide a reference voltage (with respect to a reference current) where it is compared with the actual array voltage (with respect to the actual array current). The resulting voltage discrepancy (with respect to current discrepancy) must be reduced as much as possible using a voltage PID controller (with respect to current PID controller). In fact, the preceding indirect control mode based on the P&O algorithm has recently attracted many scientists.

Among them, Kollimalla & Mishra (2014) developed the indirect P&O-MPPT control strategy the current regulation of the PV panel under solar irradiation variation using a proposed reference current disturbance. Accordingly, the current PI controller proves better power performances over the ones provided by the standard P&O-MPPT control strategy [7]. Also, Harrag & Messalti (2015) generated a variable step-size for the P&O-MPPT control strategy using the genetic algorithm [8]. Accordingly, the Proportional-Integral- Derivative controller

is included for the cascade voltage regulation, providing thus a fast tracking behavior in the presence of several weather conditions. In addition, Babki & Al-Thabiti (2022) proposed a closed-loop system based on a small-signal model for voltage regulation. They were used either, a Proportional controller, equipped with a low-pass filter or a PI controller where its parameters have been designed through applying the Ziegler-Nichols method based on root locus approach [9]. Accordingly, the simulation results show that the proposed control strategy offers better stability characteristics over the one provided by the standard one. Finally, Lasheen et al., (2017) proposed an adaptive reference voltage-based technique for panel, which has been exposed to a radiation profile characterizing by a fast rate of change [10]. With respect of all preceding works, the new control strategy in this paper has two indispensable stages. In the first one, the system mathematical model is of the global solar system is designed using the small- signal principle. Afterward, the MPPT-based INC algorithm is modified, in which an optimal reference voltage is generated through the existing values of solar irradiance and absolute temperature. Finally, the optimal update of the existing duty cycle control is ensured by the proposed-stabilized voltage controller, whose parameters are determined by the trial-and- error approach, which is available in MATLAB® software. The given simulation results by the proposed control strategy will confirm that the desired is captured, even during a rapid variation of the solar irradiance. The remainder of the paper will be organized as follows: The introduction is presented in section1. The equivalent electrical circuit model description is given in section 2. The typical solar power system, modeled by the linear small-signal model is reviewed in Section3. Section4 will be focused on the synthesis of the voltage PID controller, used in the improved INC-MPPT control strategy. The simulation results are shown in section5. Finally, conclusions are drawn in Section 6.

2. Modeling of KC200GT panel.

In general, the modeling of the actual behavior of the KC200GT panel is often performed using an equivalent electric circuit having a specific number of diodes, resistors connected between them in series and other resistors connected between them in parallel. Hence, the electrical circuit can be shown in Fig. 1:

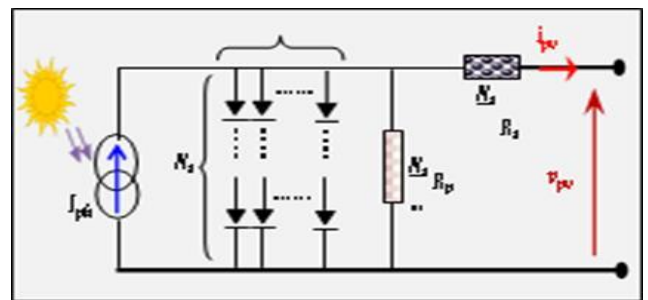


Fig.1 Equivalent-electrical circuit used for modeling the KC200GT panel

According to Fig.1, the nonlinear characteristic $I - V$ of the KC200GT panel is derived through expressing predicted PV current. I_{pv} It is defined by [11,12]:

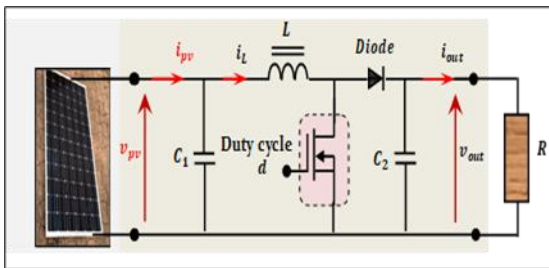
$$I_{pv} = N_p I_{ph} - N_p I_0 \left[\exp \left(\frac{q \left(\frac{V_{pv}}{N_s} + \frac{R_s I_{pv}}{N_p} \right)}{a N_s K T} \right) - 1 \right] - \frac{N_p V_{pv} + R_s I_{pv}}{R_p} \quad (1)$$

I_{pv} : Solar cell current (A).

- I_{ph} : Light generated current (A).
- I_0 : Diode saturation current (A).
- q : Electron charge (1.6×10^{-19} C).
- K : Boltzmann constant (1.38×10^{-23} J/K).
- T : Cell temperature in Kelvin (K).
- V_{pv} : Solar cell output voltage (V).
- R_s : Solar cell series resistance (Ω).
- R_p : Solar cell shunt resistance (Ω).
- N_c : The number of series cells.
- N_w : The number of series strings.
- N_p : The number of parallel strings.
- a : Diode ideality factor.

3. Modeling of global solar system

In general, most real-world applications require more power than the one generated by the basic KC200GT panel. Therefore, the introduction of the DC-DC boost converter becomes essential between it and the electrical device to be powered. Therefore, Fig.2 shows the equivalent electrical circuit describing the interconnection system including the KC200GT panel, the DC-DC boost converter and the resistive load.



The small-signal principle is applied for the linearization step of the preceding nonlinear state-space representation. This aim is achieved through applying some steps, described in [13]. Fig.2. Interconnection system including the KC200GT panel, DC-DC boost converter and the resistive load

From Fig.2, the power required to supply the resistive load is highly dependent on the proper voltage regulation that is provided by the switch (transistor) control of the DC-DC boost converter. Here, the appropriate voltage PID controller must be provided the optimal duty cycle control which then send as a Pulse Width Modulation PWM signal having the prefixed frequency f . As a result, the controller-synthesis of desired controller requires a prior linear model that associates the output PV voltage V_{pv} with the input control d . Accordingly, the corresponding nonlinear state-space representation is given by [13]

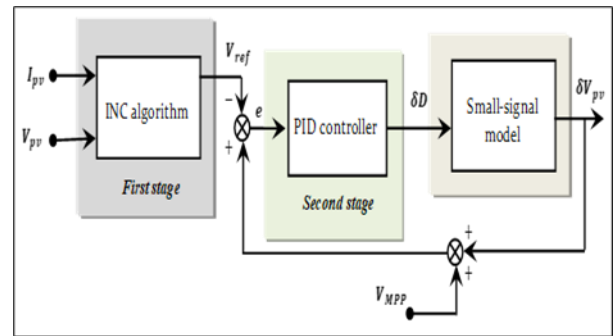
$$\begin{aligned} \dot{V}_{pv} &= \frac{1}{C_1} \cdot I_{PV} - \frac{1}{C_1} \cdot I_L \\ I_L &= \frac{1}{L} \cdot V_{pv} - \left(\frac{1-d}{L}\right) \cdot V_{out} \\ \dot{V}_{out} &= \left(\frac{1-d}{C_2}\right) \cdot I_L - \frac{1}{R \cdot C_2} \cdot V_{out} \end{aligned} \quad (2)$$

Therefore, the resulting linear state-space representation is given by

$$\begin{bmatrix} \delta V_{pv} \\ \delta I_L \\ \delta V_{out} \end{bmatrix} = \begin{bmatrix} -\frac{1}{R_{eq} C_1} & -\frac{1}{C_1} & 0 \\ \frac{1}{L} & 0 & \frac{1-D_{MPP}}{L} \\ 0 & \frac{1-D_{MPP}}{C_2} & -\frac{1}{R C_2} \end{bmatrix} \begin{bmatrix} \delta V_{pv} \\ \delta I_L \\ \delta V_{out} \end{bmatrix} + \begin{pmatrix} 0 \\ -\frac{V_{outMPP}}{L} \\ -\frac{I_{LMPP}}{C_2} \end{pmatrix} \delta d \quad (3)$$

4. Synthesis of voltage PID controller

The indirect implementation of the previous control strategy, which brings out the new improved INC-MPPT control one, is realized in two different steps. In the first step, the INC algorithm will be adapted, in which the reference voltage V_{ref} is computed using the existing PV voltage and PV power. This last is compared by the actual PV voltage, providing the voltage error in each sampling time. This error must be minimized in the second stage by the synthesized PID controller whose parameters are designed through the linear small-signal model that is given by ‘(3)’. The general scheme of the improved control strategy is shown in Fig.3 as below



According to Fig.3, it is clear to see that the reference voltage is generated according to the following modified flow-chart, described in Fig.4 as below

Fig.3. General scheme of the improved INC – MPPT control strategy

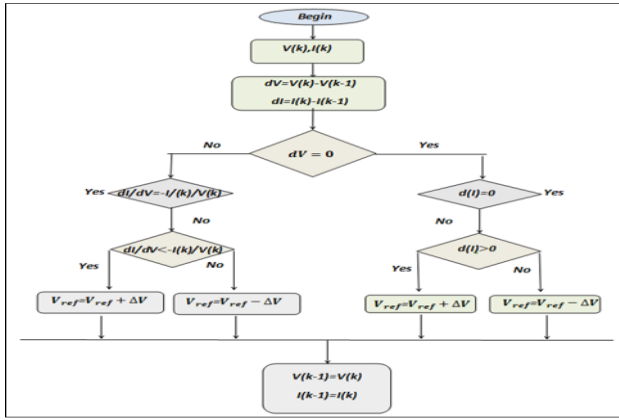


Fig.4. Modified flow-chart used to generate the reference voltage in the improved INC-MPPT control strategy

5. Results and Discussion

To demonstrate the effectiveness of the improved INC-MPPT control strategy, the package of MATLAB®/SIMULINK is used. Here, the solar system parameters are summarized in TABLE.I Indeed, The transfer function describing the small-signal model is computed using ‘(3)’. This last associate the duty cycle input variation with the PV voltage output . It is given by

$$F(s) = \frac{1.6827e08 (s+3.333)}{(s+1.835) (s^2 + 63.84s + 5.334e06)} \tag{4}$$

Starting from the preceding transfer function, the synthesis step of the voltage PID controller is performed using the PidTuner function of MATLAB® software. Hence, the tuning parameters are performed using the time domain specification, whose setting parameters are given by

- Response time : $1.008 \cdot 10^{-3}$
- Transient behavior : 0.5
- PID structure:PIDF
- PID formParallel

The resulting transfer function $K_{PID}(s)$ is given by

$$K_{PID}(s) = 0.0103 + \frac{5.207}{s} + \frac{2.002 \times 10^{-5}s}{1 + 1.65 \times 10^{-6}s} \tag{5}$$

Table 1.Solar system parameters used in simulation result

	Parameter	Value	Unit
KC200GT panel	I_0	9.825×10^{-8}	A
	I_{sc}	8.214	A
	V_{oc}	32.9	V
	a	1.3	-
	R_p	415.405	Ω
	R_s	0.221	Ω
	N_c	54	-
	N_s	1	-
	N_p	1	-
	Simplified circuit	V_{eq}	51.597
R_{eq}		3.3242	Ω
PV Parameters given at MPP	V_{MPP}	26.3	V
	V_{outMPP}	316.34	V
	I_{MPP}	7.61	A
	D_{MPP}	0.91686	-
DC – DC boost converter	L	0.4	mH
	C_1	4700	μF
	C_2	1200	μF
Resistive load	R	500	Ω

The Power-Voltage, i.e., (P-V) characteristic of the KC200GT panel is shown in Fig.5 for some varying solar irradiances and absolute temperature. Therefore, it is clear to see that the maximum power at Standard Test Condition STC (i.e., $T=25^\circ C$ and $G=1000W/m^2$) is equal to $P_{max}=200.1 W$, which is supplied at the PV voltage $V_{MPP}=26.3 V$. This peak power is reduced as a function of the reduction, especially of the solar irradiance value. Indeed, the main target is to design the voltage PID controller, by which the dynamic MPP should be well kept up despite any change in the climatic conditions. To verify the controller performances, the preceding two climatic conditions are chosen according the profile given

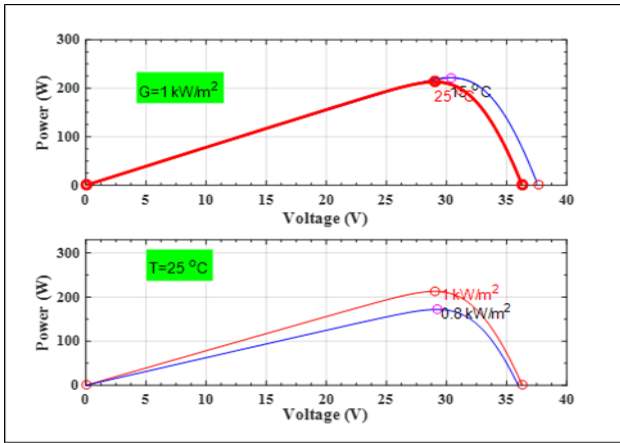


Fig.5. ($P - V$) characteristic of KC200GT panel

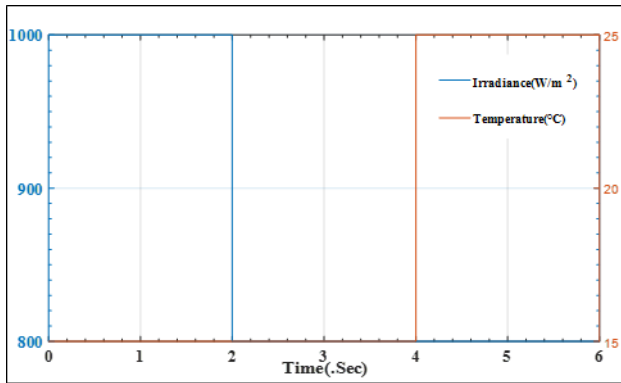


Fig.6. Irradiance and temperature variation

As a result, the tracking dynamic of the reference voltage, vided by the modified INC algorithm, for the improved INC-MPPT control strategy is given by Fig.7 as below

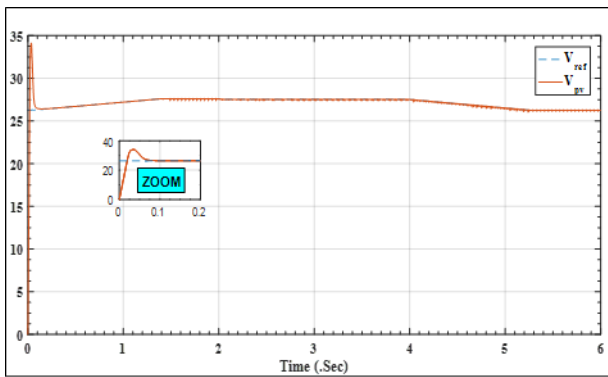


Fig.7. Reference and PV voltages describing the voltage tracking behavior

According to Fig.7, it can be seen that the proposed voltage PID controller is able to track the reference voltage that is previously imposed by the modified INC algorithm. The dynamics in question is characterized in transient-state by a fast rise time and a very acceptable settling time. It also characterized in steady-state by a reduced tracking error. These good dynamic characterizations certainly allow providing the maximum PV power which is shown in Fig.8 as follows

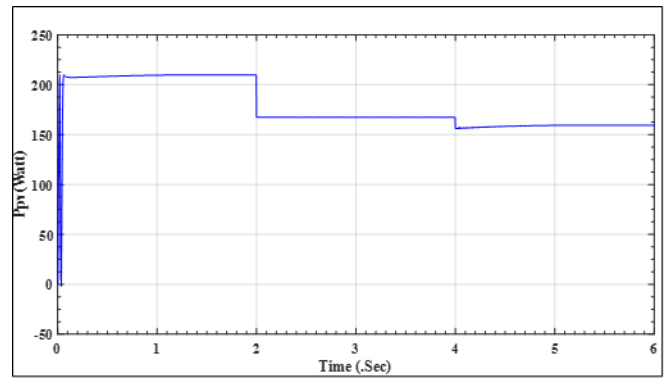


Fig.8. Power output response used to feed the varying climatic conditions

From Figs. 6 and 8, it is clear that the change in PV power response depends heavily on the change in solar irradiance, so they have the same pattern. However, the effect of absolute temperature on the PV power response is slightly more important compared to the effect of solar irradiance. Finally, Obtaining a smooth maximum power response confirms that the ripple problem in the neighbourhood of the MPP is completely avoided, leading to achieve the main target of the proposed control strategy. This last point is achieved by providing the duty cycle control as well as its variation, which are given together in Fig.9 as below

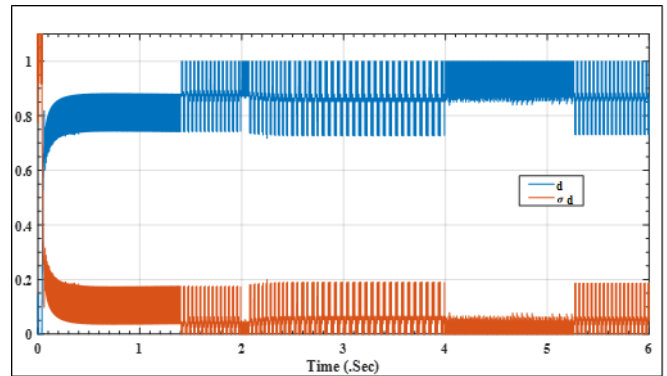


Fig.9. Duty cycle control and the corresponding variation

From Fig. 9, the resulting optimal duty cycle control always varies in the range $0 < D < 1$. This confirms the feasibility of the proposed control strategy, as this fluctuation range allows increasing the PV voltage of the $KC200GT$ panel from $V_{PV} = 26.3V$ to $V_{out} = 316.34W$ at STC .

6. Conclusions and Recommendations

The improved $INC-MPPT$ control strategy was applied to monitor the solar system based on the $KC200GT$ panel. The corresponding MPP tracking was achieved by performing two separate steps. First, the INC algorithm has previously modified to generate the optimal reference voltage where the existing solar irradiance and absolute temperature are examined. Afterward, the actual solar behavior was modeled by the linear small-signal model, by which the desired voltage PID was synthesized. The simulation results given by the resulting new control strategy have confirmed its efficiency in terms of the tracking dynamic of the reference voltage, the form of the power output and closed loop robustness against the sudden change in atmospheric conditions.

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Robust and accurate photoelectric system model design using the small-signal principle

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Abstract

Due to the importance of modeling and the urgent need for it in various applications, the design of an accurate model that simulates and is compatible with the real system to carry out various studies correctly, this has become a great challenge for researchers. Therefore, this research proposes the design of a mathematical model using the method of the small signal of the photovoltaic system consisting of the photovoltaic panel KC200GT feeding the load Through a DC-DC converter. This modeling method converts the mathematical model of the DC-DC converter from nonlinear behavior to linear behavior given in the state space formula, then the application of the Laplace transform will be used to obtain the transfer function. The latter is used in the studies to design the MPP controller. The simulation results showed that the modeling method based on the small signal method enables us to obtain an efficient and accurate model that is compatible with the real system and shows this compatibility in the voltage and energy between them.

Keywords: PV panel; DC-DC Boost converter; Maximum Power Point Tracking MPPT; small-signal.

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1. Introduction

The very negative impact of fossil fuels and their derivatives on all living organisms and on the environment has pushed researchers to find an alternative to them, namely renewable and natural energies, which are pure and economical, the most important of which is solar energy. It is operated with the help of a photovoltaic device consisting of its photovoltaic cells which have the ability to convert sunlight directly into electricity, a DC-DC step-up power converter, and a resistive load; The main objective is as follows: despite the change of weather (temperature and lighting), the output voltage of the load must be maintained at a constant value. This can be achieved by fabricating an MPPT maximum power point tracking controller, which uses the voltage and current generated by the PV system to provide the optimal α^* cycle feeding the DC-DC converter. The design of a powerful MPP controller requires the use of an accurate linear model that accurately describes the behavior of the photovoltaic cell, so the behavior of the latter must be converted from non-linear to linear around the balance point, and given the importance of the process of modeling photovoltaic systems and the urgent need to design models that accurately simulate real systems prompt researchers to conduct research And several studies, including: Almeida et al. (2017) a comparative study of PV predictions using parametric and non-parametric PV models, where parametric modeling considers the PV system as a white box where each subsystem or component is modeled using a set of physical parameters and equations. While nonparametric modeling considers the PV system as a black box, assuming there is no information about the internal properties and processes of the PV system. Using a historical time series of inputs and outputs, the behavior of the photovoltaic system is estimated [1]; Wang Qiu (2020) et al. proposed a modeling method based on matrix variables for a distributed grid-connected PV system. The central idea of the modeling method is to simplify the complex model containing many PV-DCO generating units and turn it into an average two-unit model.

In this paper, the modeling process is done using the small signal method, which is an easy method that enables us to obtain an accurate model. The simulation results showed that the obtained model is consistent with the real system.

This paper is organized as follows. In the first section, the introduction is given, and then in the second section it is about photovoltaic modeling. In Section 3, the photovoltaic system is modeled using the small-signal principle. In Section 4, the photovoltaic system was validated using Matlab®/Simulink software. Finally, conclusions are drawn in Section 6.

2. Modeling of solar cells and electrical characteristics of the PV module

The electric cell can be represented by the electric model shown below

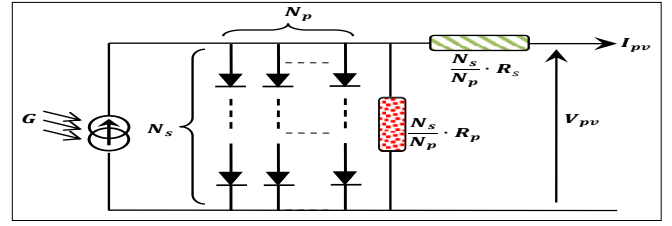


Fig. 1. Equivalent electrical circuit of the PV panel model

The $i \times v$ characteristic equation describing the single-diode model is shown in Fig. 1:

$$I_{pv} = N_p I_{ph} - N_p I_0 \left[\exp \left(\frac{\frac{V_{pv}}{N_s} + \frac{R_s I_{pv}}{N_p}}{a V_t} \right) - 1 \right] - \frac{N_p V_{pv} + R_s I_{pv}}{R_p} \quad (1)$$

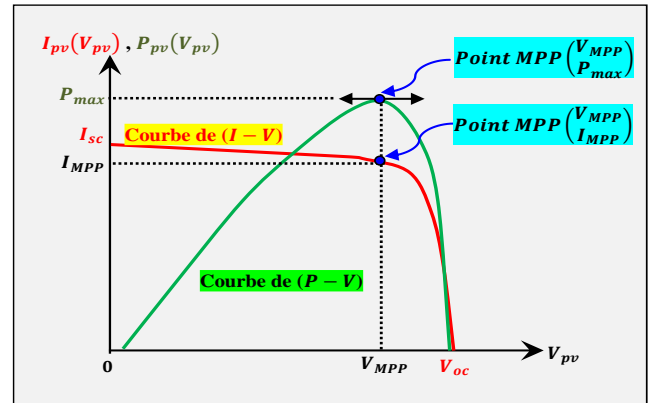


Fig. 2. Nonlinear $i \times v$ characteristic of the KC200GT solar panel and linear MPP equivalent model

Where T is the temperature of the PV cells constant, R_s is the equivalent series resistance, q is the electronic charge and k is the Boltzmann, $V_t = N_c k T / q$ is the thermal voltage, N_c is the number of cells connected in series, N_s and N_p are series and parallel string respectively, I_{pv} and I_0 are the photovoltaic (PV) currents and saturation, a is the ideality constant of the diode, R_p is the equivalent shunt resistance.

This equation is at the origin of the I-V curve of figure 2, we note the points of interest which are the maximum power P-mpp, the voltage V-mpp at the maximum point, the current I-mpp at the maximum point.

We derive the non-linear curve at the point MPP, the photovoltaic panel becomes linear, i.e. the nominal curve $i \times v$ becomes linear, when differentiating we get:

$$g(V_{MPP}, I_{MPP}) = -\frac{N_p I_0}{N_s a V_t} \exp \left(\frac{V_{MPP}}{N_s a V_t} + \frac{R_s I_{MPP}}{N_p a V_t} \right) - \frac{N_p}{N_s R_p} \quad (2)$$

The linear model obtained at the linear point is represented by the tangent of the curve $i \times v$:

$$I_{pv} = gV_{pv} + (I_{MPP} - gV_{MPP}) \quad (3)$$

At the MPP point we represent PV in the equivalent circuit FIG 3 The constituent elements of R_{eq} and V_{MPP} :

$$R_{eq} = -\frac{1}{g}, V_{eq} = V_{MPP} + R_{eq} I_{MPP} \quad (4)$$

Figure 3 represents the photovoltaic generator circuit at the linear point (V, I). At this point, we get the weak signal pattern. It is desirable that the operating point should always be near the maximum point MPP, no matter how the climatic conditions change, so a controller must be designed to ensure the optimum work of the photovoltaic system

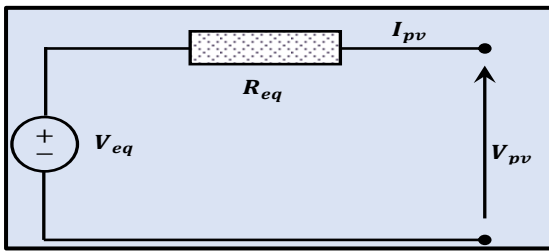


Fig. 3. Linear equivalent circuit valid for point linearization

The performance of a solar PV system depends on climatic conditions: Irradiation and temperature (ambient temperature) (Garcia, O., and others 2013).

The characteristics of photovoltaic cells change with weather conditions, temperature and solar radiation

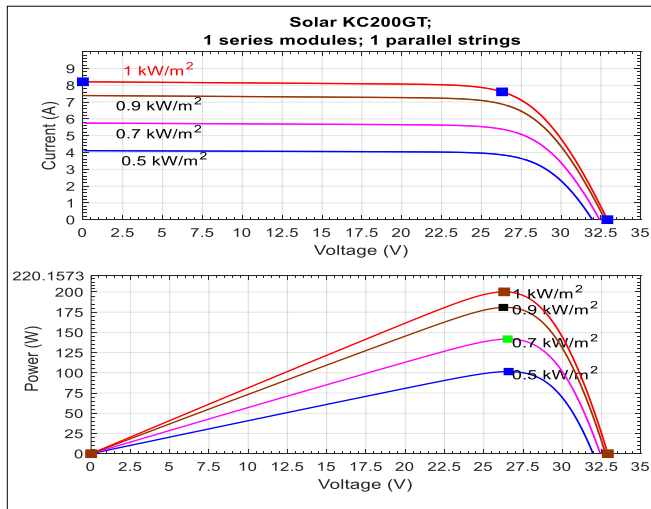


Fig.4. Characteristics (I-V) and (P-V) for variable G and $T_n=25^\circ\text{C}$

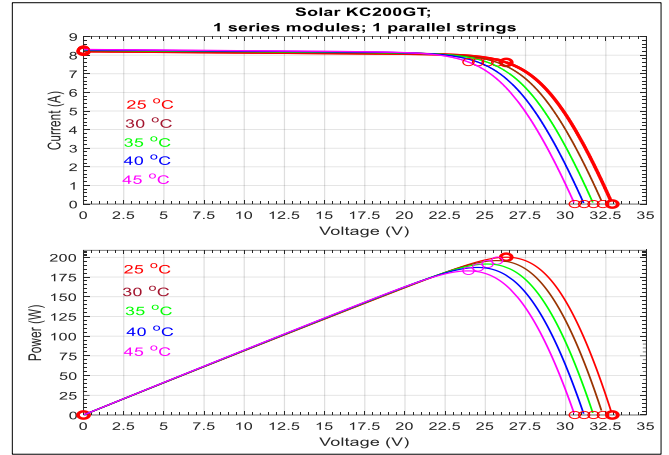


Fig.5. Characteristics (I-V) and (P-V) for variable T and $G_n=1000\text{W}\cdot\text{m}^{-2}$

3. Modeling of global solar system

In general, most real-world applications require more power than the one generated by the basic KC200GT panel. Therefore, the introduction of the DC-DC boost converter becomes essential between it and the electrical device to be powered. Therefore, Fig.2 shows the equivalent electrical circuit describing the interconnection system including the KC200GT panel, the DC-DC boost converter and the resistive load.

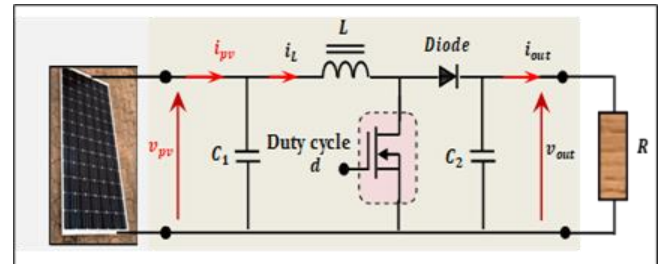


Fig.6. Interconnection system including the PV, DC-DC boost and the resistive load

According to Fig.6, it is easy to determine the nonlinear state space representation of the global MPPT scheme as below

$$\begin{aligned} \frac{d}{dt} v_{pv}(t) &= \frac{1}{C_1} i_{pv}(t) - \frac{1}{C_1} i_L(t) \\ \frac{d}{dt} i_L(t) &= \frac{1}{L} v_{pv}(t) - \frac{1-d}{L} v_{out}(t) \\ \frac{d}{dt} v_{out}(t) &= \frac{1-d}{C_2} i_L(t) - \frac{1}{RC_2} v_{out}(t) \end{aligned} \quad (5)$$

When calculating the small-signal model from a state-to-state representation, given by Eq.5 even if the switching harmonics of the Boost DC-DC converter are removed, the averaged model result is still non-linear. It is therefore necessary to apply the principle of small signals according to the following steps:

State vector and variable inputs are defined for the global model.

- the operating point around which the linearization must be carried out are defined, ie the MPP supplied to STC.

•Disturbances, that is to say small variations, are introduced into all the inputs of the model, which leads to disturbances in all the state variables of the global model.

• The high frequency terms, the continuous and nonlinear terms are removed and only the disturbed components are kept. As a consequence, the average representation of the state space of the global model is given by considering only these perturbed components. It is important to mention that the perturbation applied to each state variable is given as follows:

$$\begin{aligned} V_{pv}(t) &= V_{pvMPP} + \delta V_{pv}(t) \\ i_L(t) &= I_{LMPP} + \delta i_L(t) \\ V_{out}(t) &= V_{outMPP} + \delta V_{out}(t) \\ d(t) &= D_{MPP} - \delta d(t) \\ i_{pv}(t) &= I_{MPP} + \delta i_{pv}(t) \end{aligned} \quad (6)$$

Where the sigma variable i.e. $\delta x(t)$ is the disturbance value added to the constant steady state value X_{MPP} of the state variable $X(t)$

$$\begin{aligned} \frac{d}{dt}(V_{MPP} + \delta V_{pv}) &= \frac{1}{C_1}(I_{MPP} + \delta i_{pv}) - \frac{1}{C_1}(I_{LMPP} + \delta i_L) \\ \frac{d}{dt}(I_{LMPP} + \delta i_L) &= \frac{1}{L}(V_{MPP} + \delta V_{pv}) - \frac{1-(D_{MPP}+\delta d)}{L}(V_{outMPP} + \delta V_{out}) \\ \frac{d}{dt}(V_{outMPP} + \delta V_{out}) &= \frac{1-(D_{MPP}+\delta d)}{C_2}(I_{LMPP} + \delta i_L) - \frac{1}{R.C_2}(V_{outMPP} + \delta V_{out}) \end{aligned} \quad (7)$$

We eliminate the constant values and obtain the linear state-space representation of the photovoltaic system

$$\begin{bmatrix} \frac{d}{dt} \delta v_{pv}(t) \\ \frac{d}{dt} \delta i_L(t) \\ \frac{d}{dt} \delta v_{out}(t) \end{bmatrix} = \begin{bmatrix} -\frac{1}{R_{eq}C_1} & -\frac{1}{C_1} & 0 \\ \frac{1}{L} & 0 & \frac{1-D_{MPP}}{L} \\ 0 & \frac{1-D_{MPP}}{C_2} & -\frac{1}{RC_2} \end{bmatrix} \begin{bmatrix} \delta V_{pv}(t) \\ \delta i_L(t) \\ \delta V_{out}(t) \end{bmatrix} + \begin{bmatrix} 0 \\ -\frac{V_{outMPP}}{L} \\ \frac{I_{LMPP}}{C_2} \end{bmatrix} \delta d(t) \quad (8)$$

We apply the Laplace transform using the values given in the following data table we find the following transfer function $G(s)$:

$$G(s) = \frac{1.683e08.s + 5.609e08}{s^3 + 65.67s^2 + 5.464e05.s + 1.808e06} \quad (9)$$

4. Simulation results and discussion Validation of the photovoltaic system model based on the small signal principle Using Matlab®/Simulink Software

Table 1. system data

	Parameter	Value	Unit
KC200GT panel	I_0	9.825×10^{-8}	A
	I_{sc}	8.214	A
	V_{oc}	32.9	V
	a	1.3	-
	R_p	415.405	Ω
	R_s	0.221	Ω
	N_c	54	-
	N_s	1	-
	N_p	1	-
	Simplified circuit	V_{eq}	51.597
R_{eq}		3.3242	Ω
PV Parameters given at MPP	V_{MPP}	26.3	V
	V_{outMPP}	316.34	V
	I_{MPP}	7.61	A
	D_{MPP}	0.91686	-
DC – DC boost converter	L	0.4	mH
	C_1	4700	μF
	C_2	1200	μF
Resistive load	R	500	Ω

Using the transfer function and MATLAB, we find photovoltaic system Bode Diagram:

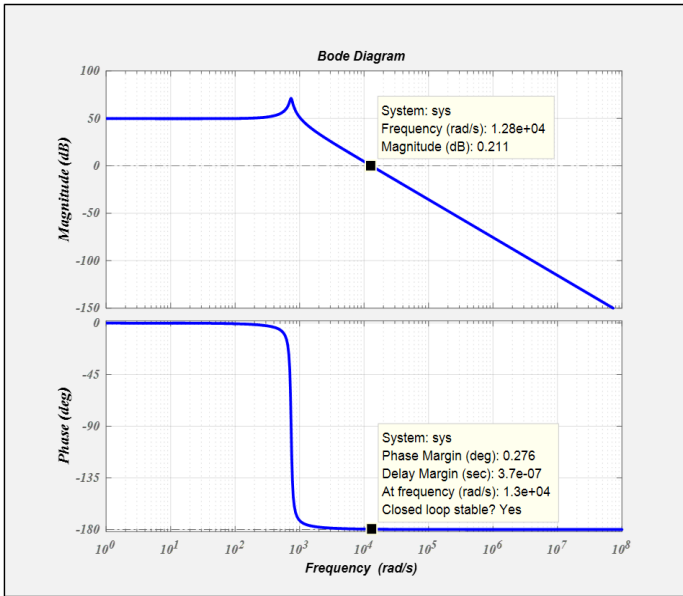


Fig7.Boost Converter Bode Diagram

$$K_p = 0.002607$$

$$K_i = 8.15 \quad (10)$$

$$K_d = 2.082 \times 10^{-5}$$

The obtained linear model is verified with matlab; Figure 8 shows the output voltages of the real system V_{real} and the output voltages of the model V_{mod} based on the principle of the small signal that is modeled in this paper for the photovoltaic system consisting of a photovoltaic panel KC200GT, a Boost DC-DC converter - and a resistive load.

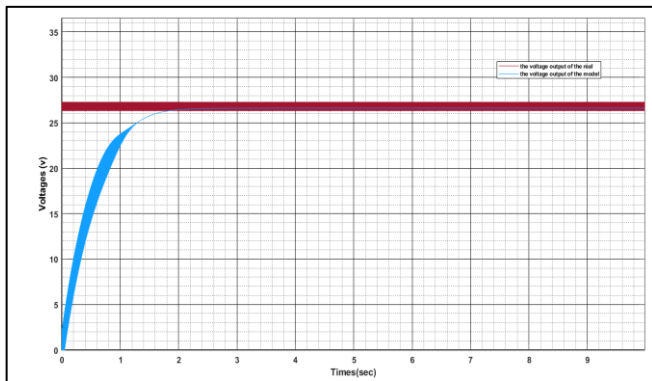


Fig.8.shows the output voltages of the real system V_{real} and the output voltages of the model V_{mod} based on the principle of the small signal

The obtained linear model is verified with matlab; Figure 9 shows the output power of the real system P_{real} and the output power of the model P_{mod} based on the principle of the small signal that is modeled in this paper for the photovoltaic system consisting of a photovoltaic panel KC200GT, a Boost DC-DC converter - and a resistive load.

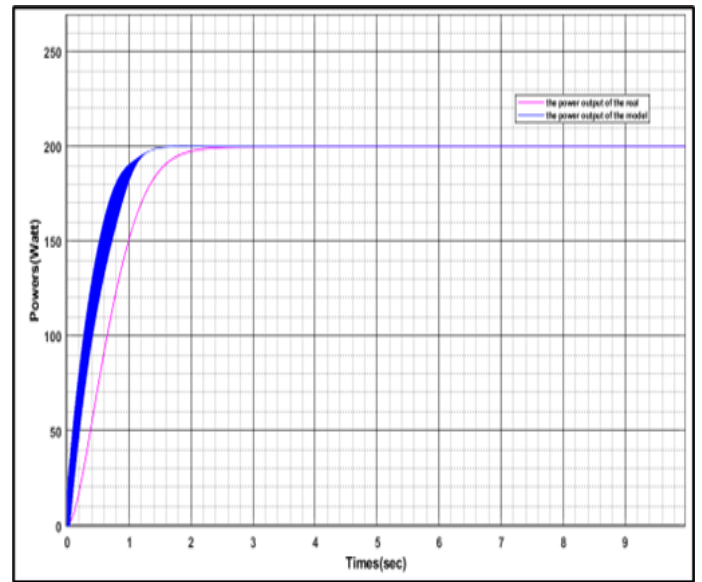


Fig.9.shows the output power of the real system P_{real} and the output power of the model P_{mod}

Simulation results show that the voltage and power produced by the model based on the small signal model, which has been modeled in this paper, are almost equal to the voltage and power produced by the real system.

5. Conclusions and Recommendations

In this paper, the principle of small-signal modeling of the photovoltaic system consisting of the KC200GT photovoltaic panel feeding the Boost DC-DC converter and converting the nonlinear behavior of the system into a linear behavior near the equilibrium point is studied and discussed; We obtain a model that is more accurate and compatible with the real system than other modeling methods, and this is shown by the simulation results. This linear model will be used later in designing an effective MPP controller that guarantees good and excellent tracking dynamics for MPP.

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Sıvı Gereksinimi Uygulamalarına Yönelik İnovatif Ürünler

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Öz

İnovatif ürün örnekleri günlük hayatımızda her alanda sıklıkla karşımıza çıkmaktadır. Bu alanlardan biri de sağlık sektörüdür. Sağlık sektöründe geliştirilen inovatif ürünler, hasta bakımına yönelik olan uygulamalarda hem bakımın kalitesini hem de hasta memnuniyetini artırmaktadır. Diğer yandan sağlık çalışanlarının iş yükünü de azaltmaktadır. Dolayısıyla bu inovatif ürünler oldukça önemli bir yere sahiptir. Bu araştırma, sıvı gereksinimi uygulamalarına yönelik inovatif ürün örneklerini ortaya koymayı amaçlamıştır. Bu doğrultuda Türk Patent ve Marka Kurumu'nun resmi sayfasında buluş özeti kısmına "hasta" kelimesi yazılarak patent ve faydalı model sonuçları elde edilmiştir. Türk Patent ve Marka Kurumu'nun resmi sayfasında başvuru süreci tamamlanmış ya da devam eden birçok patent ve faydalı model örneği yer almakta olup bu metinde son 5 yılı kapsayan sıvı gereksinimi uygulamaları ile ilgili patent ve faydalı model sonuçlarına yer verilmiştir. Patent örnekleri arasında "Yeni Tip Santral Venöz Kateter", "Güvenli Hasta El Sabiti", "Kateterizasyon Sabitleme ve Etiketleme Cihazı" ve "Jugüler Venöz Kateter Sabitleyici Pansuman Aparatı" yer almaktadır. Faydalı model örneği olarak "Bir Medikal Serum Askılığı" ele alınmıştır. Sonuç olarak, sıvı gereksinimi uygulamalarına yönelik geliştirilen bu inovatif ürünler, hastanın bakım ve tedavisinde sağlık çalışanlarına kolaylık sağlayacaktır. Özellikle geliştirilen bu ürünlerin takip edilmesi, kullanılması ve çıktılarının diğer kullanıcılarla paylaşılması bu ürünlerin sayılarının artmasına ve kullanımlarının yaygınlaşmasına yol açacaktır.

Anahtar Kelimeler: Bakım, Faydalı model, Hasta, İnovatif ürün, Patent, Sıvı gereksinimi

Innovative Products For Fluid Requirements

Abstract

Innovative product examples are frequently encountered in every field in our daily life. One of these areas is the health sector. Innovative products developed in the health sector increase both the quality of care and patient satisfaction in patient care applications. On the other hand, it also reduces the workload of health workers. Therefore, these innovative products have a very important place. This research aimed to reveal innovative product examples for fluid requirement applications. In this direction, patent and utility model results were obtained by writing the word "patient" in the invention summary section on the official page of the Turkish Patent and Trademark Office. On the official page of the Turkish Patent and Trademark Office, there are many examples of patents and utility models whose application process has been completed or ongoing, and this text includes patent and utility model results related to fluid requirement applications covering the last 5 years. Examples of patents include "New Type Central Venous Catheter", "Safe Patient Hand Constant", "Catheterization Fixation and Labeling Device" and "Jugular Venous Catheter Stabilizing Dressing Apparatus". As an example of a utility model, "A Medical Serum Hanger" is discussed. As a result, these innovative products developed for fluid requirement applications will provide convenience to healthcare professionals in the care and treatment of patients. Following, using and sharing the outputs of these developed products with other users will lead to an increase in the number of these products and their widespread use.

Keywords: Care, Fluid requirement, İnnovative product, Patent, Patient, Utility model

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1. Giriş

Günümüzde teknolojik gelişmelere bağlı sağlık sektöründe değişim ve dönüşüm kaçınılmazdır (Barış Eren, 2021). Geliştirilen inovatif ürünler sağlık alanında bakımı destekleyerek bakımın kalitesini artırmaktadır. Aynı zamanda hasta memnuniyetini olumlu yönde etkilemektedir (Barış Eren, 2022; Orhan, 2022; Sevil ve Demirel Bozkurt, 2018). Bu alanda büyük yatırımlar yapılmakta olup bu teknolojiler sağlık bakım alanına birçok yenilik getirmektedir (Donel, 2018; Kalis ve ark., 2018; McGrow, 2019). Bu yenilik alanlarından biri de sıvı gereksinimi uygulamalarıdır.

Sıvı gereksinimi, hastanın vücudundaki sıvı dengesini sürdürmesi için ihtiyacı olan sıvı miktarıdır. Temel hemşirelik becerilerinden biri olan sıvı gereksinimi uygulamaları aşağıda yer almaktadır. Bunlar:

1. İntravenöz (damar içi) kateter uygulaması
2. İntravenöz sıvı tedavisini başlatma
3. İntravenöz solüsyon torbasını/şişesini değiştirme
4. İntravenöz sıvı seti portundan bolus/puşe yolu ile ilaç uygulama
5. İntravenöz kateterden/üç yollu musluktan bolus/puşe yolu ile ilaç uygulama
6. İntravenöz kateterin çıkarılması
7. Venöz kan örneği alma (Göçmen Baykara ve ark., 2019; Özaras Öz, 2021).

Yaşamın sürdürülmesi ve hücre fonksiyonlarının devamlılığı, vücut sıvılarının dengeli olmasına bağlıdır. Vücudumuzun en temel bileşeni olan su, vücut ağırlığının %60'ını oluştururken vücut sıvılarının ise %90-95'ini oluşturur. Bu oran cinsiyet, yaş ve vücuttaki yağ oranı gibi çeşitli faktörlere bağlı değişiklik gösterebilir. Hayati bir öneme sahip olan su; besinlerin, elektrolit ve gazların taşınmasını sağlar. Besinlerin sindirimi ve boşaltımında rol alır. Eklemleri ve membranları nemlendirir. Ayrıca vücut ısısının düzenlenmesini sağlar (Bayraktar ve Faydalı, 2017; Ören, 2008).

Günlük hayatta vücuda alınan ve atılan sıvı miktarı dengelidir, birbirine eşittir. Bu durum hemostatik mekanizma ile sağlanır (Ören, 2008). Eğer bireyin aldığı sıvı miktarı çıkardığına göre daha fazla ise sıvı volüm fazlalığı, aksine çıkardığı sıvı aldığına göre daha fazla ise dehidratasyon gibi sıvı volüm eksikliği geliştiği düşünülür (Enç, 2015). Birey, sıvı elektrolit gereksinimini ağız yoluyla karşılayamadığı ya da karşılayamama riski olduğunda doğrudan damar yoluyla (ven) çeşitli solüsyonlar kan dolaşımına verilerek günlük sıvı gereksinimi karşılanır ve aynı zamanda sıvı elektrolit dengesinin sürekliliği korunur (Uzelli Yılmaz, 2021). Dolayısı ile hemşireler aldığı çıkardığı sıvı takibini dikkatli bir şekilde düzenli olarak yapmalıdır. Gerektiğinde bireyin vücudundaki sıvı dengesini sağlayacak girişimlerde bulunmalıdır. Bunları yaparken yeterli bilgi ve beceriye sahip olmaları gerekir (Kestel, 2020; Koçhan ve Akın, 2018; Uzelli Yılmaz, 2021). Buna ek olarak sıvı gereksinimi uygulamalarına yönelik ilgili teknoloji bilgisine de sahip olmalıdırlar (Barış Eren, 2021; Kartal ve Kantek, 2018; Orhan, 2022; Sevil ve Demirel Bozkurt, 2018; Uzelli Yılmaz, 2021). Bu

çerçevede sıvı gereksinimi uygulamalarına yönelik inovatif ürün örnekleri ele alınmıştır.

2. Materyal ve Metot

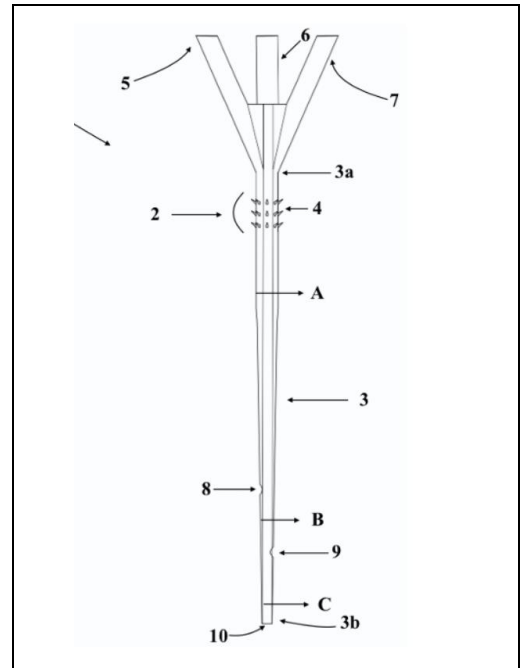
Tablo 1'de 02.09.2022 tarihinde Türk Patent ve Marka Kurumu'nun resmi sayfasında buluş özeti kısmına "hasta" kelimesi yazılarak son 5 yılı kapsayan sıvı gereksinimine yönelik faydalı model ve patent sonuçlarına ulaşılmıştır (<https://www.turkpatent.gov.tr/>). Bunların başvuru süreci devam etmekte olup Türk Patent ve Marka Kurumu sayfasında henüz tescil tarihleri yoktur.

3. Sıvı Gereksinimine Yönelik Patent ve Faydalı Model Örnekleri

3.1. Yeni Tip Santral Venöz Kateter

Periferik ve santral kateter takılarak damar yolu ile hastaya çeşitli solüsyonlar verilir. Ayrıca bazı ilaç uygulamaları da bu yolla yapılır. Yeterli beslenemeyen hastalar da damar yolundan beslenir. Bunun için takılan kateterin damar içinde sabit kalması dolayısıyla uygun şekilde tespit edilmesi/sabitlenmesi gerekir.

Bu yeni tip santral kateter, tırtıklı alana sahiptir ve kateterin kullanımı sırasında bu alan cilt altında kalır. Bu tırtıklar sayesinde cilt ile santral venöz kateter arasında bariyer oluşturmakta ve enfeksiyona neden olan mikroorganizmaların vücuda girmesini engellemektedir. Kateter, bunu iki yolla gerçekleştirir. İlk olarak hasarlanan dokuda iyileşme sürecinde oluşan granülasyon dokusunun oluşum süresini kısaltır. Granülasyon dokusu; bakterilerin geçişine karşı bariyer görevi görerek geçişi azaltır. İkincil olarak ise kateterin tırtıklı alanı cilt altında kateterin sabit kalmasını sağlayarak dışarı çıkmasını engeller. Dolayısıyla kateterin hareketi ile cilt altına bakteri girişi engellenir. Bununla birlikte tırtıklı alan sayesinde cilt altında hareketsiz kalan kateterin dikilme gereksinimi ve yerinden çıkma endişesi de ortadan kalkar (Şekil 1).



Şekil 1. Yeni Tip Santral Venöz Kateter

Tablo 1. Patent ve Faydalı Model Örnekleri

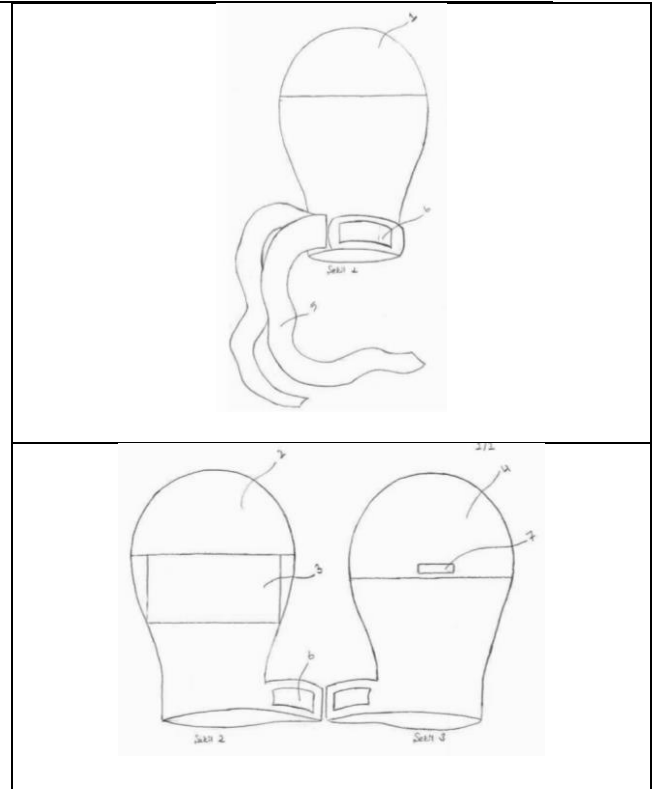
Buluş Başlığı	Başvuru Tarihi	Koruma Tipi	Buluş Sahipleri
Yeni Tip Santral Venöz Kateter	25.12.2018	Patent	Yahya Yıldız
Güvenli Hasta El Sabiti	11.10.2021		Şehri Bozkurt Elif İnci Keskin
Kateterizasyon Sabitleme ve Etiketleme Cihazı	09.12.2021		Serap Güngör Nursemin Ünal Ezgi Dirgar Nursemin Ünal
Jugüler Venöz Kateter Sabitleyici Pansuman Aparatı	13.12.2021		Melis Alkışla Bediye Öztaş Demet Bal Gamze Acavut Nursemin Ünal
Bir Medikal Serum Askılığı	28.02.2022	Faydalı Model	Eda Balaban Rafet Demirel Osman Özçelik

Patent ve faydalı model örnekleri başvuru tarihine göre sıralanmıştır.

3.2. Güvenli Hasta El Sabiti

Bilinci bulanık olan hastalarda kateterin yerinden çıkma ve hastanın kendine zarar verme riskine karşı kolları yatağa tespit edilir/ sabitlenir. Hastanın düzenli olarak dolaşımı kontrol edilir. Belli aralıklarla tespitler gevşetilerek farklı yerden tekrar sabitlenir.

Bu güvenli hasta el sabiti ile bilinci yerinde olmayan hastaların güvenli bir şekilde tedavi ve bakımı almaları sağlanmaktadır. Özellikle kateteri olan, yoğun bakımda takip edilen hastaların üzerinde yer alan kateterleri ve EKG kablolarını çekmelerini, sondalarını çıkarmalarını ve solunum cihazına bağlı olanların tüplerini çekmelerini önlemek ve hasta güvenliğini sağlamak amacıyla geliştirilmiştir. Parmaksız olarak pamuklu kumaştan üretilen ürünün parmakların uygun pozisyonda kalmasını sağlamak amacıyla el sabit iç yüzeyine avuç içine gelecek şekilde elyaf dolgu yerleştirilmiştir. Hastanın parmaklarının kavrama işlevini engellemek için el sabit altına cep oluşturulmuş, karton yerleştirilmiştir. Parmakların temas ettiği yüzeye baskı yarısı oluşumunu engellemek için sıkıştırılmış elyaf dikilmiştir. Hastanın dolaşımının kontrolü için el sabitin üst parmak ucu kısmı şeffaf kumaştan oluşturulmuştur. El sabitin elden çıkmaması için bilek kısmına cırt cırt dikilmiş olup bir şerit bileğin iç yüzeyine dikilerek yatağa tespit edilmesi planlanmıştır (Şekil 2).



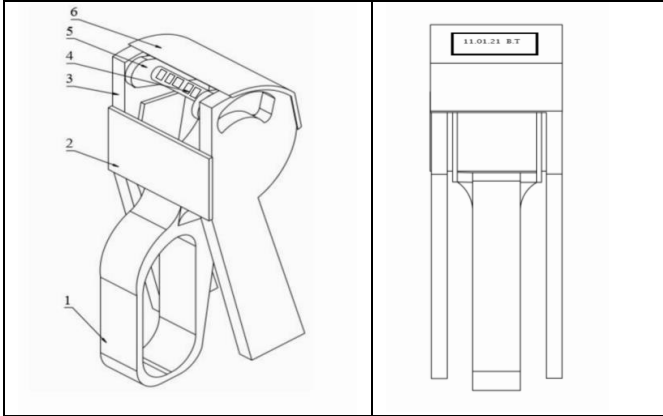
Şekil 2. Güvenli Hasta El Sabiti

3.3. Kateterizasyon Sabitleme ve Etiketleme Cihazı

İntravenöz kateterin yerinden çıkması, damar içinde kalması için tespitinin/sabitlenmesinin güvenli bir şekilde yapılması önemlidir. Ardından kateteri takan ve pansumanı yapan kişinin ad ve soyadının baş harflerini ve tarihi pansuman üzerine yazar.

İntravenöz kateterin damardan çıkması, ilacın cilt altı dokuya sızmasına neden olur. Dolayısıyla intravenöz kateterin damar içinde olup olmadığının kontrol edilmesi gerekir (Kaya ve Palloş, 2019). Kateter bölgesi şişlik, sızıntı, soğukluk ve solukluk yönünden gözlenir (Çevik ve Dedeli Çaydam, 2015).

Bu kateterizasyon sabitleme ve etiketleme cihazı ile çoğu zaman yaşanan bir durum olan kateterizasyon sabitleme işleminde tespit materyalinin eldivene yapışmasının önüne geçilmesi amaçlanmıştır. Normalde tespit işlemi sırasında eldivene yapışan materyal uygulamayı zorlaştırmakta aynı zamanda kateterin yerinden çıkmasına neden olabilmektedir. Dolayısıyla çalışan sağlık personeli eldivensiz işleme devam edebilmekte ve enfeksiyon riski artmaktadır. Bu cihaz ile kateter sabitleme işlemi hijyenik olarak kolaylıkla çalışan tek bir sağlık personeli tarafından kısa sürede yapılabilmektedir. Bunun yanında cihaz, tespiti yapan kişinin ad ve soyadının baş harflerini ve tarihi yazan etiket sunar (Şekil 3).



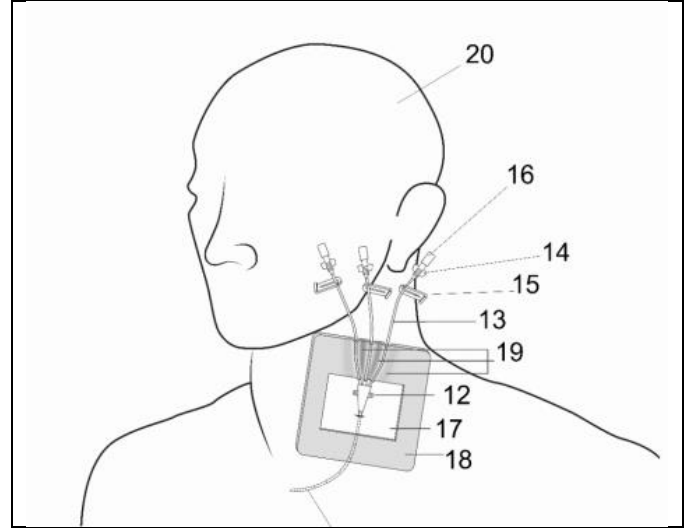
Şekil 3. Kateterizasyon Sabitleme ve Etiketleme Cihazı

3.4. Jugüler Venöz Kateter Sabitleyici Pansuman Aparatı

Kateter pansumanı yapılırken kateter giriş yeri enfeksiyon, kızarıklık, ısı artışı, ağrı ve hassasiyet yönlerinden kontrol edilir. Diğer yandan kateterin pansumanı sırasında kateterin yerinden çıkması gibi istenmeyen durumlar da gelişebilmektedir. Bu konuda gereken özen gösterilmelidir. Kateterin yerinden çıkması durumunda ağrı, damar zedelenmesi, trombus ve enfeksiyon gibi komplikasyonlar gelişebilir. Ayrıca kateter bölgesi şişlik, sızıntı, soğukluk ve solukluk yönünden gözlenir (Çevik ve Dedeli Çaydam, 2015; Kaya ve Palloş, 2019).

Geliştirilen bu jugüler venöz kateter sabitleyici pansuman ile kateterin derinden çıkmasını önlemek amaçlanmıştır. Bu aparat, katetere bağlı lümenlerin sarkmasını önleyen lümen sabitleyici içerir. Ayrıca kateter giriş yerinin gözlenebilmesini sağlayan şeffaf bir bölüm bulundurmaktadır. Pansuman aparatı ise hidrokolloid malzemeden yapılmış olup mevcut kullanılan pansuman malzemelerinden farklıdır. Hidrokolloid malzeme, yara bakım ürünlerinde kullanılmakta olup kateter pansumanında yoktur. Ancak geliştirilen bu pansuman aparatında mevcut olup

hidrokolloid örtünün yapışkan özelliği sayesinde kateteri daha iyi desteklemekte ve sıvı emici özelliği ile bölgenin kuru kalmasını ve enfeksiyona karşı korunmasını sağlar (Şekil 4).

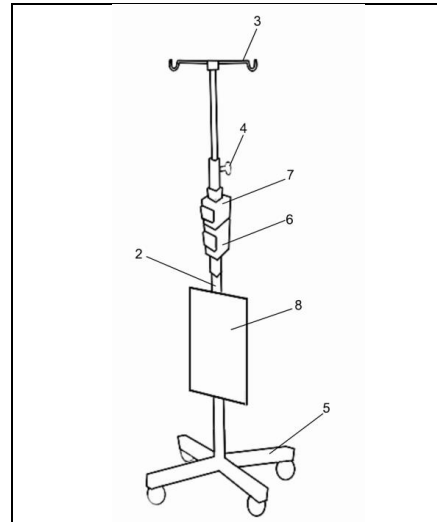


Şekil 4. Jugüler Venöz Kateter Sabitleyici Pansuman Aparatı

3.5. Bir Medikal Serum Askılığı

Sıvı gereksinimi olan bireye damar yolu ile çeşitli solüsyonlar gönderilirken serum askısı kullanılır ve bireyin hareketi kısıtlanır. Hemşire, hastaya sıvının gidip gitmediğini ve gidiş hızını saatlik ya da kurum politikasına göre belli bir aralıkta takip eder (Çevik ve Dedeli Çaydam, 2015). Aynı şekilde hastanın yaşamsal bulgularını belirli aralıklarla alarak kaydeder.

Bu ürün ile solüsyonlara bağlı bireyin bağımlılığı azalacak olup hareketi desteklenmektedir. Bu ürün buton ve elektronik devreden oluşmakta olup wifi ile ihtiyaç halinde hastanın hemşire çağrı sistemine ulaşmasını sağlamaktadır. Hastanın yaşamsal bulguları (ateş, nabız, SPO2) yapay zeka algoritması ile anlık olarak kaydedilmektedir. Hastanın butona basması ile bu yaşamsal bulgular hemşireye iletilmektedir. Ayrıca serum askısında buluna ivme ölçer aracılığıyla serum askısının ivmesi bozulduğunda hemşireye haber verir. Bunun yanında geliştirilen bu serum askısı acil bir durum olduğunda ya da hastanın yorulduğunda oturup dinlenmesini sağlayan bir oturma aparatına sahiptir. Bu durumlar dışında oturma aparatı kapalı olarak serum askısına monte haldedir (Şekil 5).



Şekil 5. Bir Medikal Serum Askılığı

4. Sonuç

Sonuç olarak görülmektedir ki geliştirilen bu inovatif ürünler sıvı gereksinimi olan hastaların tedavi ve bakım süreçlerini olumlu etkileyecektir. Ayrıca geliştirilen bu ürünlerin klinik ortamda kullanımlarının artması ve kullanım çıktılarının paylaşılması önem arz etmektedir. Bir ekip çalışmasını gerektiren sağlık bakım hizmetlerinde çok disiplinli inovatif çalışmaların yapılması önerilir.

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